1. Introduction

Welcome to the eLearning session on Gantt Charts.

At the end of this session, you will be able to:

- Explain Gantt Charts
- Create simple Gantt Charts
- Interpret Gantt Charts
- Appreciate the use of Gantt Charts in real-life situations

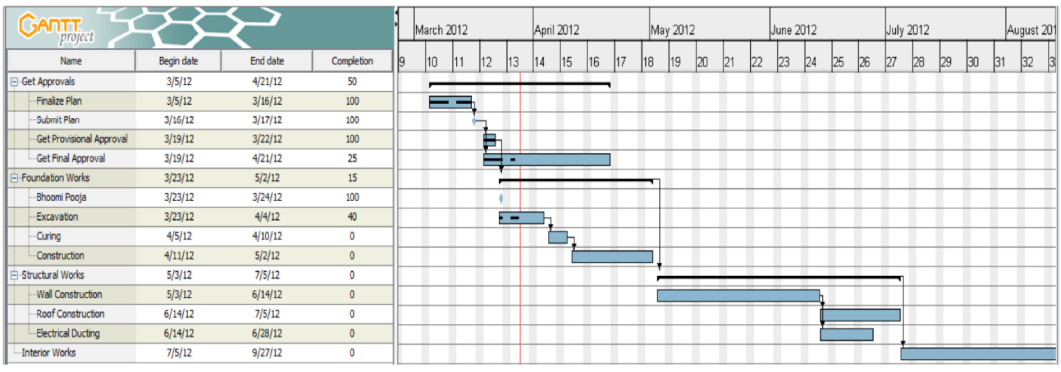
A Gantt chart is a type of bar chart used to illustrate work break down structure of a project schedule comprising of summary and detail elements, especially the tasks and the milestones.
A Gantt chart can be used to show the start and end dates, dependencies, progress or completion % and much other information related to such elements.

In Simple terms, a Gantt Chart is a visual representation of a project schedule, using horizontal bars against a timeline.

Gantt chart's purpose is to help the viewer to easily understand the important aspects of a project:

- sub-components of the project
- the tasks to be completed under each sub-component
- the flow or sequence of tasks
- the start and end date of the tasks and sub-components
- the interim and final milestones to be achieved
- the dependency between various tasks

A typical Gantt Chart will look like this:
Figure 1



Name	Begin date	End date	Completion
Get Approvals	3/5/12	4/21/12	50
Finalize Plan	3/5/12	3/16/12	100
Submit Plan	3/16/12	3/17/12	100
Get Provisional Approval	3/19/12	3/22/12	100
Get Final Approval	3/19/12	4/21/12	25
Foundation Works	3/23/12	5/2/12	15
Bhoomi Pooja	3/23/12	3/24/12	100
Excavation	3/23/12	4/4/12	40
Curing	4/5/12	4/10/12	0
Construction	4/11/12	5/2/12	0
Structural Works	5/3/12	7/5/12	0
Wall Construction	5/3/12	6/14/12	0
Roof Construction	6/14/12	7/5/12	0
Electrical Ducting	6/14/12	6/28/12	0
Interior Works	7/5/12	9/27/12	0

This is the timeline for the project.
Such horizontal bars indicate the project tasks.
These are details of the project tasks.

Gantt charts are named after Henry Laurence Gantt, an American Engineer and Social

Scientist who introduced them in the 1910s.

Gantt Charts were heavily used during World War I and later became an unavoidable part of civil construction projects.

From 1980s, computers have been used for creating complex and elaborate Gantt charts. Their primary usage is for project scheduling and for monitoring progress. With increased usage of technology, Gantt Charts have evolved over time and nowadays are used for budgeting and analysis too. With the penetration of the internet, Gantt charts have also become a common feature of web-based collaborative applications.

2. Gantt Charts and Its Association

As already mentioned, Gantt Charts are closely associated with project plans and project schedules. Hence, let us first take a quick look at the some of the basic principles of project planning & scheduling.

A project plan is a document stating of how and when a project's objectives are to be achieved.

A plan is often further elaborated through a project schedule, which shows a list of the project's summary and terminal elements with their respective start and end dates.

