

# Graphical Project Planning Techniques: An Overview of Gantt, PERT, and CPM Charts

Prepared for groups in ECE480

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## Introduction/Purpose

The purpose of this brief tutorial is to present an overview of several graphical project planning techniques and provide a “cookbook” approach to creating these charts for a project like those encountered in ECE480. This should not be taken as a definitive study of the Gantt, PERT, or CPM charts, but should be helpful for those students unfamiliar with these techniques.

## Background

Projects that involve more than one person and/or more than one step pose the following questions:

- What tasks need to be done to complete the project?
- When and in what order will these tasks be done?
- Who will do each task?
- What are the intermediate deadlines (e.g., status reports), and what will be done by these deadlines?

To answer these questions, additional issues arise, such as:

- How long will each task take?
- What dependencies exist between tasks?
- Who has the knowledge/skill/time to do each task?
- What external constraints exist (e.g., time to order parts)?

The Gantt, PERT, and CPM charts describe the answers to these questions in time-oriented diagrams.

In all cases, the “task” is the basic unit of interest. In this context, a task is some significant activity the group will need to perform to accomplish its goals. Note that the group will have goals that include the project itself as well as presentations, reports, proposals, etc.

Tasks are given:

- a name/description (typically, verb-noun, as in “design control board” or “research literature”)
- an estimate of the amount of calendar time required
- a list of other tasks (if any) that must be completed before this task can begin (or end)—i.e., *dependencies*.

Other task attributes can be added if desired, such as time required in person-hours and other resources required (e.g., financial, special skills, special equipment).

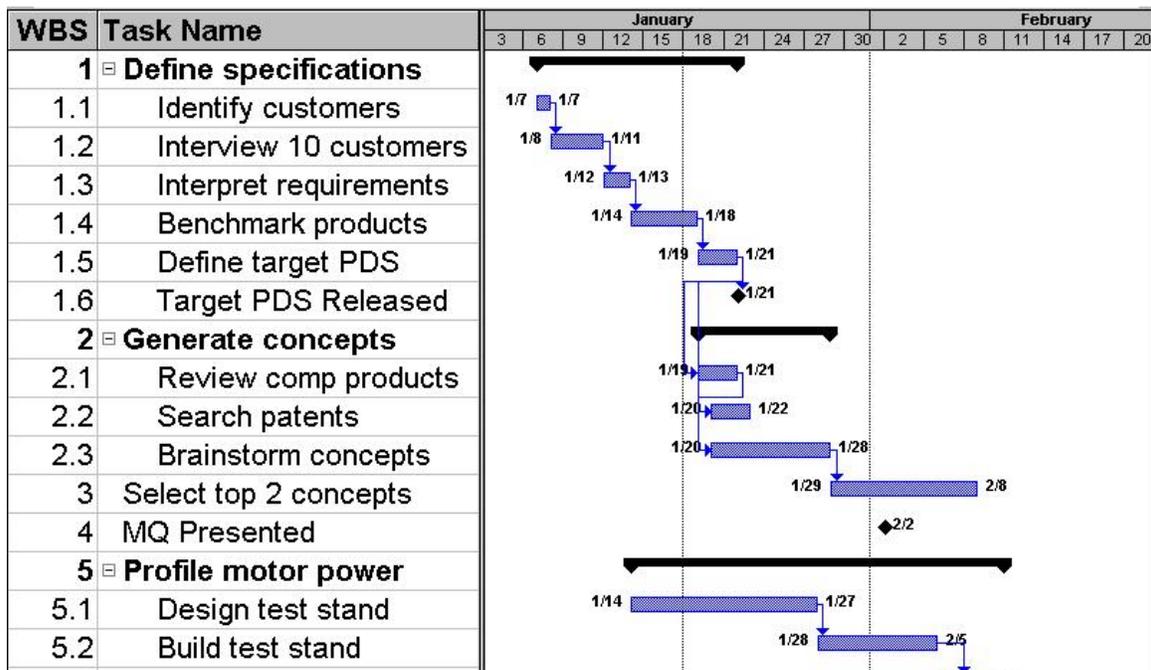
Besides tasks, other information is required, such as:

- the overall project start/end dates
- other deadlines or milestones (e.g., reports, etc.)
- factors affecting time available (e.g., holidays, breaks, other classes, presentations, etc.)

