

Course Title

Project Engineering

Chapter 3

PROJECT PLANNING AND SCHEDULING

Lecture 5 (Week 5)

Work Breakdown Structure, Introduction to Project Scheduling and Bar Chart

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Learning Objective

The main objective of this lecture is to understand about:

- Work Breakdown Structure (WBS).
- Introduction to Project Scheduling.
- Bar chart/Gantt chart

3.4 WORK BREAKDOWN STRUCTURE

How many tasks does the project have?

How much detail should the project plan have?

This query is overcome by Work breakdown structure (WBS)

This is the first major step in the planning phase of the project life cycle after the formulation of the project.

Most modern day projects are designed, organized and built by teams of specialized professionals. To organize this process efficiently it is necessary to breakdown the project into specific parts that can be coordinated and controlled. The manner in which this project is structured is termed as the project's work break down structure (WBS). The first major step in the planning process after project requirements definition is the development of work breakdown structure (WBS). [1]

Successful completion of project (or program) requires a plan that defines all its components, assigns responsibility to a specially identified organizational element, and establishes schedules and budgets for its accomplishment. WBS is a process by which the whole project is divided into various sub-projects, the sub-projects into various tasks, the tasks into various sub-tasks, and finally sub-tasks into work packages. [2]The purpose of WBS is to identify terminal elements (the actual items to be done in a project); therefore WBS serves as the basis for much of project planning.

Usually, the project manager is responsible for structuring a project into several components. The level of the smaller components should be such that each of which should be:

- **Manageable** so that specific authority, and responsibility can be assigned
- **Independent** so that there happens to be minimum interfacing with and dependence on other ongoing elements
- **Integratable** so that the total package can be seen, and
- **Measurable** in terms of progress

Level of WBS (Family tree)

Level	Description
1.	Total Program
2.	Project
3.	Task
4.	Subtask
5.	Work package

6.

Level of effort

The upper three levels of the WBS are normally specified by the project management office (customer), while the lower levels are generated by the contractor for in-house control. Each level serves a vital purpose: level 1 is generally used for the authorization and release of all work, budgets are prepared at level 2, and schedules are prepared at level 3. The reason for this subdivision of effort is simply ease of control.

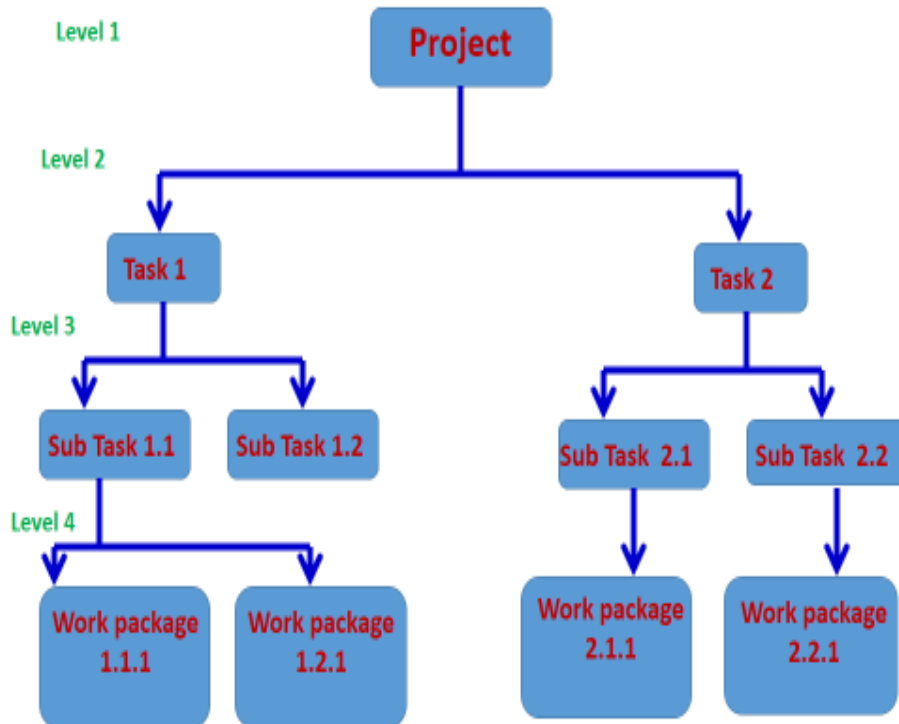


Fig: A typical WBS structure

There is no hard and fast rule as to number of levels into which the project is to be breakdown. The number of stages/ levels should be neither too few nor too large. If the project is broken down into only one or two levels, integration of activities may become difficult. On the other hand if number of level are very high it will make analysis complex and unproductive. So WBS should be carried on till such time that the work package (small element) available is capable of giving a good definition of work content, the resource required and the cost and time requirement.