Terminal elements are the lowest level tasks in a schedule, which cannot be further subdivided.
Summary elements comprise of one or more terminal elements, and hence represent a group of activities to be completed for achieving a common objective or milestone.

For example, in a software development project, many programs will have to be written, tested and integrated to create the final application. Separate tasks will be created for writing and testing of each program. Each such task is typically assigned to a single person and hence cannot be broken down any further. These are examples of lowest level tasks or terminal elements in a project schedule.

For example, creation of a module will need several programs to be coded, tested and integrated to create a single executable file. Hence, it becomes a summary task with many sub-tasks under it.

In order to create a project schedule, a work breakdown structure has to be created first. The work breakdown structure is a **tree structure**, which shows a subdivision of effort & resources required to achieve the objectives of the project.

At this stage, let us take a real-life example to understand projects and project schedules.
Let us say we want to construct a house. This calls for detailed planning and execution of several tasks over a long period in a very controlled manner.

Without proper planning and monitoring, the construction can get seriously delayed and can also overshoot the budgets. Very often, house constructions are done in “Phases”.

To make things simple, let us focus on the first phase of the project only. In this phase, we want to complete up to Plumbing Works. Four different steps have to be completed to achieve this milestone.

Step 1: Get approvals
Step 2: Build the foundation
Step 3: Construct the exterior structure
Step 4: Complete the plumbing works

Each step needs multiple smaller tasks to be completed. Some of these tasks can be done in parallel whereas some of them have to wait for other tasks

For example, to get all the approvals, four smaller tasks will have to be completed.

- We have to finalize the design & plan of the house
- The plan has to be submitted to concerned authorities (City Corporation etc.)
- A provisional approval has to be obtained (to get the works started)
- The final approval has to be obtained (this will take some time)

Here the summary task “Get Approvals” is divided into four terminal tasks, which cannot be sub-divided any further.

Decomposing the project into sub-components and tasks to achieve interim and final objectives is called “Work Break Down". The resulting tree structure with groups of tasks is called a Work Break Down Structure.
The work break down structure for our house construction project will look like this:
Figure 2

Name	Begin date	End date	Completion
Get Approvals	3/5/12	4/21/12	50
Finalize Plan	3/5/12	3/16/12	100
Submit Plan	3/16/12	3/17/12	100
Get Provisional Approval	3/19/12	3/22/12	100
Get Final Approval	3/19/12	4/21/12	25
Foundation Works	3/23/12	5/2/12	15
Bhoomi Pooja	3/23/12	3/24/12	100
Excavation	3/23/12	4/4/12	40
Curing	4/5/12	4/10/12	0
Construction	4/11/12	5/2/12	0
Structural Works	5/3/12	7/5/12	0
Wall Construction	5/3/12	6/14/12	0
Roof Construction	6/14/12	7/5/12	0
Electrical Ducting	6/14/12	6/28/12	0
Plumbing Works	7/5/12	8/16/12	0
Bathroom Works	7/5/12	8/16/12	0
Kitchen Works	7/5/12	8/16/12	0

In this figure, we can see that the 13 Terminal (low-level) elements have been grouped under 4 Summary tasks. Two of these are milestones, indicating interim goals to be achieved.
A project schedule is then created using the work break down structure.

As we have already discussed, a schedule is primarily made up of tasks. A task represents work to be accomplished within certain timelines, in order to achieve all or some of the project’s objectives.
The lowest level tasks represent the individual and specific work elements, which cannot be

broken down any further.

Let us take the scenario of a student preparing for examinations. The student has identified three tasks to prepare for Physics. These are:

- Revision of chapters 3 to 5
- Revision of chapter 6
- Solving of past question papers

Each such task can have several attributes. The most important ones in context of building Gantt charts are:
Task Name: This will be a short description of the objective or nature of the task.
In this example, ‘Revision of chapters 3 to 5’ is the task name.

Start Date/Time: This will be the planned start date, if the task is yet to begin. It will be the actual start date, if the task has already begun.
In this example, 23rd Feb is the start date.

End Date/Time: This will be either the planned end date (if the task is yet to begin or is in progress) or actual end date (if the task is already completed).
In this example, 3rd March is the end date.