Now the three methods (Gantt, PERT, CPM) will be described. Following that, a “cookbook” approach to the creation of a Gantt chart will be presented.

## Gantt

The Gantt chart was invented in the early 1900’s by Henry L. Gantt, an American engineer and social scientist. The horizontal axis is (linear) time; each task is given its own horizontal band where the calendar duration of the task is indicated by a box, line, or other object with a variable horizontal dimension. Tasks are often grouped into categories, and each category can be treated as a summary task whose duration spans all the tasks within that category.



**Figure 1: Example Gantt chart, generated using Microsoft Project (source: <http://www.me.umn.edu/courses/me4054/assignments/gantt.html>)**

Tasks are generally listed from top to bottom in the order they will occur; if there are groups of tasks, the tasks are chronological (by starting date) within a group, and the groups ordered by starting date.

The horizontal axis has a resolution appropriate to the type of tasks; a resolution of one day is useful for most projects. Note that if significant work is not expected to be done on weekends, these should be omitted from the chart, otherwise tasks will have their durations distorted if they straddle days when no work is likely.

A vertical line is usually placed on the chart to show the current date. Other important milestones can be noted (and labeled) with dotted vertical lines at the appropriate dates.

The advantages of the Gantt chart are

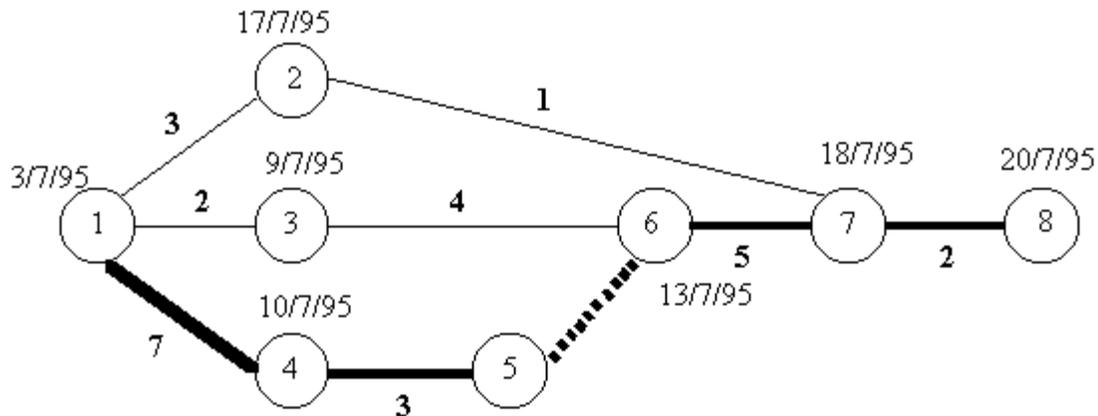
- time is explicit (and linear)
- all tasks visible in relationship to others
- deadlines are shown
- project status at intermediate times is shown
- can show progress by “filling in” task boxes

The unmodified Gantt chart has the following shortcomings:

- tasks might not be associated with people (solution: tag tasks with the initials of the people responsible)
- person-hours are not indicated, only calendar time (solution: note person-hours near the task “box”)
- dependencies are not explicit (solution: imply dependencies by ordering tasks, or use extra lines and arrows)
- no summary of the load on a person (solution: create an additional set of horizontal “task” lines for each person, showing what tasks they are working on when)
- other resources not shown (e.g., financial) (solution: note resources in description or near task “box”)
- critical paths are not explicit (solution: use highlighting or other graphical means to indicate the sequence of tasks along the critical path)
- does not record difference between original plan and actual (solution: enhance the task “box” to show two different durations—an upper (actual) and lower (estimated))

## **PERT**

A few of the shortcomings of the Gantt chart are solved in the PERT chart (Program Evaluation and Review Technique). (See Figure 2.) The PERT chart uses a connected series of nodes to make explicit dependencies between tasks. In addition, the order of tasks is given by the flow of the connections left to right, but the horizontal axis is not necessarily linear in time.



