Project Management

Objectives

By the end of the topic the students should be able to:

- Define the terms *project* and *project management*, and differentiate between project and process management.
- Describe causes of failed information systems and technology projects.
- Describe basic competencies required of project managers.
- Describe basic functions of project management.
- Differentiate between *PERT* and *Gantt* as project management tools.
- Describe role of project management software.
- Describe eight activities in project management.
- Define *joint project planning* and its role in project management.
- Define *scope* and a write a *statement of work* to document scope.
- Use a *work breakdown structure* to decompose a project into tasks.
- Estimate tasks' durations and specify inter-task dependencies.
- Assign resources and produce a project schedule with a Gantt chart.
- Assign people to tasks and direct the team effort.
- Use critical path analysis to adjust schedule and resource allocations in response to schedule and budget deviations.
- Manage user expectations of a project and adjust project scope.

Introduction

- **Project** is a temporary sequence of unique, complex, and connected activities having one goal or purpose and that must be completed by specific time, within budget, and according to specification.
- A system development process or methodology defines a sequence of **activities** mandatory and optional.
- Every system development project is unique· that is, it is different from every other system development project that preceded it.
- The activities that comprise system development are relatively complex. They require skills and they require that you be able to adapt concepts and skills to changing conditions and unanticipated events
- An **activity** or **task** is the smallest unit of work effort within the project and consumes both time and resources which are under the control of the project manager. A project is a sequence of activities that has a definite start and finish, an identifiable goal and an integrated system of complex but interdependent relationships.
- A **schedule** allocates resources to accomplish the activities within a timeframe. The schedule sets priorities, start times and finish times.
- **Project management** is the process of scoping, planning, staffing, organizing, directing, and controlling the development of an acceptable system at a minimum cost within a specified time frame.
- The purpose of project management is to achieve successful project completion with the resources available. A successful project is one which:

- has been finished on time
- is within its cost budget
- performs to a technical/performance standard which satisfies the end user

- For any systems development project, effective project management is necessary to ensure that the project meets deadline, is developed within an acceptable budget and fulfils customer expectations and specifications.
- Project management is a cross cycle activity because it overlaps all phases of any system development methodology.
- **Process management** is the activity of documenting, managing, and continually improving the process of systems development.

Measures of Project Success

A project is considered successful if:

- The resulting information system is acceptable to the customer.
- The system was delivered "on time."
- The system was delivered "within budget."
- The system development process had a minimal impact on ongoing business operations.

Causes of Project Failure

- Not all projects meet the above criteria and as a result, not all projects are successful.
- Failures and limited success far outnumber successful information systems.
- Project mismanagement can undermine the best application of systems analysis and design methods.
- We can develop and appreciate the importance of project management by studying the mistakes of some project managers.
- The major cause of project failure is because most project managers are not educated or trained to be project managers. Being good programmers don't always go on to become good systems analysts, good systems analysts don't automatically perform well as project managers. To be a good project manager, you should be educated and skilled in the "art of project management."
- Causes of project failure include:
  1. Failure to establish upper-management commitment to the project - Sometimes commitment changes during a project.
  2. Lack of organization's commitment to the system development methodology – Many system development methodologies do little more than collect dust.
  3. Taking shortcuts through or around the system development methodology – Project teams often take shortcuts for one or more of the following reasons: − The project gets behind schedule, and the team wants to catch up.
     - The project is over budget, and the team wants to make up costs by skipping steps
     - The team is not trained or skilled in some of the methodology's activities and requirements, so it skips them.
  4. Poor expectations management – All users and managers have expectations of the project. Over time, these expectations may change. This can lead to two undesirable situations:

- Scope creep – the unaccepted growth of user expectations and business requirements for an information system as the project progresses. The schedule and budget can be adversely affected by such changes.
- Feature creep – the uncontrollable addition of technical features to a system under development without regard to schedule or budget.

5. Premature commitment to a fixed budget and schedule – You can rarely make accurate estimates of project costs and schedules before completing a detailed problem analysis or requirement analysis.
6. Poor estimating techniques – Many systems analysts estimate by making a best calculated estimate and then doubling that number. This is not a scientific approach.
7. Over optimism – Systems analysts and project managers tend to be optimists. As project schedules slip, they respond, "No big deal. We can make it up later". They fail to recognize that certain tasks are dependent on other tasks. Because of these dependencies, a schedule slip in one phase or activity will cause corresponding slips in many other phases and activities, thus contributing to cost overruns.
8. The mythical man-month – As the project gets behind schedule, project leaders frequently try to solve the problem by assigning more people to the team. It doesn't work. There is no linear relationship between time and the number of personnel. The addition of personnel usually creates more communication problems, causing the project to get even further behind schedule.
9. Inadequate people management skills – Managers tend to thrust into management positions and are not prepared for management responsibilities. This problem is easy to identify.
    - No one seems to be in charge
    - Customers don't know the status of the project
    - Teams don't meet regularly to discuss and monitor progress
    - Team members don't communicate with one another
    - The project is always said to be 95% complete
10. Failure to adapt to business change – If the project's importance changes during the project, or if the management or the business reorganizes, projects should be reassessed for compatibility with those changes and their importance to the business.
11. Insufficient resources – This could be due to poor estimating or to other priorities, or it could be that the staff resources assigned to a project do not possess the necessary skills or experience.
12. Failure to "manage the plan" – Various factors may cause the project manager to become sidetracked from the original project plan.

Responsibilities of the Project Manager

- Every project has a project manager. **Project manager** is the person responsible for supervising a systems project from initiation to conclusion.
- The responsibilities of a project manager include:

1. To plan thoroughly all aspects of the project, soliciting the active involvement of all functional areas involved, in order to obtain and maintain a realistic plan that satisfies their commitment for performance.
2. To control the organization of manpower needed by the project.
3. To control the basic technical definition of the project, ensuring that "technical" versus "cost" trade-offs determine the specific areas where optimization is necessary.
4. To lead the people and organizations assigned to the project at any given point in time. Strong positive leadership must be exercised in order to keep the many disparate elements moving in the same direction in a co-operative.
5. To monitor performance, costs and efficiency of all elements of the project and the project as a whole, exercising judgement and leadership in determining the causes of problems and facilitating solutions.
6. To complete the project on schedule and within costs, these being the overall standard by which performance of the project manager is evaluated.

Project Manager Competencies

- There exists a core set of competencies that good project managers possess.
- Some of these competencies can be taught, both in courses, books, and professional workshops; however, some of these competencies come only with professional experience in the field.
- First, you usually cannot manage a process you have never used.
- Second, you cannot manage a project without understanding the business and culture that provides a context for the project.

Competency	Explanation
	Business Achievement Competencies
Business awareness	Ties every systems project to the mission, vision, and goals of the organization.
Business partner orientation	Keeps managers and users involved throughout a systems project.
Commitment to quality	Ensures that every systems project contributes to the quality expectation of the organization as a whole.
	Problem-Solving Competencies
Initiative	Demonstrates creativity, calculated risks, and persistence necessary to get the job done.
Information gathering	Skillfully obtains the factual information necessary to analyze, design, and implement the information system.
Analytical thinking	Can assess and select appropriate system development processes and use project management tools to plan, schedule, and budget for system development.
	Can solve problems through the analytical approach of decomposing systems into their parts and then reassembling the parts into improved systems.
Conceptual thinking	Understands systems theory and applies it to systems analysis and design of information systems.

	Influence Competencies
Interpersonal awareness	Understands, recognizes, and reacts to interpersonal motivations and behaviors.
Organizational awareness	Understands the politics of the organization and how to use them in a project.
Anticipation of impact	Understands implications of project decisions and manages expectations and risk.
Resourceful use of influence	Skillfully obtains cooperation and consensus of managers, users, and technologists to solutions.
	People Management Competencies
Motivating others	Coaches and directs individuals to overcome differences and achieve project goals as a team.
Communication skills	Communicates effectively, both orally and in writing, in the context of meetings, presentations, memos, and reports.
Developing others	Ensures that project team members receive sufficient training, assignments, supervision, and performance feedback required to complete projects.
Monitoring and controlling	Develops the project plan, schedule, and budget and continuously monitors progress and makes adjustments when necessary.
	Self-Management Competencies
Self-confidence	Consistently makes and defends decisions with a strong personal confidence in the process and/or facts.
Stress management	Works effectively under pressure or adversity.
Concern for credibility	Consistently and honestly delivers on promises and solutions. Maintains technical or business currency in the field as appropriate.
Flexibility	Capable of adjusting process, management style, or decision making based on situations and unanticipated problems.

Ten Hints for Project Leadership

1. Be Consistent.
2. Provide Support.
3. Don't Make Promises You Can't Keep.
4. Praise in Public; Criticize in Private.
5. Be Aware of Morale Danger Points.
6. Set Realistic Deadlines.
7. Set Perceivable Targets.
8. Explain and Show, Rather Than Do.
9. Don't Rely on Just Status Reports.
10. Encourage a Good Team Spirit.