3. Dependency

Dependency: In some cases, execution of a task may depend upon the status of another task. In such cases, both these tasks become “linked” and a dependency is established between them. In other words, such tasks cannot be executed independently; they are influenced by the status of one or more other tasks.

1. Finish to Start (FS):
A FS B *means* B cannot start before A is finished.
In our example, we cannot start the revision of chapter 6, without finishing the revision of Chapters 3 to 5.

2. Finish to Finish (FF)
A FF B *means* B cannot finish before A is finished.
In our example, we can end the solving of past question papers only after ending the revision.

3. Start to Start (SS)
A SS B *means* B cannot start before A starts.
In our example, we can start the solving of past question papers only after starting the revision.

4. Start to Finish (SF)
A SF B *means* B cannot finish before A starts.
There is no such dependency in our example of preparation for Physics.
For start to finish dependency, we can take an example of a factory. Here, the current production shift cannot end before the new shift starts (means an overlap between two shifts is necessary). In this case, (B=Current Shift) SF (A=New Shift).

Dependency is a very important aspect of project scheduling. They determine the complexity of a project and the “critical path” to complete the project. Depicting and tracking dependencies is always a challenge for project managers.

In our example of preparation for the examination, there are two types of tasks.
These are the three tasks each representing specific work to be done. Each can be completed independently, subject to fulfilling their dependencies.

There is one group level or summary task, which has three sub-tasks. In our example, it is “Preparation for Physics”.

This summary task will be completed only when all the sub-tasks are completed.
The start date of the summary task is determined by the earliest start date of all its sub-tasks.
Its end date is determined by the latest end date of all its sub-tasks.

A milestone is a reference point in a project schedule to indicate an important interim goal or objective to be achieved while the project is getting executed.
Milestones carry just one target date (“End date”). However, they can have all the other attributes of tasks, including dependencies with other milestones and tasks.

Tasks can have dependencies with milestones too.

Since a project is all about achieving stated objectives, its overall status or progress can be ascertained by looking at the status of the interim milestones, without having to get into details of tasks. Hence, milestones are very useful for project reviews.

There is an important point to note here. From a project management angle, a lot more information is recorded and analyzed for both tasks and milestones. Such information includes duration, effort, people allocation, cost, priority status, progress % and so on.
However, the key attributes required for preparing Gantt Charts are the start/end dates and dependencies. Hence, we will limit our discussion to these attributes only.

4. Uses of Gantt Charts in Project Scheduling

In today's world, project schedules are invariably prepared using software based project management tools. We have used an open source project management software tool to illustrate the examples in this session.
Let us create a schedule for our house construction project Phase 1 involving the following 4 steps.

1. Get approvals
2. Build the foundation
3. Construct the exterior structure
4. Complete the plumbing works

We have to create the Work Break Down structure by grouping the low-level tasks into meaningful summary components.
Figure 3

Name	Begin date	End date	Duration	Predecessors
Get Approvals	3/5/12	4/21/12	35	
Finalize Plan	3/5/12	3/16/12	9	
Submit Plan	3/16/12	3/17/12	1	3
Get Provisional Approval	3/19/12	3/22/12	3	5
Get Final Approval	3/19/12	4/21/12	25	5

Here, we have created 4 tasks under the summary "Get Approvals".

We have entered the start and end dates for each task. The duration for the lower level and group task is calculated by the tool based on the start and end dates.

We have specified the dependencies for each task. For example, "Provisional Approval" has a "Finish to Start" dependency on "Submit Plan". In other words, Provisional Approval can be started without Submitting the Plan.

In a similar manner, the entire Work Break Down structure has to be converted into a project schedule. The full Work Break Down structure in our example will look like this:
The 4 group tasks and 13 low level entries are now created with start/end dates and dependencies

Out of the 13 terminal entities, 2 are milestones – "Submit Plan" and "Bhoomi Pooja". All others are tasks.

This project plan is now in a tabular form. A much better visualization is possible using a Gantt Chart, which will look like this:
All the tasks and milestones are plotted against the project timeline, showing the flow of work

towards completing the project.