Types of WBS

1. Deliverable-Based Work Breakdown Structure

A Deliverable-Based Work Breakdown Structure clearly demonstrates the relationship between the project deliverables (i.e., products, services or results) and the scope (i.e., work to be executed). In figure below, the Level 1 Elements are summary deliverable descriptions. The

Level 2 Elements in each Leg of the WBS are all the unique deliverables required to create the respective Level 1 deliverable.

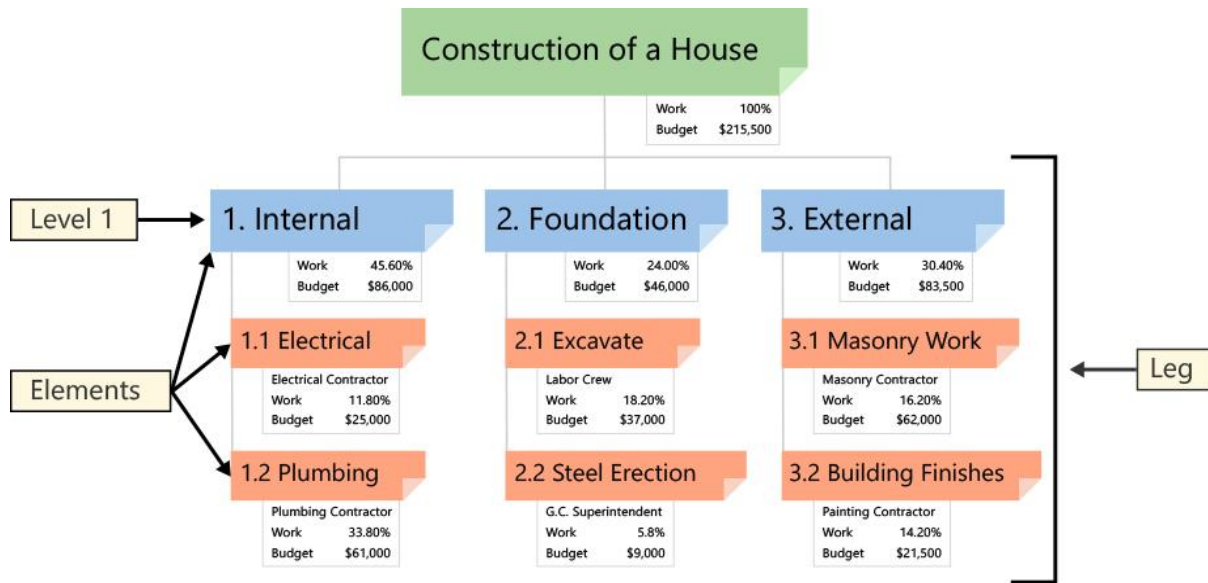


Fig Source: [3]

2. Phase-Based Work Breakdown Structure

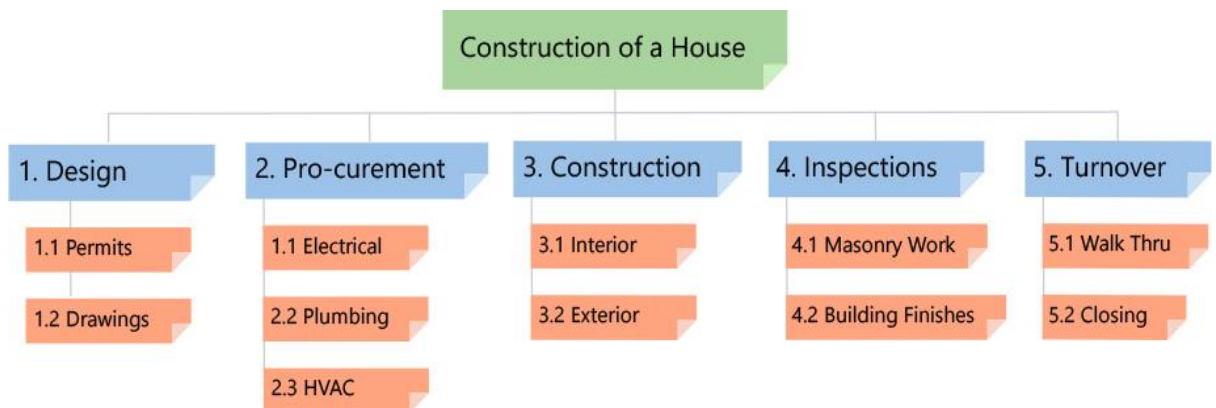


Fig Source: [3]