Project Management Functions

The basic functions of a project manager have been studied and refined by management theorists for many years. These functions include scoping, planning, staffing, organizing, scheduling, directing, controlling, and costing:

- *Scoping* – Scope defines the boundaries of the project. A project manager must scope the project expectations and constraints in order to plan activities, estimate costs and manage expectations
- *Planning* – Planning identifies the tasks required to complete the project. This is based on the manager's understanding of the project scope and the methodology used to achieve the goal.
- *Estimating* – Each task that is required to complete the project must be estimated. For example, some estimates may include:
    - Time that will be required
    - The number of people that will be needed
    - The skills that will be needed
    - Tasks that must be completed before other tasks are started
    - Tasks that overlap
    - The cost
- *Scheduling* - Given the project plan, the project manager is responsible for scheduling all the project's activities. The project schedule should be developed with an understanding of the required tasks, task duration and task prerequisites.
- *Organizing* – The project manager should make sure that members of each project team understand their own individual roles and responsibilities as well as reporting relationship to the project manager.
- *Directing* – Once the project has begun, the project manager must direct the team's activities. Every project manager must demonstrate people management skills to coordinate, delegate, motivate, advise, appraise and reward team members.
- *Controlling* – This is the manager's most difficult and important function. Few plans will be executed without problems and delays. The project manager must monitor and report progress against goals, schedule and costs and make appropriate adjustments when necessary.
- *Closing* – Good project managers always assess successes and failures at the conclusion of a project. They learn from their mistakes and plan for continuous improvement of the system development process.

Note: All the above functions are dependent on ongoing interpersonal communication among the project manager, the team and other managers.

Project Management Tools & Techniques

- A number of project management tools and techniques are available:
    1. **The Gantt chart**, first conceived by Henry L. Gantt in 1917, is the most commonly used project scheduling and progress evaluation tool. *Gantt chart* is a bar chart used to depict project tasks against a calendar.
    2. **PERT** (Project Evaluation and Review Technique) – PERT was developed in the late 1950s to plan and control large weapons development projects for the U.S. Navy. *PERT*

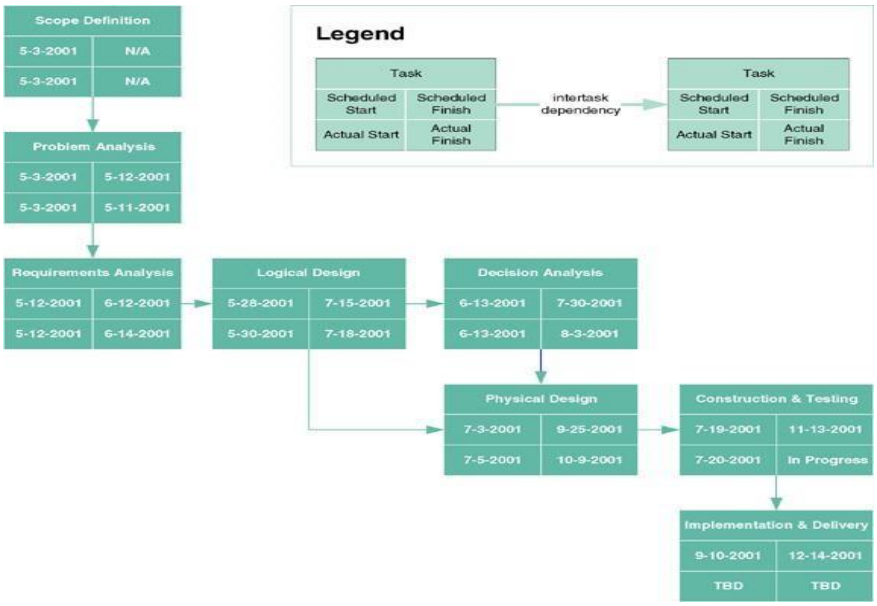
chart is a graphical network model used to depict the interdependencies between a project's tasks.

3. The **critical path method** (CPM) – CPM is a step-by-step project management technique for process planning that defines critical and non-critical tasks with the goal of preventing time-frame problems and process bottlenecks. The CPM is ideally suited to projects consisting of numerous activities that interact in a complex manner.
4. **Project Management Software** – This software is routinely used to help project managers plan projects, develop schedules, develop budgets, monitor progress and costs, generate reports and effect change. Examples include Microsoft Primavera's Project Planner and Project Manager

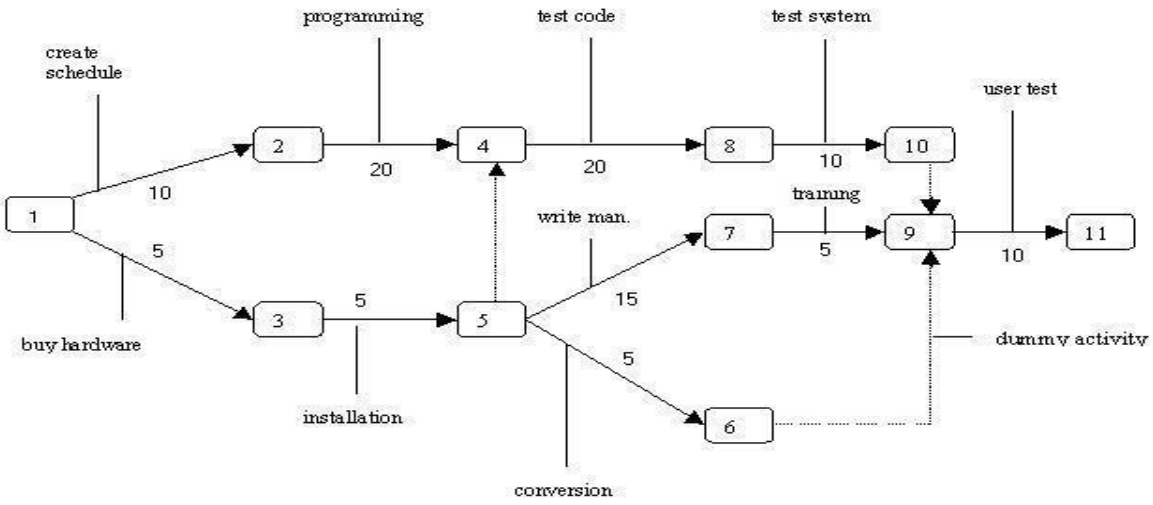
- The tools are not mutually exclusive (especially when PERT is based on "activity on the node" conventions). That is why (and how) most project management software tools maintain both views simultaneously.

PERT Chart

- A PERT (Program Evaluation Review Technique) chart is a project management tool used to schedule, organize, and coordinate tasks within a project.
- PERT methodology was developed by the U.S. Navy in the 1950s to manage the Polaris submarine missile program. A similar methodology, the Critical Path Method (CPM) was developed for project management in the private sector at about the same time.
- PERT was developed to make clear the *interdependence* between project tasks before those tasks are scheduled.



- The boxes represent project tasks (phases of systems development). (The content of the boxes can be adjusted to show various project attributes such as schedule and actual start and finish times.)
- The arrows indicate that one task is dependent upon the start or completion of another task.
- The "data" recorded in the nodes on a PERT chart vary with project management software tools. Microsoft *Project* supports different combinations of data in the nodes.



* Numbered rectangles are nodes and represent events or milestones.
* Directional arrows represent dependent tasks that must be completed sequentially.
* Diverging arrow directions (e.g. 1-2 & 1-3) indicate possibly concurrent tasks
* Dotted lines indicate dependent tasks that do not require resources.

- A PERT chart presents a graphic illustration of a project as a network diagram consisting of numbered *nodes* (either circles or rectangles) representing events, or milestones in the project linked by labelled *vectors* (directional lines) representing tasks in the project. The direction of the arrows on the lines indicates the sequence of tasks. In the diagram, for example, the tasks between nodes 1, 2, 4, 8, and 10 must be completed in sequence. These are called *dependent* or *serial* tasks. The tasks between nodes 1 and 2 and nodes 1 and 3 are not dependent on the completion of one to start the other and can be undertaken simultaneously. These tasks are called *parallel* or *concurrent* tasks. Tasks that must be completed in sequence but that don't require resources or completion time are considered to have *event dependency*. These are represented by dotted lines with arrows and are called *dummy activities*. For example, the dashed arrow linking nodes 6 and 9 indicates that the system files must be converted before the user test can take place, but that the resources and time required to prepare for the user test (writing the user manual and user training) are on another path. Numbers on the opposite sides of the vectors indicate the time allotted for the task.
- The PERT chart is sometimes preferred over the Gantt chart, another popular project management charting method, because it clearly illustrates task dependencies. On the other hand, the PERT chart can be much more difficult to interpret, especially on complex projects. Frequently, project managers use both techniques.