Summary tasks (thick lines with bent edges) are shown separately from Lower level tasks (wide bars).

Milestones (diamond-shaped objects) are distinguished from tasks (bar-shaped objects).

Dependencies (thin lines with arrows) between linked tasks and milestones are clearly highlighted.

Progress (dotted lines) with execution of tasks is shown on top of the task bars.

- As you can see, the Gantt chart presents a much better view of the project plan. It helps us to quickly form a high level impression about the duration and sub-components of the project. It also helps us to easily understand the flow of work and the dependencies associated with the tasks.
- From another perspective, a Gantt chart will help us to appreciate the complexities involved with a project in an easier and quicker manner.
- Gantt Charts use very little text and hence are ideal to share Project Plans & Schedules across multi-lingual, multi-cultural teams.

With several such advantages, Gantt Charts have become the preferred way of presenting project plans & schedules, across the world.

- There are no default colour codes for tasks, milestones and other components of a Gantt Chart. You are free to choose your preferences. Most of the project management tools provide you with options to manipulate the look & feel of Gantt Charts.
- Modern project management tools support several enhanced versions of Gantt Charts giving additional information about progress, criticality, etc.
- Although a Gantt chart is useful and valuable for small projects that fit on a single sheet or screen, they can become quite unwieldy for projects with a large number of activities or with long time horizon. Gantt charts may not be suitable for certain computer displays. Similarly, displaying a large number of dependencies may result in a cluttered or unreadable Gantt chart.
- Hence, in case of very large and complex projects, it is recommended to create smaller (child) charts and integrate them into summary (parent) charts. Most of the project management software tools support such requirements.
- Gantt charts primarily focus on Project Schedule management. They are not quite efficient in representing cost and scope of projects. They also do not represent the size of a project.

5. Uses of Gantt Charts

Gantt Charts are very widely used by managers in every industry sector dealing with projects:

- Software projects and product development
- Civil construction projects (buildings and structures)
- Defence planning (deployment of troops and weapons, infrastructure creation)
- Heavy Engineering projects (commissioning of plants, machinery, etc)
- Aeroplane and Automobile design and development projects
- Governmental programs (public services and utilities)

Gantt Charts are also used for team communication and workplace collaboration across company networks and internet.

Gantt Charts have emerged as the world's preferred technique for presenting project plans and schedules. With the availability of powerful project management software products, generating and updating Gantt Charts have become quite easy.

Even in today's digitized world, large and colourful Gantt chart printouts decorate the project management offices across the world. They represent the pride and commitment of teams towards the success of complex, mission-critical projects.

To understand more about dependencies, let us take an example of software projects. The first step is to get a sign off from the customer about the scope of the project. Without completing this, no other activities should start. Here, this task has a Finish to Start dependencies with all other activities in the project.

Every module developed by the team has to undergo independent testing without that the application module cannot be released to the customer. Hence, independent testing has a Finish to Finish dependency with the developed module.

The same dependency can be expressed differently. We can say that an independent testing has a Finish to Start dependency with a release of a module. Meaning that the release can be done only after completing independent testing.

Architecture definition and high level design are typically done at the beginning of the project. It is not necessary for them to wait for each other completion. However, design cannot start before architecture. This means an architecture definition has a *Start to Start* dependency with the high level definition.

Coding and testing of programmes always overlap with each other. Testing will invariably bring up defects and changes that have to be recoded into the programme. This loop will continue until the programme becomes defect free. Hence, we can say coding cannot finish before commencing of testing. This means testing has a *Start to Finish* dependency with coding.

Dependency is a very important aspect of project scheduling. Dependency represent the constraints in the project, hence they determine the complexity of the project and the critical

path to complete the project.

Depicting and tracking the dependency is always a challenge for project managers. One interesting point to note is that the same constraint can be addressed using different types of dependencies.

Project managers can apply their creativity in determining the best or least complex way of establishing dependencies in their project plan.

Here's a summary of our learning in this session:

- Explain Gantt Charts
- Create simple Gantt Charts
- Interpret Gantt Charts
- Appreciate the use of Gantt Charts in real-life situations