**Figure 2: CPM (PERT) chart. Nodes are events (here numbered 1-8), which occur on completion of tasks. Lines connecting events are tasks (activities), which have a calendar duration (in days) noted. The bold lines show the critical path. (Source: <http://www.doc.mmu.ac.uk/online/SAD/T04/projman.htm>)**

The PERT chart can be more compact than the Gantt, but does so at the cost of a linear time scale. The time resources required by a task are given numerically, rather than appearing graphically (i.e., horizontal dimension) as in the Gantt chart; this may make it harder to quickly see what areas are using the most time resources.

## CPM

The CPM (Critical Path Management) chart is similar to the PERT chart but includes an explicit indication of the “critical path”—that sequence of tasks that defines the minimum amount of time for the project. Put another way, these are the tasks that a delay within will delay the entire project. One or more sequences of such tasks always exists; the CPM chart makes these paths (usually just one) explicit. Otherwise, CPM shares the same strengths and weaknesses as the PERT, and the two are often lumped together as one technique.

For complex, time-critical projects, the CPM/PERT charts might be useful in providing a clear indication of the critical sequences of tasks necessary to keep the project on schedule. However, the Gantt chart—especially when augmented by notations to show dependencies—is easier to produce and update, and is a good all-around project planning tool.

## A “Cookbook” Approach for the Gantt Chart

What follows is one way of creating a Gantt chart.

1. List all known milestones, deadlines, and deliverables (papers, presentations, etc.)
2. List all outside constraints on time (holidays, exams, etc.), money, equipment, etc.
3. Create a list of tasks

- a. brainstorm a list of as many possible tasks for the project as possible  
(Brainstorming: In a set amount of time, say 5 minutes, the group lists as many ideas as possible *without criticizing them*. Some will be useless; the idea here is to get as many different possibilities out as possible. Some might be tasks, others might be general categories of tasks.)
- b. group these brainstormed tasks into categories (e.g., documentation, software, etc.). Some elimination of ideas can be done at this point.
- c. review each category and brainstorm additions within the category
4. Because these tasks have been brainstormed, go back and eliminate any tasks that are not significant or relevant.
5. For each task in the list
  - a. time (in person-hours, then estimate calendar)
  - b. dependencies (other tasks)
  - c. resources (money, parts, equipment)

(Note—the procurement of parts, equipment, and even expertise/knowledge might be a task in itself.)

- d. who will be doing it (perhaps a function of required knowledge/skill, or time)
6. Organize the task groups by starting date (or other logical and consistent criteria), and tasks within groups by starting date

Note: You might find it useful to list each task on a small Post-It note so you can create a large scale version before working on the computer.

7. Use Excel or other tool to create the Gantt chart
  - a. Remember to include only working days on the time axis
  - b. Significant (and possibly recurring) milestones or deadlines can be shown as tasks (of minimal duration), as vertical lines at the appropriate date, or on the time axis.
  - c. Provide a table of symbols or any other necessary information to interpret the chart
  - d. Always show the current date as a vertical line; note the last revision date of the chart as well somewhere on the chart

PERT and CPM charts may require either special software or more flexible software like diagramming/paint programs. Choose a chart type and method of creating the chart such that you can easily update the chart for your progress reports and even weekly meetings.

## Resources

Overview of Gantt charts, description of how to create a Gantt chart in MS Excel:  
<http://www.me.umn.edu/courses/me4054/assignments/gantt.html>

Commercial site with Gantt chart overview & tutorial:  
<http://www.smartdraw.com/resources/centers/gantt/>

Example Gantt chart: <http://curry.edschool.virginia.edu/go/ITcases/Terry/chart.html>

Overview of Gantt, PERT, CPM: <http://studentweb.tulane.edu/~mtruill/dev-pert.html>

Gantt and PERT/CPM, with good information on creating and analyzing PERT/CPM:  
<http://www.doc.mmu.ac.uk/online/SAD/T04/projman.htm>