PERT Terminologies

- ***PERT event*:** a point that marks the start or completion of one or more activities. It consumes no time and uses no resources. When it marks the completion of one or more activities, it is not "reached" (does not occur) until *all* of the activities leading to that event have been completed.

- ***Predecessor event***: an event that immediately precedes some other event without any other events intervening. An event can have multiple predecessor events and can be the predecessor of multiple events.
- ***Successor event***: an event that immediately follows some other event without any other intervening events. An event can have multiple successor events and can be the successor of multiple events.
- ***PERT activity***: the actual performance of a task which consumes time and requires resources (such as labour, materials, space, machinery). It can be understood as representing the time, effort, and resources required to move from one event to another. A PERT activity cannot be performed until the predecessor event has occurred.
- ***PERT sub-activity***: a PERT activity can be further decomposed into a set of sub activities. For example, activity A1 can be decomposed into A1.1, A1.2 and A1.3. Sub activities have all the properties of activities; in particular, a sub-activity has predecessor or successor events just like an activity. A sub-activity can be decomposed again into finer-grained sub-activities.
- ***Optimistic time***: the minimum possible time required to accomplish an activity (o) or a path (O), assuming everything proceeds better than is normally expected
- ***Pessimistic time***: the maximum possible time required to accomplish an activity (p) or a path (P), assuming everything goes wrong (but excluding major catastrophes).
- ***Most likely time***: the best estimate of the time required to accomplish an activity (m) or a path (M), assuming everything proceeds as normal.
- ***Expected time***: the best estimate of the time required to accomplish an activity (te) or a path (TE), accounting for the fact that things don't always proceed as normal (the implication being that the expected time is the average time the task would require if the task were repeated on a number of occasions over an extended period of time).

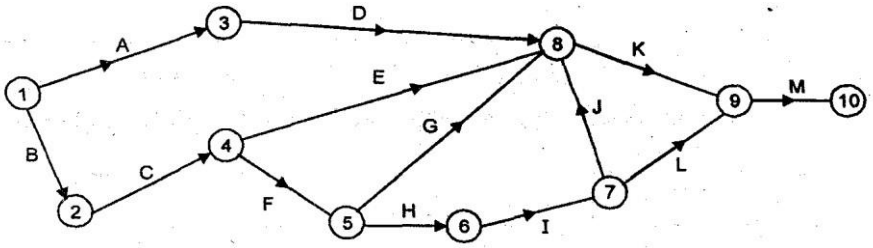
  $$\mathbf{te} = (\mathbf{o} + \mathbf{4m} + \mathbf{p}) \div \mathbf{6}$$
- ***Float*** *or* ***slack*** is a measure of the excess time and resources available to complete a task. It is the amount of time that a project task can be delayed without causing a delay in any subsequent ***tasks*** (*free float*) or the whole project (*total float*). Positive slack would indicate *ahead of schedule*; negative slack would indicate *behind schedule*; and zero slack would indicate *on schedule*.
- ***Critical path***: the longest possible continuous pathway taken from the initial event to the terminal event. It determines the total calendar time required for the project; and, therefore, any time delays along the critical path will delay the reaching of the terminal event by at least the same amount.
- ***Critical activity***: An activity that has total float equal to zero. An activity with zero float is not necessarily on the critical path since its path may not be the longest.
- ***Lead time:*** the time by which a *predecessor event* must be completed in order to allow sufficient time for the activities that must elapse before a specific PERT event reaches completion.
- ***Lag time***: the earliest time by which a *successor event* can follow a specific PERT event.
- ***Fast tracking***: performing more critical activities in parallel
- ***Crashing critical path***: Shortening duration of critical activities

Examples

Construct the network for the following activity data:

Activity	Preceded by	Activity	Preceded by
A	-	-	-
B	–	H	F
C	B	I	H
D	A	J	I
E	C	K	D,E,G,J
F	C	L	I
G	F	M	K,L

Solution



Critical Path Method (CPM)

- **Critical Path Method** is one of the most used scheduling techniques in the construction industry due to its simplicity and powerful resource that it can be.
- **Critical Path Method** is a useful tool that can lead to achieving project results and help in delivering the project on time.
- Critical Path Method schedule includes all work specified in the Contract Documents, including **all expected activities** of subcontractors, vendors, suppliers and all other parties associated with construction of the project.
- A CPM generates a graphical view of the project and is used to calculate how much time and resources are **required to complete an activity.** It also determines critical activities requiring attention so the project can be completed on time.
- **The Critical Path Method (CPM) can help the project managers keep projects on track.**
- **Critical path schedules**
  - Help identify the activities that must be completed on time in order to complete the whole project on time.
  - Show which tasks can be delayed and for how long without impacting the overall project schedule.
  - Calculate the minimum amount of time it will take to complete the project.
  - Tell the earliest and latest dates each activity can start on in order to maintain the schedule.
- **The CPM has four key elements...**

- Critical Path Analysis
- Float Determination
- Early Start & Early Finish Calculation
- Late Start & Late Finish Calculation

Understanding a Critical Path Method (CPM)

- **A critical path method (CPM) is a network of events**, each one of them linked to the following activities. Each activity is represented as a node on the network, and connecting lines are drawn to represent the time schedule to complete that activity.
- A critical path method schedule must be completed using the following steps:
  1. Identify the activities
  2. Determine the sequence of the activities
  3. Connect or create a network of the activities
  4. Enter the completion time for every activity listed in step 1
  5. Identify the critical path or the longest possible path to complete all activities
  6. One important and valuable component is the CPM update progress, allowing to track closely the performance and time used to complete the activities

Identify the Activities

- You may want to start developing a list of activities for the project; normally that information is obtained from the work breakdown structure or the project scope and details. This will be the key to later add sequence and duration in subsequent steps.
- Activities are identified by name, coding, accounting string or other and must have a duration or target date in the case of milestones.

Determine the Sequence of the Activities

- **This is one key factor of a critical path method (CPM)**.
- A complete and thorough understanding of the sequence of the activities is needed to prepare and connect the list of activities prepared in the previous step. The project manager needs to understand the activities that are linked or are related so they can show the proper connection in the schedule.
- Sometimes project managers fail to identify these relationships causing delays and other problems during project execution.

Creating the Network

- The CPM is created summarizing all defined activities and showing interdependence between them.
- It is of vital importance that all critical work sequence has been linked with **logical coordination and planning requirements**.
- The **CPM format shall be based on calendar days** as their main planning unit. A CPM schedule should avoid using working days as it might lead to confusion and errors.

Estimate Activity Completion Time

- Using previous experience, time estimates can be presented and shall represent the necessary time to complete the activity for a single resource unit.

- It is one of the most important steps when preparing a CPM because it will help you determine the time needed or available to perform an activity.

How to Identify the Critical Path

- **The critical path is the longest-duration path through the network.** What does this mean? Activities located on this path cannot be delayed without delaying the project. Because of its impact on the entire project, critical path analysis is an important aspect of project planning.
- The critical path can be identified using these parameters:
  - ES – Early Start: earliest time to start a predetermined activity, given that prior activities must be completed first
  - EF – Early Finish: earliest finish time for the activity
  - LF - Late Finish: latest time the activity must be completed without delaying the entire project
  - LS – Late Start: latest start date that the activity must be started without delaying the project
- The critical path is the path through the project network in which none of the activities have been delayed, that is, the path for which ES=LS and EF=LF for all activities in the path.
- A delay in the critical path delays the project.

How to Update CPM Diagram

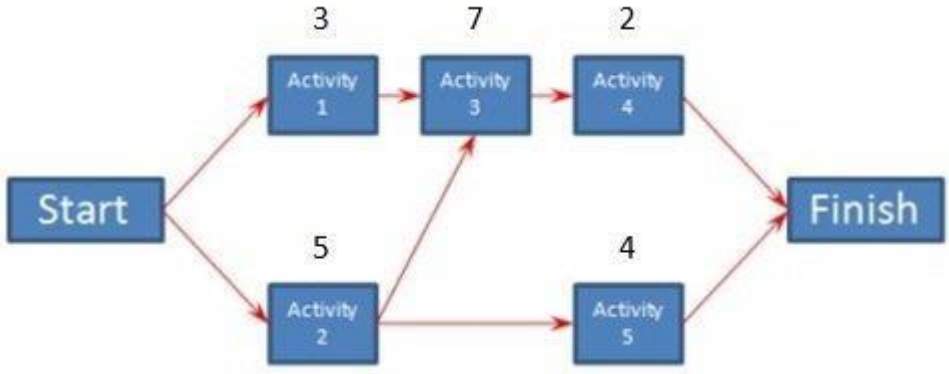
- As the project is being developed, **a critical path method can be updated.** Analyzing a new critical path may be possible when entering all the duration times of activities already completed.
- A new path might be possible and alternative solutions can be presented to either **accelerate the project or continue working as projected**. Sometimes it is also necessary to incorporate changes and extra works that were not part of the original critical path.

