Manufacturing and Service Operations Planning

Spring 2019

Project Management in Practice

characterize project completion times and other outputs of the simulation analysis. Furthermore, it has a comprehensive set of probability distributions available and the selection of these distributions is facilitated by graphically showing the analyst the shape of the distribution based on the parameters specified. This capability allows the user to interact with the software when specifying the parameters of a distribution. The analyst can immediately assess the impact that alternative parameter settings have on the shape of the distribution. Another powerful feature of Crystal Ball® is its ability to quickly calculate the probability associated with various outcomes such as the probability that the project can be completed by a specified time. In addition, CB can display the results in a variety of formats including frequency charts, cumulative frequency charts, and reverse cumulative frequency charts. It also provides all relevant descriptive statistics as was illustrated earlier.


Risk

Using the sample problem, risk analysis is carried out by a simulation using Crystal Ball®. Each step in the process is described. Conclusions similar to those reached in the statistical procedure of Section 5.2 are reached through simulation. The two procedures are compared by examining the assumptions on which they are based as well as the problems encountered in using them. The computational effort and assumptions required by the traditional statistical approach lead us to the conclusion that simulation is the preferred technique for carrying out risk analysis.

5.4 THE GANTT CHART

Henry Gantt, a major figure in the "scientific management" movement of the early twentieth century, developed the Gantt chart around 1917. A Gantt chart displays project activities as bars measured against a horizontal time scale. It is the most popular way of exhibiting sets of related activities in the form of schedules.

The Chart

Figure 5-21 shows a Gantt chart of the sample project in Table 5-4. The expected times are used in this illustration. Clearly, Gantt charts are easy to draw. Because task names are usually descriptive, each task shows its name, WBS number, or ID number in order to identify predecessors. Any activity that has no predecessors starts at the beginning of Day 1 and extends to its duration (as in task **a**). An activity with predecessors begins when its latest predecessor has been completed (as in task **f** or **h**).

Problems in understanding the chart can arise, however, when several tasks begin at the same time and have the same duration. If one such task is on the critical path and the others are not, it may be difficult to find the critical path on a Gantt chart. For instance, had **c** and **d** both been the same duration, it would not have been possible to tell which was predecessor to **f** and which to **g**, just by looking at the chart. This is only a problem when the Gantt chart is prepared manually. Most software, MSP included, will use arrows, bolded bar outlines, colored boxes, or some other visible means of marking the critical path on a Gantt chart as in Figure 5-22.

Even with software aid, the technical dependencies are harder to see on a Gantt chart than on a PERT/CPM network. On the network, technical dependencies are the

WBS	Task	Duration	Predecessors
1	a	10.67 days	
2	b	12.17 days	1
3	c	12.33 days	2
4	d	6 days	2
5	e	14.33 days	2
6	f	9.33 days	3, 4
7	g	10.33 days	4
8	h	7.83 days	5, 7

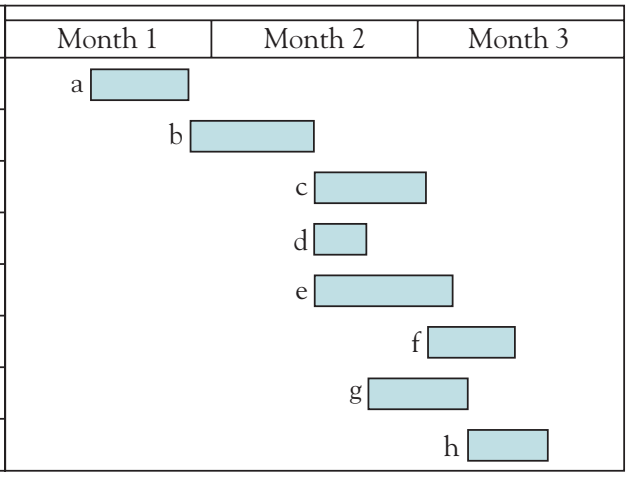
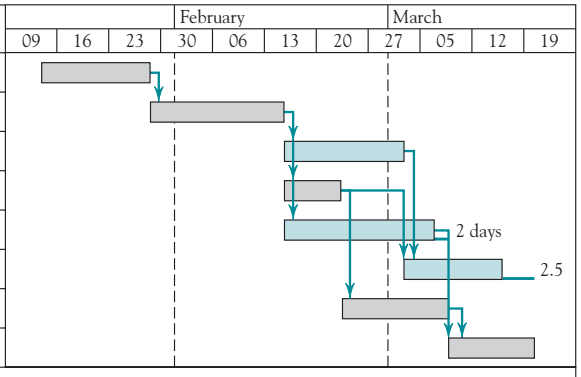


Figure 5-21 A Gantt chart of a sample project in Table 5-4 (MSP).