In Figure, a Phase-Based WBS, the Level 1 has five Elements. Each of these Elements are typical phases of a project. The Level 2 Elements are the unique deliverables in each phase. Regardless of the type of WBS, the lower Level Elements are all deliverables. A Phase-Based WBS requires work associated with multiple elements be divided into the work unique to each Level 1 Element. A WBS Dictionary is created to describe the work in each Element.

Role of WBS

The WBS is the single most important element because it provides a common framework from which: [1]

1. The total program can be described as a summation of subdivided elements.
2. Costs and budgets can be established.

3. Time, cost and performance can be tracked.
4. Objectives can be linked to a company resources in a logical manner.
5. The responsibility assignment for each element can be established.
6. Network construction and control planning can be initiated.

Criteria for developing WBS

- The WBS and work description should be easy to understand.
- All schedules should follow the WBS.
- No attempt should be made to subdivide work arbitrarily to the lower possible level.
- Since scope of effort can change during a program, every effort should be made to maintain flexibility in the WBS.
- The WBS can act as tangible milestones
- The WBS can be used to segregate recurring from nonrecurring costs.
- Most WBS elements (at the lowest control level) range from 0.5 to 2.0 percent of the total project budget.

3.5 PROJECT SCHEDULING

Projects are growing increasingly complex and costly; therefore attention must be paid to the control of both time and cost. Improved management and scheduling of projects are imperative to the success of any project, particularly large scales ones. Therefore it is necessary to schedule a project by using proper techniques. A schedule is defined as “time phased” plan for performing the work necessary to complete the project.

A schedule is graphical representation which shows the starting and completion dates of each activity and the sequential relationship among the various activities. Project scheduling refers to the process of laying out all the actual activities of the project in the time order in which they are to be performed. [2]The schedule development process must often be inter-related along with cost estimating prior to determination of the project schedule. [4]

Scheduling is the process of listing a number of duties or events in the sequence that they will occur. It is a time table and it formulates the activities that must be accomplished to reach a certain goal or objective. [5]Schedule let people and organizations to know in advance when to expect a certain action to take place. Now a day’s large project consist of innumerable activities interdependent to one another, it is necessary to make the schedule in a systematic way for easy understanding and reference. [6]

Scheduling is done in the following steps [7]

1. **CALCULATE** : Detailed control information
2. **ASSIGN**: Timings to events and activities.

3. **GIVE:** Consideration to the resources. The manager is generally concerned with those resources whose availability is limited and may impose a constraint on the project.
4. **ALLOCATE:** The resources

Therefore scheduling also can be said as allocation of resources needed at each stages of production, along with the expected completion time of each activity.

Why Project Scheduling?

- To predict project completion time and activity completion time.
- To control financing and payment.
- To serve as a record.
- To support delay claim.
- To manage changes and uncertainties

METHODS OF PROJECT SCHEDULING

1. Bar chart / Gantt chart
 - Linked Bar Chart
 - Milestone Chart
2. Network Analysis
 - Critical Path Method (CPM)
 - Program Evaluation Review Technique (PERT)
 - Precedence Diagramming Method (PDM)
3. Line of Balance Technique.

3.5.1 BAR CHART/GANTT CHART

The oldest formal planning tool is the bar chart. It is developed as a production control tool in 1917 by Henry L. Gantt, an American mechanical engineer, hence also called Gantt chart in his respect. It is a graphical or pictorial representation showing the various activities involved in a project. The job/ activities are listed vertically as per their sequence and each of them is allotted a horizontal strip, denoting the estimated time to complete that particular activity as per calendar days/months. [6] Bar chart is used as scheduling tool for small and medium size project.

Steps in Preparing Bar Chart

- Breakdown the whole project into various activities or into sub activities.
- Develop a logical sequence of the activities and also find out the activities that can be executed concurrently.
- Decide the time duration for each activity for its completion.

- Finally by using a number of bars, as required, the different activity to be performed are indicated on a chart.