Examples

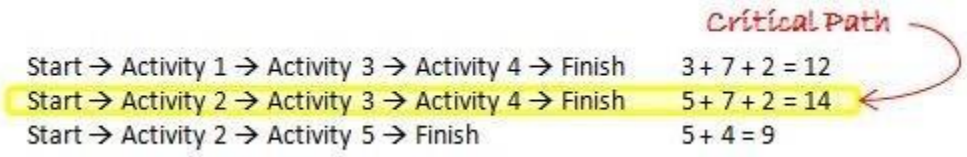
Example 1

Critical Path Analysis

- The critical path is the sequence of activities with the longest duration. A delay in any of these activities will result in a delay for the whole project.



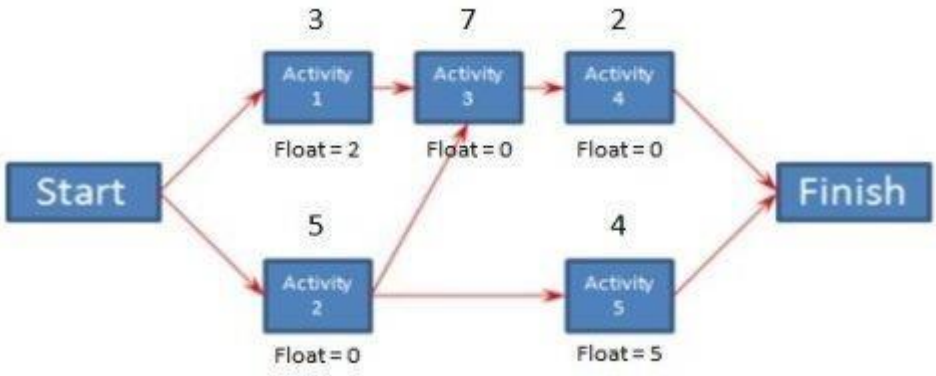
- The duration of each activity is listed above each node in the diagram. For each path, add the duration of each node to determine its total duration. The critical path is the one with the longest duration.
- There are three paths through this project...



Use Critical Path Analysis to find Your Critical Path

Float Determination

- Once you've identified the critical path for the project, you can determine the float for each activity. *Float is the amount of time an activity can slip before it causes your project to be delayed.* Float is sometimes referred to as *slack.*
- Figuring out the float using the Critical Path Method is fairly easy. You will start with the activities on the critical path. Each of those activities has a float of zero. If any of those activities slips, the project will be delayed.
- Then you take the next longest path. Subtract it's duration from the duration of the critical path. That's the float for each of the activities on that path.
- You will continue doing the same for each subsequent longest path until each activities float has been determined. If an activity is on two paths, it's float will be based on the longer path that it belongs to.

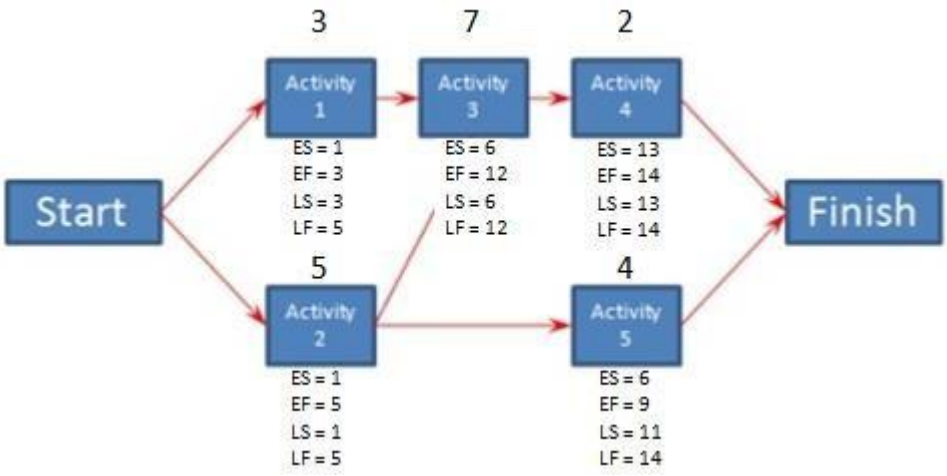


Determining Float

- Using the critical path diagram from the previous section, Activities 2, 3, and 4 are on the critical path so they have a float of zero.
- The next longest path is Activities 1, 3, and 4. Since Activities 3 and 4 are also on the critical path, their float will remain as zero. For any remaining activities, in this case Activity 1, the float will be the duration of the critical path minus the duration of this path. 14 - 12 = 2. So, Activity 1 has a float of 2.
- The next longest path is Activities 2 and 5. Activity 2 is on the critical path so it will have a float of zero. Activity 5 has a float of 14 - 9, which is 5. So as long as Activity 5 doesn't slip more than 5 days, it won't cause a delay to the project.

Early Start & Early Finish Calculation

- The Critical Path Method includes a technique called the **Forward Pass** which is used to determine the earliest date an activity can start and the earliest date it can finish. These dates are valid as long as all prior activities in that path started on their earliest start date and didn't slip.
- Starting with the critical path, the **Early Start (ES)** of the first activity is one. The **Early Finish (EF)** of an activity is its ES plus its duration minus one. Using our earlier example, Activity 2 is the first activity on the critical path: ES = 1, EF = 1 + 5 -1 = 5.



Critical Path Schedules

- You then move to the next activity in the path, in this case Activity 3. Its ES is the previous activity's EF + 1. Activity 3 ES = 5 + 1 = 6. Its EF is calculated the same as before: EF = 6 + 7 - 1 = 12.
- If an activity has more than one predecessor, to calculate its ES you will use the activity with the latest EF.

Late Start & Late Finish Calculation

- The **Backward Pass** is a Critical Path Method technique you can use to determine the latest date an activity can start and the latest date it can finish before it delays the project. You'll start once again with the critical path, but this time you'll begin from the last activity in the path. The **Late Finish (LF)** for the last activity in every path is the same as the last activity's EF in the critical path. The **Late Start (LS)** is the LF - duration + 1.
- In our example, Activity 4 is the last activity on the critical path. Its LF is the same as its EF, which is 14. To calculate the LS, subtract its duration from its LF and add one. LS = 14 - 2 + 1 = 13.
- You then move on to the next activity in the path. Its LF is determined by subtracting one from the previous activity's LS. In our example, the next Activity in the critical path is Activity 3. Its LF is equal to Activity 4 LS - 1. Activity 3 LF = 13 -1 = 12. Its LS is calculated the same as before by subtracting its duration from the LF and adding one. Activity 3 LS = 12 - 7 + 1 = 6.

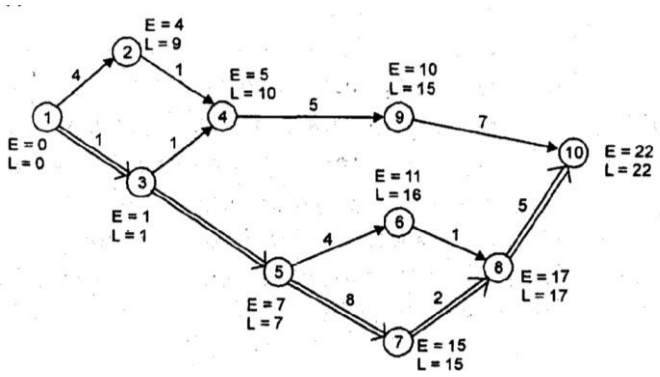
- You will continue in this manner moving along each path filling in LF and LS for activities that don't have it already filled in.

