Projects typically start with a statement of work (SOW) provided by the client. This is the simple, narrative statement provided by the client. From this a PDS (or requirements document) is developed. It specifies all the characteristics of the product. This is developed in coordination with the client; both you and the client must be in agreement with the PDS. But as you recall, it is a working document and changes inevitably occur in a PDS as more knowledge of the project is gained.

**Work Breakdown Structure**

Planning starts with the development of a work breakdown structure (WBS). A WBS is “is a deliverable-oriented grouping of project elements which organizes and defines the total scope of the project.” (Smith)

“The WBS is a listing of all the tasks needed to complete the project, organized in a way to help the team understand how all of the tasks fit into the overall design project.” (Dym and Little)

There are several levels of WBS within a project such as **program, project, task, subtask**, etc.

Some guidelines for WBS (Dym and Little)

1. Any task that is taken to a lower level is broken into TWO or more subtasks at the lower level.
2. If the duration of a task or who will do it cannot be determined, it probably should be broken down further to subtasks.
3. A WBS should be complete in that ALL activities or resources are included. {documentation, meeting, presenting results.
4. The time required to complete a task should be the sum of time to complete all levels below.

WBS is not

1. an organizational chart for completing the work. It is a breakdown of tasks not roles or people.
2. a flow chart showing the relationships between or sequence of tasks.
3. a list of all the disciplines or skills needed to complete the project

Development of a Work Breakdown Structure for the sequence of tasks for a Preparing and Eating a Meal Project.

A two level WBS might be

**Preparation**

- Boil soup,
- Boil rice,
- Boil peas,
- Brown chicken,
- Prepare sauce,
- Bake chicken, rice and sauce,
- Open wine and let it breathe.

**Eating**

- Eat soup
- Eat entrée

**Activity on Node** – Each node has an activity from WBS associated with it. The interconnection of activities shows their relationship to other tasks. Figure 4.6 Dym and Little
Types of relationships

1. Finish to Start – One task cannot begin until another is finished.
2. Finish to Finish – One task cannot be finished (though it may be started) before another task is finished.
3. Start to Start – One activity cannot be started till another is started.

Activity On Node (Figure 6.1 Smith) and Precedence Network or Activity Network (Figure 6.2 Smith)
Note that details of each task including duration of the task are included.

Critical Path Method (CPM) or Project Evaluation and Review Technique (PERT)

Forward Pass – Early Start (ES) and Early Finish (EF) (Figure 6.3 Smith)
- Early Start – Earliest start of a task considering dependence upon other tasks - Upper Left
- Early Finish – Earliest time to finish a task (corresponds to the early start of succeeding tasks) – Upper Right

Backward Pass – Late Start (LS) and Late Finish (LF) (Figure 6.4 Smith)
- Late Start – Latest possible starting time of a task considering dependence on other tasks – Lower Left
- Late Finish – The result of late start – Lower Right

Critical Path – Paths for which the earliest and latest times are equal. That is, they cannot be delayed without delaying the duration of the entire project.
The remaining non-critical activities have some float (or slack) and can have their duration increased by some amount before they become critical and delay the total duration of the project.
Float (or Slack) The amount by which termination of a non-critical activity can be delayed before it causes one of its successors to be delayed is called the free float of that activity. The float for an activity is calculated as the minimum early start for the activities that follow it minus the early start for the activity itself minus the duration of the activity or in equation form
\[ FF_i = (ES_{i+1})_{min} - ES_i - D_i \]

This information is used to note the important tasks and possibly to alter the timing of other non-critical paths due to their float. Software makes this easy to implement, even in Excel. But commercial versions are automatic. Figures 5.2, 5.3 & 5.4 (Dominick, Demel, et al.)

Gantt Charts – Convey the same information as an AON chart, but with time along horizontal the axis. All the tasks are shown along with milestones. Software often includes links that shows the relationships between the different tasks to better illustrate their inter-dependence. Critical paths can be identified and highlighted automatically by the software.