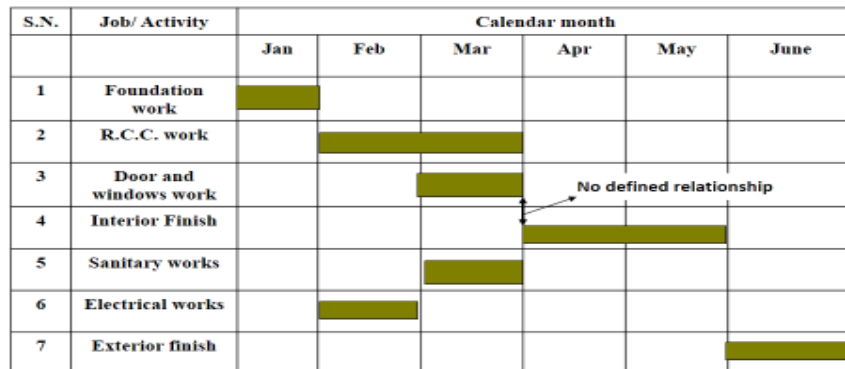


Fig: Bar Chart for a typical building project [6]

Advantages

- The simple graphical form of bar chart results in relatively easy general comprehension. [8]
- It gives the pictorial representation of the status of a project at any point of time, which is easily understood by the laymen.
- The overall performance of the activity can be judged from chart without going through the status or detailed report. [6]
- It is useful for reporting who are not involved in day to day management.
- Bar chart is used as the preliminary planning tool.

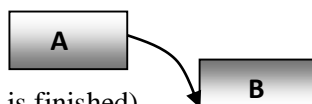
Limitation /Disadvantages

- If too many activities are shown separately in a bar chart, then it becomes messed up. Hence it is not suitable for large and complicated project.
- Lack of interrelationship and interdependencies among the activities.
- It cannot be used as control tool for large projects.
- Each activity receives the consideration with no indication where management attraction should be focused.
- Critical activities are difficult to be identified and floats are unknown.

LINKED BAR CHART

One of the major limitation of bar chart is it does not show the inter relationship and inter dependencies among the activities. So a linked bar chart is introduced which is a modified form to overcome some of the limitation of bar chart. It shows the link between an activity and the preceding activities which have to be completed before this activity can start and the succeeding activities which are dependent on this activity. Linked bar chart uses the links (arrow) to show the relationship between activities.

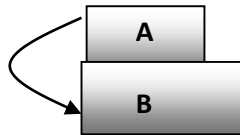
1. Finish to Start



(Activity B cannot start until Activity A is finished)

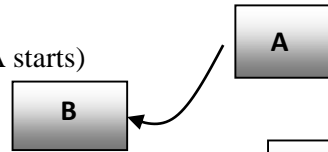
2. Start to Start

(Activity B must start when activity A starts)



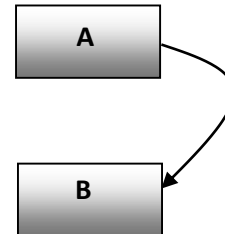
3. Start to Finish

(Activity B should be finished when activity A starts)



4. Finish to Finish

(Activity B must be finished when activity A finishes)



MILESTONE CHART

It is a modification over the original bar chart. When a particular activity represented by a bar on a bar chart is very long, the details lack. A Chart that graphically depicts key events along a timescale, usually with triangles representing each event, is called milestone chart. Milestones provide a sense of accomplishment and show project team how the work they're doing contributes to the overarching project objective. It only identify the scheduled start or completion of major deliverables and key external interfaces. [4]

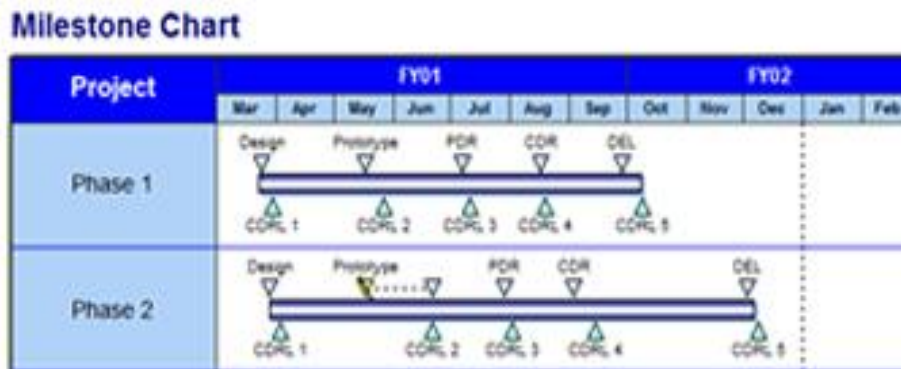


Fig Source: [9]

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