Example 2

A project has the following time schedules

Activity	1 – 2	1 – 3	2 – 4	3 – 4	3 – 5	4 – 9	5 – 6	5 – 7	6 – 8	7 – 8	8 – 9	8 – 10	9 – 10
Time weeks	4	1	1	1	6	5	4	8	1	2	1	5	7

i. Draw network diagram and find the critical path.



ii. Calculate the float of each activity

Activity	Duration (weeks)	Start Time		Finish Time		Total Float
		E	T_{LS}	T_{EF}	L	
1 – 2	4	0	5	4	9	5
1 – 3	1	0	0	1	1	0
2 – 4	1	4	9	5	10	5
3 – 4	1	1	9	2	10	8
3 – 5	6	1	1	7	7	0
4 – 9	5	5	10	10	15	5
5 – 6	4	7	12	11	16	5
5 – 7	8	7	7	15	15	0
6 – 8	1	11	16	12	17	5
7 – 8	2	15	15	17	17	0
8 – 10	5	17	17	22	22	0
9 – 10	7	10	15	17	22	5

Critical path 1—3—5—7—8—10 with project duration of 22 weeks

Differences between CPM and PERT

CPM

1 CPM is activity oriented i.e.; CPM network is built on the basis of activities.

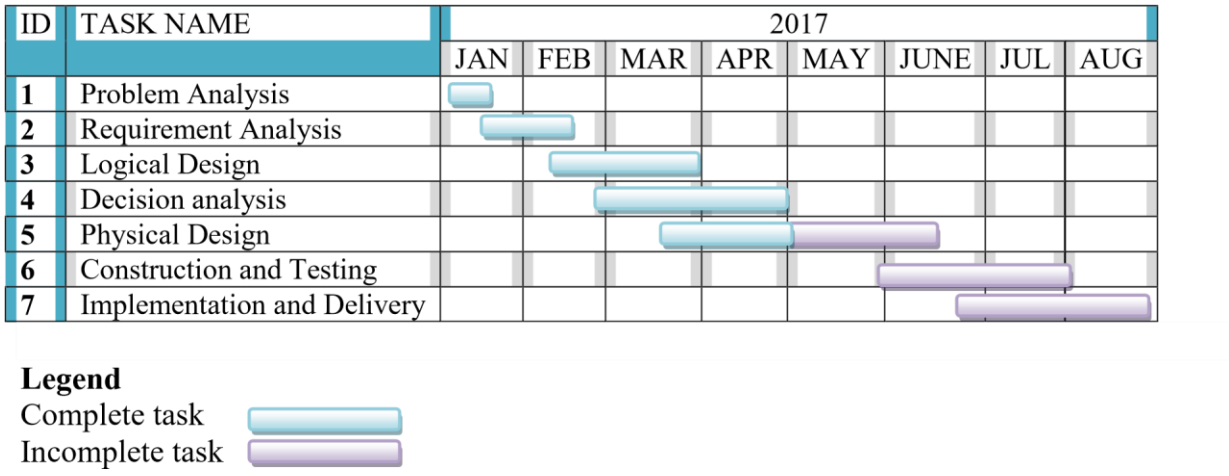
2 CPM is a deterministic model. It does not take into account in uncertainties involved in the estimation of time.

3 CPM places dual emphasis on project time as well as cost and finds the tradeoff between project time and project cost.
4 CPM is primarily used for projects which are repetitive in nature and comparatively small in size.

PERT
1. PERT is event oriented.
2. PERT is a probabilistic model.
3. PERT is primarily concerned with time only.
4. PERT is used for large one-time research and development type of projects.

Gantt chart

Gantt charts offer the advantage of clearly showing *overlapping* tasks, that is, tasks that can be performed at the same time. The bars can be shaded to clearly indicate percentage completion and project progress. The figure demonstrates which phases are ahead and behind schedule at a glance. The popularity of Gantt charts stems from their simplicity; they are easy to learn, read, prepare, and use.



Project Management Life Cycle

- The Capability Maturity Model defines a framework for assessing the quality of an organization's Information system development activities.
  - CMM Level l is defined as Initial and is characterized by the lack of any consistent project or process management function. The first stage of maturity improvement is to implement a consistent project management function - called CMM Level 2.
  - In this topic we discuss project management life cycle representative of CMM Level 2 maturity.
- The project management process incorporates a joint project planning (JPP) technique. **Joint project planning** (JPP) is a strategy in which all stakeholders attend an intensive workshop aimed at reaching consensus on project decisions.

Activity 1 – Negotiate Scope

- The most important prerequisite to effective project management occurs at the beginning.
- All parties must agree to the project scope before any attempt is made to identify and schedule tasks or to assign resources (people) to those tasks.
- Negotiating scope of a project is a necessary activity in the project management life cycle.
- Scope defines the expectations of a project and expectations ultimately determine satisfaction and degree of success.
- Scope defines the boundaries of a project – the parts of the business that are to be studied, analyzed, designed, constructed, implemented, and ultimately improved.
- Scope also defines the aspects of a system that are considered outside the project. The answers to five basic questions influence the negotiation of project scope:
  - *Product* – What do you want?
  - *Quality* - How good do you want it to be?
  - *Time* – When do you want it?
  - *Cost* – How much are you willing to pay for it?
  - *Resources* – What resources are you willing or able to bring to the table?

Negotiation of the above factors is a give-and-take activity that includes much iteration. The deliverable is an agreed-on **statement of work** that describes the work to be performed during the project.

- Statement of Work comprises:
  1. Purpose
  2. Background
     i. Problem, opportunity, or directive statement
     ii. History leading to project request
     iii. Project goal and objectives
     iv. Product description
  3. Scope
     i. Stakeholders
     ii. Data
     iii. Processes
     iv. Locations
  4. Project Approach
     i. Route
     ii. Deliverables
  5. Managerial Approach
     i. Team building considerations
     ii. Manager and experience
     iii. Training requirements
     iv. Meeting schedules
     v. Reporting methods and frequency

vi. Conflict management
vii. Scope management

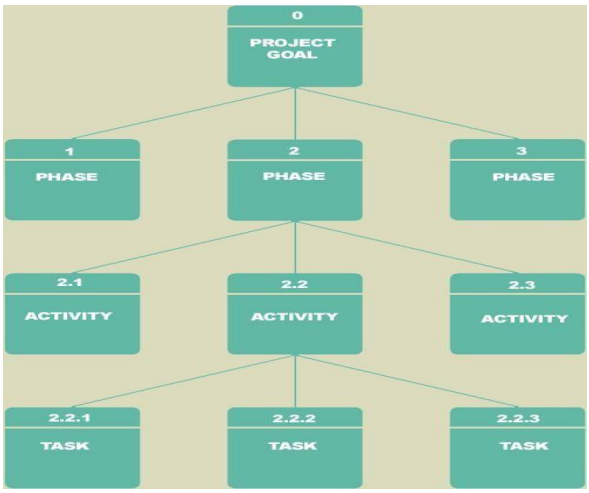
6. Constraints
    i. Start date
    ii. Deadlines
    iii. Budget
    iv. Technology
7. Rough Estimates
    i. Schedule ii. Budget
8. Conditions of Satisfaction
    i. Success criteria
    ii. Assumptions iii. Risks
9. Appendices

Activity 2 – Identify Tasks

- Given the project scope, the next activity is to identify project tasks.
- Tasks identify the work to be done. Typically, the work to be done is defined in a top down, outline manner.
- We have learned about system development methodologies and their phases, but these phases are too large and complex for planning and scheduling a project. We need to break them down into activities and tasks until each task represents a manageable amount of work that can be planned, scheduled, and assigned.

  The project manager will determine the level of detail in the outline; however, some system development methodologies decompose phases into suggested activities and tasks.
- One popular tool used to identify and document project activities and tasks is a **work breakdown structure (WSB).**
- Work breakdown structure (WBS) is a graphical tool used to depict the hierarchical decomposition of the project into phases, activities, and tasks.
- Work breakdown structures can be drawn using top-down hierarchy charts similar to organization charts
- Microsoft Project offers a military numbering scheme to represent hierarchical decomposition of a project as follows:

  1. Phase l of the project
      1.1 Activity I of Phase I
          1.1.1 Task I of Activity I in Phase I 1.1.2 Task 2 of Activity I in Phase I
      1.2 Activity 2 of Phase I .. .
  2. Phase 2 of the project . . .
- We may want to include in a WBS special tasks called **milestones**. Milestones are events that signify the accomplishment or completion of major deliverables during a project.
- In information systems projects, an example of a milestone might be the completion of all the tasks associated with producing a major project deliverable such as a requirements statement.
- It useful to distinguish milestones from other tasks.



Activity 3 – Estimate Task Durations

- Given a work breakdown structure with a suitable level of detail, the project manager must estimate duration for each task.
- Duration of any task is a random variable subject to factors such as the size of the team, number of users, availability of users, aptitudes of users, complexity of the business system, information technology architecture, experience of team personnel, time committed to other projects and experience with other projects.
- Most system development methodologies not only define tasks but also provide baseline estimates for task duration. The project manager must adjust these baselines into reasonable estimates for each unique project.

  In Microsoft Project, all phases, activities, and tasks of a methodology are all called tasks. The work breakdown structure can then consist of both summary and primitive tasks.
  - A summary task is one that consists of other tasks e.g. phases and activities
  - A primitive task is one that does not consist of any other task
- For primitive tasks that are not milestones, durations must be estimated. In estimating task duration, it is important to understand the concept of *elapsed time.*
- Elapsed time takes into consideration two important factors with respect to people:
  - *Efficiency* - No worker performs 100% efficiency. Most people take breaks
  - *Interruptions* – People experience phone calls, visitors and other unplanned interruptions that increase the time required for project work.
- Given a task that could be completed in 10 hours with 100% efficiency and no interruptions, assuming a worker's efficiency of 75% and 15% interruptions, the true estimate for the task would be:

$$10\ hours \div 0.75 = 13.3\ hours \div (1.00 - 0.15) = 15.68\ hours$$

- There are many techniques for estimating task duration. The following is a classic technique.