WBS	Task	Estimate dur	Start	Finish	Late start	Late finish
1	a	10.67 days	01/14	01/28	01/14	01/28
2	b	12.17 days	01/28	02/15	01/28	02/15
3	c	12.33 days	02/15	03/03	02/18	03/07
4	d	6 days	02/15	02/23	02/15	02/23
5	e	14.33 days	02/15	03/07	02/17	03/09
6	f	9.33 days	03/03	03/16	03/07	03/20
7	g	10.33 days	02/23	03/09	02/23	03/09
8	h	7.83 days	03/09	03/20	03/09	03/20



Critical path and slack shown

Figure 5-22 A Gantt chart of the sample project in Table 5-4 showing critical path, path connections, slack, ES, LS, EF, and LF (MSP).

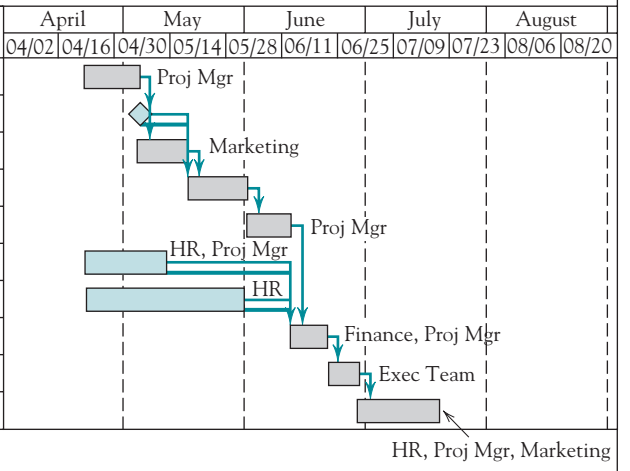
focus of the model. As can be seen in Figure 5-22, information can easily be added to the chart to show such things as ES, EF, LS, LF, and slack.

Selecting another example for illustration purposes, it is simple to show resource requirements as in the Day Care project (see Table 5-6). The three-time estimates can be shown in Figure 5-23 as well as in Table 5-6, but Figure 5-23 shows only T_E to save space. Time and resource requirements may also be automatically transferred to the Gantt chart if desired.

It is also easy to show the current status of a project that is partially complete, as in Figure 5-24. This project was started on April 21, and its progress is being measured as of June 6. (The calendar dates shown as column titles above the bars indicate the first

Day Care Service Investigation Project Plan

ID	Task Name	Predecessors	TE Duration
1	Develop employee survey to assess need and desire		2 wks
2	Send survey out to staff	1	0 wks
3	Develop and campaign to get staff to participate in survey	1	1.67 wks
4	Surveys returned	2, 3	2.33 wks
5	Analyze results	4	1.27 wks
6	Meet with YMCA to assess and verify proposal service		2.83 wks
7	Identify other centers in the area (usage, fee structure, etc.)		5.83 wks
8	Cost/Benefit analysis complete	6, 7, 5	1.5 wks
9	Go/No Go decision	8	1.07 wks
10	If Go, develop implementation action plan	9	3 wks



Critical path, slack, and resources shown

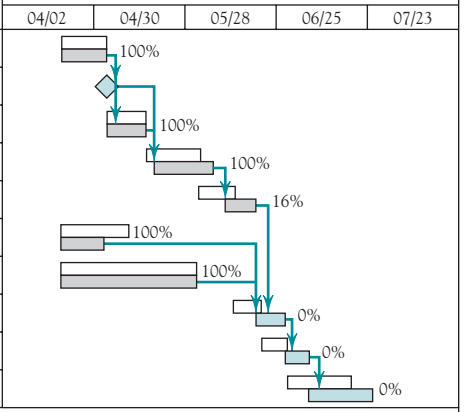
Task Critical task Milestone Slack

Project start date: 04/21
Project finish date: 07/20

Figure 5-23 A Gantt chart of a day care project showing expected durations, critical path, milestone, and resource requirements (MSP).