- Estimate the maximum amount of time it should take to perform the task. This is called **optimistic duration (OD)**. The optimistic duration assumes that even the most likely interruptions or delays, such as occasional employee sickness will not happen.
- Estimate the maximum amount of time it could take to perform the task. This is called the **pessimistic duration (PD)**. The pessimistic duration assumes that nearly anything that can go wrong will go wrong. All possible interruptions or delays, such as labour strikes, illnesses, inaccurate specification or requirements, equipment delivery delays, and underestimation of the system's complexity, are assumed to be inevitable.
- Estimate the **expected duration (ED)** that will be needed to perform the task. Don't just take the median of the optimistic and pessimistic durations. Attempt to identify interruptions or delays that are most likely to occur, such as occasional employee illnesses, inexperienced personnel, and occasional training.
- Calculate the most likely duration (D), as follows:

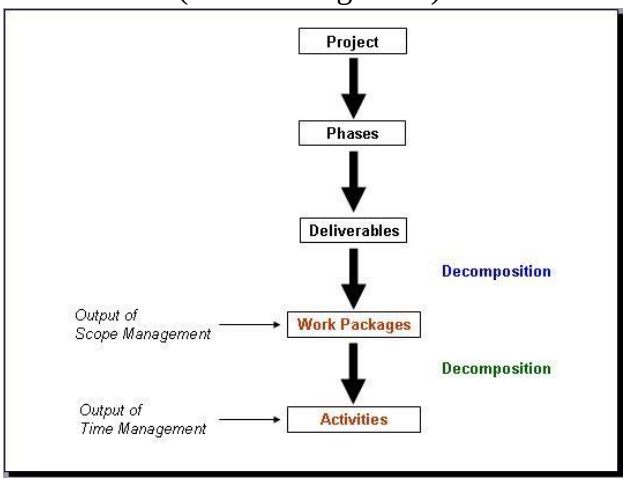
$$D = \frac{(1 \times OD) + (4 \times ED) + (1 \times PD)}{6}$$

Where 1, 4, and 1 are default weights used to calculate a weighted average of the three estimates.

Developing OD, PD and ED estimates can be tricky and require experience. Three most common techniques used in estimating are: COCOMO, Decomposition and Function point analysis.

Decomposition

- Decomposition is a technique used in project management that breaks down the workload and tasks into small, manageable pieces that can be estimated based on historical data of past projects and similarly complex pieces before the creation of the work breakdown structure. This important step can save time in the long run.
- Decomposition is an important technique used in WBS creation (Scope Management) and definition of activities (Time Management).



1. In scope management, project deliverables are subdivided into smaller and more manageable components until the work and deliverables are defined to the work package level. This is called as decomposition.
2. Roughly, there are six steps involved with the decomposition process.
    i. Once you have determined the project objectives, you will need to gather the information involving the project's deliverables and the tasks that have already been determined. Knowing what needs to be produced as the end products and knowing the important milestones will help guide the project to keep it on course.
    ii. Once deliverable and task information has been gathered, decomposition takes a top-down approach to determining tasks and subtasks. The project manager will break down the biggest items (deliverables, milestones, and major tasks) into the smallest tasks. This process can occur in the work breakdown structure format, or it can be completed as a mind map and structured later. The idea is to move from the most general aspects of the project to the most specific and detailed tasks in the project. For example, if you are writing a technical manual, you would break it down into its smallest components – chapters. Each chapter could be broken down into research, outline, draft, revision, print-ready copy.
    iii. Once the project has been broken down into the smallest tasks, then work packages can be created. A work package is a collection of related action items that can be assigned to a resource as a sub-set of the whole of work that must be created.
    iv. Double-check that the project has been sufficiently decomposed into the smallest parts possible.
    v. The project manager organizes the work packages into the work breakdown structure. Each package can be assigned a specific code.
    vi. Once the work breakdown structure creation is completed, then the work packages are assigned to resources.

3. When done properly, decomposition will make clear the relevance of each task to the bigger project picture. However, excessive decomposition may lead to more work without much value for the time spent. It can also lead to inefficient use of resources, and decreased work efficiency. So, knowing few basics about work package helps us in deciding the level of decomposition. Few of them are:
    - Work package is the lowest level of WBS
    - Usually, a work package is the quantum of work which is assigned to a single resource as a whole and produces a verifiable outcome − Project's cost and schedule estimation is done at work package level
    - The accuracy of these estimations depends on the level of detailed work package that is defined
    - The level to which work packages need to be detailed vary from project to project

 In Time Management, each work package within the WBS is decomposed into the activities required to produce the work package deliverables.

Take this scenario:
You are a software developer. You need to solve a customer bug. What do you do?
You will:

1 First, identify the activities you need to execute to reproduce the customer issue.
2 Then, modify the software code to rectify the issue.
3 Lastly, deploy the fix at customer end.

Your list may contain more activities than what is listed above. Here, we subdivided a work package into smaller and manageable components of activities. This is often performed by the project team members responsible for the work package. Activities are vital input in performing a work. Correct level of decomposition in time management can produce accurate estimate of schedule & timely completion of project.

Benefits of decomposition

While decomposing a project might seem unnecessary, it can prove beneficial. It might take time to decompose a project fully, but this saves time in the end.

i. **Avoid Team Member Confusion -** If tasks are broad or vague, project team members will do one of two things: Come to you for clarification (best-case scenario) or guess what you meant (more likely). If they guess, they may miss the mark. Imagine the following scenario: The vague task is to research the history of Kenya for a video game concept. George researches the contemporary history of Kenya. He hands in the report. You sigh, noting that his report lacks any information about the Mau Mau Rebellion. By breaking the task of research down into the smallest and most detailed tasks, time and frustration are saved.
ii. **Eliminate the Feeling of Being Overwhelmed -** Another risk is that team members will become overwhelmed and not know where to start. They might procrastinate for fear of being sack.
iii. **Create a More Accurate Budget -** When tasks have been broken down into their most detailed components, a more accurate picture of what the project will cost can be drawn up.

The Constructive Cost Model (COCOMO)

- The Constructive Cost Model (COCOMO) is an algorithmic software cost estimation model that uses a basic regression formula, with parameters that are derived from historical project data and current project characteristics.
- COCOMO was first published in 1981 Barry W. Boehm's Book Software engineering economics as a model for estimating effort, cost, and schedule for software projects.

Function Points Analysis

- Function Point Analysis (FPA) is a model-based technique used to measure the functional size of an information system. FPA measures the functional size by looking at the (functional) transactions and (logical) data files that are relevant to the user in the business.
- The unit of measurement is “function points”; the functional size of an information system is expressed by a number of function points.

- Function points are a good measure of the functional size of an information system; the unit of measurement “function points” can be utilized in various ways.
- FPA is often used to budget a system development project. The development costs for an information system are related to its size: the bigger the system, the more expensive the development will be. Based on experiences in earlier projects an organization knows, how many hours (on average) one needs to realize one function point: the productivity rate. Size (number of function points) x productivity rate (hours per function point) is a basis for the project budgeting process.
- FPA can be applied for development, as well as for enhancement projects.
- FPA is a fast method, which does not require knowledge of computers. Assuming suitable documentation, it does not take much time to perform an FPA. It is estimated that for a system which needs one thousand development hours, An FPA can be performed in about one hour.

Activity 4 – Specify Inter-task Dependencies

- Given the duration estimates for all tasks, we can now begin to develop a project schedule. The project schedule depends not only on task durations but also on Inter-task dependencies. In other words, the start or completion of individual tasks may depend on the start or completion of other tasks. There are four types of inter-task dependencies:
  - Finish-to-start (FS)- The finish of one task triggers the start of another task. − Start-to-start (SS)- The start of one task triggers the start of another task − Finish-to-finish (FF)- Two tasks must finish at the same time.
  - Star- to-finish (SF) - The start of one task signifies the finish of another task
  - Inter-task dependencies can be established and depleted in both Gantt and PERT charts.
- Given the start date for a project, the tasks to be completed, the task durations, and the inter-task dependencies, the project can now be scheduled. There are two approaches to scheduling:
  - **Forward scheduling** establishes a project start date and then schedules forward from that date. Based on the planned duration of required tasks, their interdependencies, and the allocation of resources to complete those tasks, a projected project completion date is calculated
  - **Reverse scheduling** establishes a project deadline and then schedules backward from the date.
  - Tasks, their duration, interdependencies, and resources must be considered to ensure that the project can be completed by the deadline.

Activity 5 – Assign Resources

- Resources include the following categories:
  - People - includes all the system owners, users, analysts, designers, builders, external agents, and clerical help that will be involved in the project in any way.
  - Services - includes services such as a quality review that may be charged on a peruse basis.
  - Facilities and equipment - includes all rooms and technology that will he needed to complete the project.

  - Supplies and materials- includes everything from pencils, paper, and notebooks to toner cartridges, etc
  - Money - includes a translation of all of the above into budgeted shillings
- The availability of resources, especially people and facilities, can significantly alter the project schedule.
- Most system development methodologies identify people resources required for each task in the form of roles. A role is not the same as a job title. A role can be thought of as a hat that someone wears because he or she possesses a certain skill(s). Any given individual may be capable of wearing many hats (thus playing many roles). Also, many people may possess the skills required to play a given role.
- The project manager's task is either to assign specific people to fill roles or to gain commitments from management to provide people to fill roles.
- Roles in an information system project include: Auditor, Business Analyst, Business Subject Matter Expert, Database Administrator, Executive Sponsor, Information Systems Manager, JAD Facilitator, JAD Scribe, Management Sponsor, Network Administrator, Programmer, Project Manager, System designer etc.

Assigning People to Tasks

- Recruiting the right team members can make or break a project. The following are guidelines for selecting and recruiting the team:
  - Recruit talented, highly motivated people. Highly skilled and motivated team members are more likely to overcome project obstacles unaided and are more likely to meet project deadlines and produce quality work.
  - Select the best task for each person. All workers have strengths and weaknesses. Effective project managers learn to exploit the strengths of team members and avoid assigning tasks to team members not skilled in those areas.
  - Promote team harmony. Project managers should select team members who will work well together.
- Plan for the future. Junior personnel with potential to be mentored by project leaders must be considered. Although junior personnel might not be as productive as the seasoned veterans, project managers will need them and have to rely on them on future projects.
- Keep the team size small. By limiting the team size, communication overhead and difficulties will be reduced. A 2-person team has only 1 communication path, a 4-person team has 6 communication paths and a 50-person team has at least 1,200 communication paths. The more communication paths then are, the greater the probability that there will be increased communication problems. By the same token the teams should be large enough to provide adequate backup and coverage in key skills if a team member is lost.

Resource Levelling

- It is common to over allocate resources when assigning resources to tasks. *Over allocate* refers to the act of assigning more resources than are available.
- For example, during a specific period in the project (day, week, etc.), a project manager may have assigned a specific person to work on multiple tasks that add up to more hours than the person has available to work during that period. This renders the overall schedule infeasible

because the over allocated resource cannot reasonably complete all assigned tasks according to schedule. To correct this problem, project managers must use a technique called **resource levelling**. Resource levelling is a strategy used to correct resource over allocations by some combination of delaying or splitting *tasks.*

- *Delaying tasks* is based on the concepts of *critical path* and *slack time.* When it comes to the project schedule, some tasks are more sensitive to schedule delays than others. For this reason, project managers must become aware *of* the critical path for a project. The critical path for a project is the sequence of dependent tasks that have the largest sum of *most likely durations.* The critical path determines the earliest possible completion date of the project.
- The critical path tasks have no slack time available, thus, any delay in completion of any of the tasks on the critical path will cause an overall delay in the completion of the entire project. The opposite of a critical task is one that has some slack time. The slack time available for any noncritical task is the amount of delay that can be tolerated between the starting time and the completion time of a task without causing a delay in the completion date of the entire project. Tasks that have slack time can get behind schedule by an amount less than or equal to the slack time without having any impact on the project's final completion date. The availability of slack time in certain tasks provides an opportunity to delay the start of the tasks to level resources while not affecting d1e project completion date. This may be necessary to delay a critical path task to level resources, unless you can split the task.
- *Splitting tasks* involves breaking a task into multiple tasks to assign alternate resources to the tasks. Thus, a single task for which a resource was over allocated is now apportioned to two or more resources that are (presumably) not over allocated. Splitting tasks requires identifying and assigning new resources such as analysts, or consultants.
- Resource levelling is an ongoing activity because the schedule and resource assignments are likely to change over the course of a project.

Schedule and Budget

 Given a schedule based on levelled resources and given the cost of each resource (e.g., cost per hour of a systems analyst or database administrator) the project manager can produce a printed (or Web-based) document that communicates the project plan to all concerned parties. Project management tools will provide multiple views of a project such *as* calendars, Gantt chart, PERT chart, resource and resource levelling reports, and budget reports. All that remains is to direct resources to the completion of project tasks and deliverables.

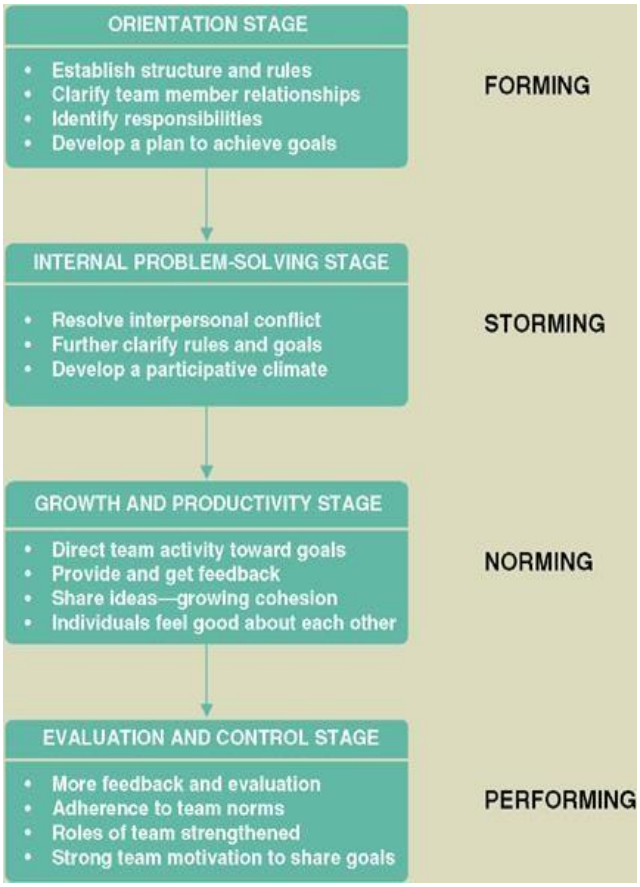
Communication

- The statement of work, timetable for major deliverables, and overall project schedule should be communicated to all parties involved in the project.
- This communication must also include a plan for reporting progress, both orally and in writing, the frequency of such complications, and a contact person and method for parties to submit feedback and suggestions. A corporate Intranet can be an effective way to keep everyone informed of project progress and issues.

Activity 6 – Direct the Team Effort

- All the preceding project management activities led to a master plan for the project.

- There are several dimensions to directing the team effort.
- The hardest job in management is people.
- Few new project managers are skilled at supervising people. Most learn supervising through their own experiences as subordinates - things they liked and disliked about those who supervised them.



Stages of team maturity

Activity 7-Monitor and Control Progress

 While executing the project, the project manager must control the project; monitor its progress against the scope, schedule and budget. The manager must report progress and when necessary, adjust scope, schedule and resources.

Progress Reporting

Progress reporting should be frequent enough to establish accountability and control, but not so frequent as to become a burden and impediment to real project progress. For example, many firms, recommends that progress reports or meetings occur every two weeks.

Project progress reports can be verbal or written. Project progress reports (or presentations) should be honest and accurate even if the news is not good. Project progress reports should report

successes but should clearly identify problems and concerns such that they can be addressed before they escalate into major issues.

Sample Outline for Progress Report

I. Cover Page

A. Project name or identification
B. Project manager
C. Date or report

II. Summary of progress

A. Schedule analysis
B. Budget analysis
C. Scope analysis
(changes that may have an impact on future progress)
D. Process analysis
(problems encountered with strategy or methodology)
E. Gantt progress chart(s)

III. Activity analysis

A. Tasks completed since last report
B. Current tasks and deliverables
C. Short term future tasks and deliverables

IV. Previous problems and issues

A. Action item and status
B. New or revised action items
1. Recommendation
2. Assignment of responsibility
3. Deadline

V. New problems and issues

A. Problems
(actual or anticipated)
B. Issues
(actual or anticipated)
C. Possible solutions
1. Recommendation
2. Assignment of responsibility
3. Deadline

VI. Attachments (*include relevant printouts from project management software)*

Change Management

- It is not uncommon for scope to grow out of control even when a properly completed statement of work was agreed on early in the planning process.
- **Change management** is a formal strategy in which a process is established to facilitate changes that occur during a project.
- Changes can be the result of various events and factors including:

- An omission in defining initial scope
- A misunderstanding of the initial scope
- An external event such as government regulations that create new requirements
- Organizational changes
- Availability of better technology
- Shifts in planned technology that force changes to the business organization, culture, and/or processes
- Management's desire to have the system do more
- Reduced funding for project or imposition of an earlier deadline

Expectations Management

- Experienced project managers often complain that managing system owners' and users' expectation of a project is more difficult than managing cost, schedule, people or quality
- Expectations management matrix is a tool used to understand the dynamics and impact of changing the parameters of a project.