Day Care Investigation

ID	Task Name	Actual Dur.	Baseline Dur.	Start	Finish	Baseline Start	Baseline Finish
1	Develop employee survey to assess need and desire	2 wks	2 wks	04/21	05/04	04/21	05/04
2	Send survey out to staff	0 wks	0 wks	05/04	05/04	05/04	05/04
3	Develop ad campaign to get staff to participate in survey	1.67 wks	1.67 wks	05/05	05/17	05/05	05/17
4	Surveys returned	2.33 wks	2.33 wks	05/19	06/05	05/17	06/01
5	Analyze results	0.2 wks	1.27 wks	06/09	06/19	06/02	06/12
6	Meet with YMCA to assess and verify proposal service	2 wks	2.83 wks	04/21	05/04	04/21	05/11
7	Identify other centers in the area (usage, fee structure, etc.)	5.83 wks	5.83 wks	04/21	06/01	04/21	06/01
8	Cost/Benefit analysis	0 wks	1.5 wks	06/19	06/28	06/12	06/21
9	Go/No Go decision	0 wks	1.07 wks	06/28	07/06	06/21	06/29
10	If Go, develop implementation action plan	0 wks	3 wks	07/06	07/27	06/29	07/20



Project start date: 04/21
Project current date: 6/06

Task
Progress
Baseline task
Completed milestone
Milestone

Progress shown

Figure 5-24 A progress report on a day care project showing actual progress vs. baseline (MSP).

day of the period, in this case, 4 one-week periods.) Note that Activity 4 starts 1½ days late. It was scheduled to start at midday on May 17, but did not begin until May 19. Activity 4 finishes a week late. If nothing is done to correct the matter, and if nothing happens to increase the lateness, the project will finish about a week late.

Software such as MSP makes it easy to use a Gantt chart or network to view critical tasks and paths of a project. One can even experiment with adjustments to the project—play "what if" with the project schedule, immediately observing results of the experiments on the screen. At times the PM may question an estimate of task duration, or of the *a*, *m*, and *b* time estimates, submitted by a member of the project team. It is simple to enter alternate time estimates and instantly see the impact on project duration. Of course, this can also easily be done using MSP's PERT network and using simulation.

A great deal of information can be added to Gantt charts without making them difficult to read. A construction firm of our acquaintance added the following symbol to activities that were slowed or stopped because of stormy weather  . They used other symbols to indicate late deliveries from vendors, the failure of local government to issue building permits promptly, and other reasons why tasks might be delayed. Milestone symbols—diamonds, ◇, in MSP—are added to the charts, with different shading or color to differentiate between "scheduled" and "completed" milestones. MSP is limited only by the PM's imagination in what can be shown on a network, Gantt chart, or in a project plan.

The major advantage of the Gantt chart is that it is easy to read. Such charts commonly decorate the walls of the project office (or "war room"). They can be updated easily. This is both the strength and the weakness of the Gantt chart. Anyone interested in the project can read a Gantt chart with little or no training—and with little or no technical knowledge of the project. This is the chart's strength. Its weakness is that to interpret beyond a simplistic level what appears on the chart or to alter the project's course may require an intimate knowledge of the project's technology—not necessarily visible on the chart, but available on the network or the project plan. Not uncommonly, the Gantt chart is deceptive in its apparent simplicity.

We should add that one must be cautious about publicly displaying Gantt charts that include activity slack, or LSs and LFs. Some members of the project team may be tempted to procrastinate and tackle the work based on the LS or LF. If done, this makes a critical path out of a noncritical path and becomes an immediate source of headaches for the PM who, among other things, loses the ability to reschedule the resources used by tasks that once had slack. Senior managers have even been known to view activity slack as an invitation to shorten an entire project's due date. We recommend caution and careful education of the boss.

At base, the Gantt chart is an excellent device to aid in monitoring a project and/or in communicating information on its current state to others. Gantt charts, however, are not adequate replacements for networks. They are complementary scheduling and control devices.

The Gantt chart is a useful complement to a project network. It is easily constructed and read. It can contain a considerable amount of information and is an excellent communication device about the state of a project. Its major weakness is that it does not easily expose the project's technology, that is, the technical relationships between a project's many activities. Even with predecessors marked on a Gantt chart, it is difficult to see the project technology and, thus, to use the Gantt chart alone to manage a complex project. PERT/CPM networks are often used as complements to Gantt charts.