Schedule Adjustments-Critical Path Analysis

- When it comes to the project schedule, some tasks are more sensitive to schedule delays than others. For this reason, project managers must become aware of the critical path and slack times for a project.
- Understanding the critical path and slack time in a project is indispensable to the project manager. Knowledge of such project factors influences the people management decisions to be made by the project manager. Emphasis can and should be placed on the critical path tasks, and if necessary, resources might be temporarily divested from tasks with slack time to help get critical tasks back on schedule.
- The critical path and slack time for a project can be depicted on both Gantt and PERT charts; however, PERT charts are generally preferred because they more dearly depict inter-task dependencies that define the critical path.

Example

A project consists of nine primitive tasks. The most likely duration (in days) for each task is recorded. There are four distinct sequences of tasks in a project. They are:

Path 1: $A \rightarrow B \rightarrow C \rightarrow D \rightarrow I$
Path 2: $A \rightarrow B \rightarrow C \rightarrow E \rightarrow I$
Path 3: $A \rightarrow B \rightarrow C \rightarrow F \rightarrow G \rightarrow I$
Path 4: $A \rightarrow B \rightarrow C \rightarrow F \rightarrow H \rightarrow I$

The total of most likely duration times for each path is calculated as follows:

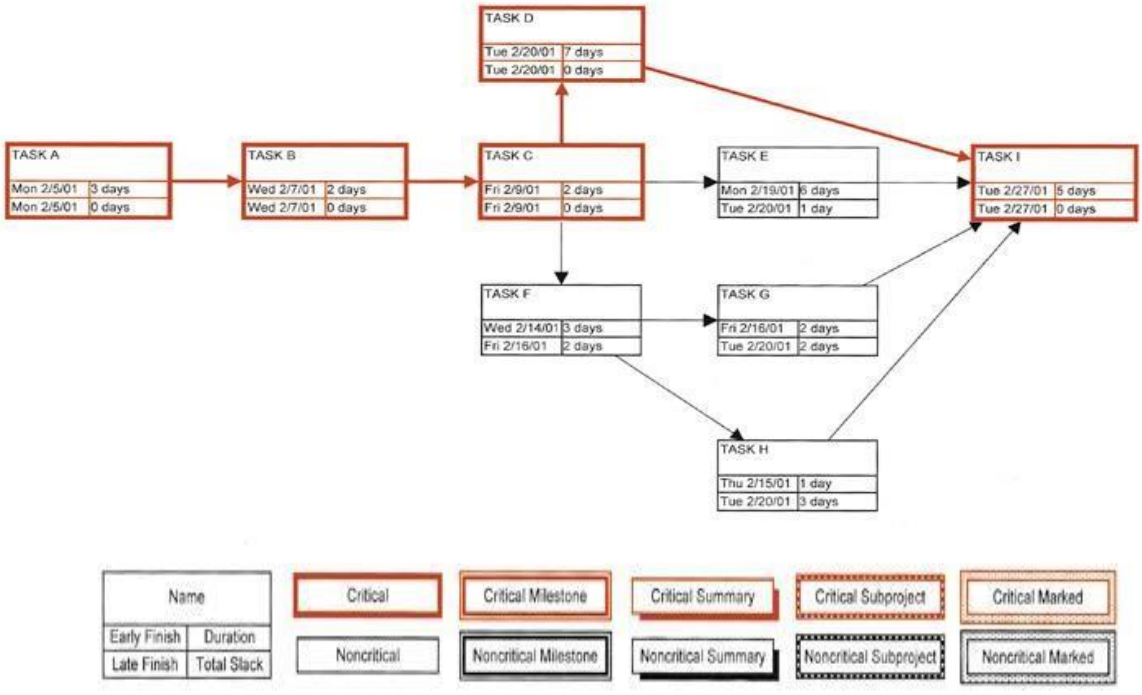
Path 1: $3 + 2 + 2 + 7 + 5 = 19$
Path 2: $3 + 2 + 2 + 6 + 5 = 18$
Path 3: $3 + 2 + 2 + 3 + 2 + 5 = 17$
Path 4: $3 + 2 + 2 + 3 + 1 + 5 = 16$

In this example, path 1 is the *critical path* at 19 days. (Note: You can have multiple critical paths if they have the same total duration.)

1. Using inter-task dependencies, determine every possible path through the project.
2. For each path, sum the durations of all tasks in the path.
3. The path with the longest total duration is the critical path.

The critical path is the sequence of tasks with the largest sum of *most likely durations*. The critical path determines the earliest completion date of the project.

The slack time for any non-critical task is the amount of delay that can be tolerated between starting and completion time of a task without causing a delay in the entire project.



Activity 8 – Assess Project Results and Experience

- Project managers must learn from their mistakes! They should embrace continuous process improvement. This final activity involves soliciting feedback from project team members (including customers) concerning their project experiences and suggestions aimed at improving the project and process management of the organization.
- Project review(s) should be conducted to answer the following fundamental questions:
  - Did the final product meet or exceed user expectations?
  - Did the project come in on schedule?
  - Did the project come in under budget?
- The answers to these questions should be followed up with the basic question “Why” or “why not?” Subsequently, and based on the responses to the above questions, catalogues should be made to improve the system development and project management methods that will be used on future projects. Suggestions for improvements are communicated to Centres for Excellence," which can modify standards and processes, as well as share useful ideas and experiences with other project teams that may solicit their help or expertise. Project assessments often contribute improvements to specific project deliverables (milestones), processes or tasks that created the deliverables, and the overall management of the project.

Summary

1. A project is a (temporary) sequence of unique, complex, and connected activities that have one goal or purpose and that must be completed by a specific time, within budget, and according to specification.
2. Project management is the process of scoping, planning, staffing, organizing, directing, and controlling the development of an acceptable system at a minimum cost within a specified time frame.
3. Process management is an ongoing activity that documents, manages the use of, and improves an organization's chosen methodology (the "process") for systems development.
4. From a project management perspective, a project is considered a success if the resulting information system is acceptable to the customer, the system is delivered "on time" and "within budget," and the system development process had a minimal impact on ongoing business operations.
5. The Project Management Institute has created the Project Management Body of Knowledge (PMBOK) for the education and certification of professional project managers. It addresses:
    a. Project manager competencies.
    b. Project management functions.
    c. Tools and techniques such as:
        i) PERT charts, graphical network models that depict a project's tasks, and the relationships between those tasks.
        ii) Gantt charts, simple horizontal bar charts that depict project tasks against a calendar.
    d. Project management software.
6. Project management is a cross life-cycle activity; that is, project management tasks overlap all the system development phases. A project management process is essential to achieving CMM Level 2 maturity.
7. Joint project planning (JPP) is a strategy wherein all stakeholders in a project participate in a one- to three-day project management workshop, the result of which is consensus agreement on project scope, schedule, resources, and budget.
8. The tasks of project management include:
    a. Negotiate scope. Scope defines the boundaries of a project and is included in the statement of work, a narrative description of the work to be performed as part of a project.
    b. Identify tasks. A work breakdown structure (WBS) is a hierarchical decomposition of the project into its tasks and subtasks. Some tasks represent the completion of milestones or the completion of major deliverables during a project.

        project parameters such as cost, schedule, scope, and quality.
        iv) Schedule adjustments are required when a project's scope changes or when other factors drive schedule or budget out of the projected range.
    c. Estimate task durations. There are many techniques and tools for estimating task durations.
    d. Specify intertask dependencies. The start or completion of individual tasks may be dependent on the start or completion of other tasks. These dependencies impact the completion of any project.
    e. Assign resources. The following resources may impact a project schedule: people, services, facilities and equipment, supplies and materials, and money.
        i) Such resources must be assigned to tasks to develop a schedule.
        ii) Resource leveling is a strategy used to correct resource overallocations by some combination of delaying or splitting tasks. Resource leveling requires knowledge of:
            (1) The critical path—that sequence of dependent tasks that have the largest sum of most likely durations. The critical path determines the earliest possible completion date of the project.
            (2) Slack time—the amount of delay that can be tolerated between the starting time and completion time of a task without causing a delay in the completion date of the entire project.
    f. Direct the team effort. One of the most important dimensions of directing the team effort is the supervision of people.
    g. Monitor and control progress. During the project, the project manager must monitor project progress against the scope, schedule, and budget and, when necessary, make adjustments to scope, schedule, and resources.
        i) Progress reporting is an essential control process that uses communication to keep a project within scope, on time, and within budget.
        ii) A complete project plan provides mechanisms and a process to manage requests for changes to scope. This is called change management.
        iii) Change management frequently requires that a project manager manage the expectations of management and users themselves. An expectations management matrix is a rule-driven tool for helping management understand the dynamics and impact of changing
    h. Assess project results and experiences. This final activity involves soliciting feedback from project team members (including customers) concerning their project experiences and suggestions aimed at improving the project and process management of the organization.