

Keeping on Schedule in

2009

PART 2

In my January column (pp. 30–31), I provided information about the use of Gantt charts for project schedule management and promised a follow-up column on the use of Critical Path Method (CPM) and Program/Project Evaluation and Review Technique (PERT) scheduling approaches.

by David Elam

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CPM and PERT scheduling provide information about the interrelationships among project tasks. This information, presented in a visual format, enables the project manager to more clearly understand the effect of changes on project schedules and, consequently, make necessary adjustments to keep the project on schedule and on budget. However, these benefits come with significant costs.

First, more effort and information is required to construct PERT and CPM charts than is required for Gantt charts. Second, various CPM and PERT chart models and software applications have emerged since their development, resulting in slightly different, and sometimes confusing, ways to present the same information. Finally, interpretation of CPM and PERT chart information is not intuitive and requires training.

Both CPM and PERT were developed in the 1950s to facilitate the management of large, multitask projects. CPM was developed by DuPont Corp. to manage the shut down and start up of chemical plants in connection with maintenance operations. PERT, meanwhile, was developed by Booz, Allen, and Hamilton under contract to the U.S. Navy in connection with the Polaris missile program.

Example Water Reclamation Project

To examine these scheduling tools, we'll expand the project we described in January: A facility wants to add a water reclamation loop to an existing

wastewater treatment system that discharges to a publicly owned treatment works (POTW).

As a significant water user in the community, the facility can achieve water savings with the reclamation loop; however, the addition of the loop will change wastewater discharge characteristics and potentially affect operations at the POTW. Accordingly, the facility wants to use a phased approach to explore construction and permitting of the water reclamation system.

If the POTW deems the project acceptable, the facility would like to complete construction of the water reclaim loop before late summer and thus avoid the curtailment of water supply associated with past draughts. For our current example, we will include tasks to cover bid solicitation, bid review, and contractor selection.

Table 1 summarizes the tasks associated with the project. Note that milestones that were presented separately in the Gantt chart are now included with their associated tasks. Also, the tasks have been renumbered in increments of 10 to facilitate the addition of new tasks, if needed. Finally, the table includes task duration values based on most likely, optimistic, and pessimistic projections, which are then used to calculate an expected duration.

Using this simple example, the CPM chart presented in Figure 1 can be prepared in five steps:

1. Identify the tasks needed to complete the project.
2. Determine the sequence of project tasks.
3. Estimate the completion time for each task.
4. Plot the tasks using a network diagram. The circles in Figure 1 represent the beginnings and ends of project tasks. The arrows represent project tasks and are labeled with the task number, name, and duration. If a circle has multiple arrows branching from it, it means that the tasks can be performed concurrently. When a circle has incoming arrows,

Table 1. Task information for CPM and PERT scheduling.

Task Identification Information		Task Duration Information (Days)			
No.	Name	Most Likely	Optimistic	Pessimistic	Expected ^a
10	Prepare and submit conceptual plan	5	3	7	5
20	POTW reviews and approves conceptual plan	9	5	15	9
30	Prepare and release final design	30	20	45	33
40	Prepare and submit permit application	25	20	35	26
50	Contractors prepare bids	15	15	20	16
60	Review bids and select contractor	5	3	10	6
70	POTW reviews application and issues permit	30	15	45	30

Notes: ^aExpected duration (T_e) is calculated based on most likely (T_m), optimistic (T_o), and pessimistic (T_p) estimates as follows: $T_e = \frac{T_o + 4(T_m) + T_p}{6}$

The variance (σ^2) for the duration of each task is calculated as follows: $\sigma^2 = \left(\frac{T_p - T_o}{6}\right)^2$

(Source: Tague, N.R. *The Quality Toolbox, Second Edition*; ASQ, Quality Press, 2005.)

it means that the incoming task must be completed before those tasks associated with outgoing arrows. Note that several variations of this approach are in use and it is important to understand chart construction conventions to properly understand charted information.

- Identify the critical path for the project, which is the longest duration path through the network. For this project, the critical path, highlighted in red, follows tasks 10, 20, 40, and 70.

PERT builds on CPM and enables statistical evaluation of project completion using calculated expected task times and the variance associated with those task times for the tasks along the critical path.

Although highly useful techniques, CPM and PERT are both subject to limitations. For example, CPM is perhaps best suited to complex projects with limited uncertainty in task completion times. PERT, on the other hand, addresses uncertainty in task completion times, but the uncertainty is managed based on subjective estimates. Importantly, as the project unfolds, revised task completion schedules may result in changes in the critical path.

CPM and PERT tools are built into project management applications and are also available through standalone scheduling applications. Microsoft Visio also includes PERT chart templates; however, the calculation of key charting parameters is not accomplished within Visio and must be performed separately. The CPM chart in Figure 1 was constructed using Visio's basic flowcharting features.

Consider complementing your current project schedule communications with CPM or PERT charts. Developing the information to prepare these charts provides insights that facilitate effective project planning and scheduling. Once oriented to their use, team members can use these tools to clearly see how their project assignments support the overall project schedule. And using the statistical evaluation techniques associated with PERT, you'll be better able to predict how task schedules can affect your overall project schedule, providing you more options to manage project resources for improved financial performance. **em**

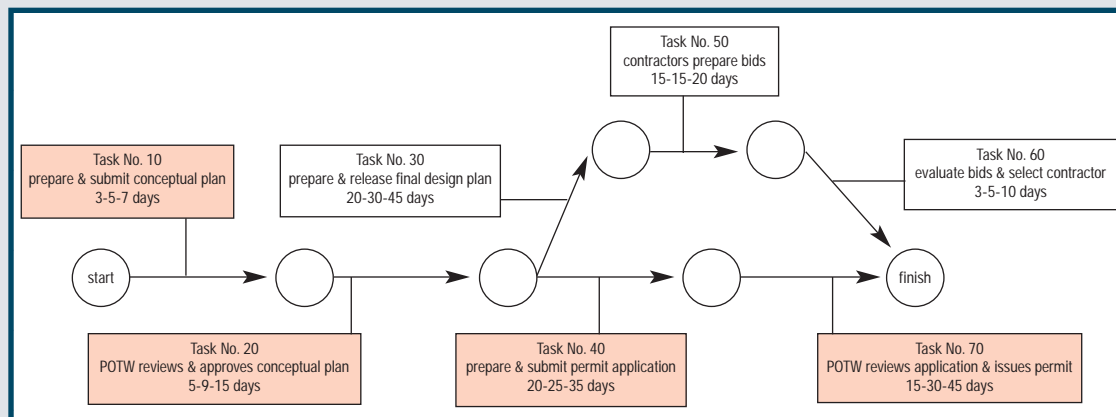


Figure 1. Example CPM chart for water reclamation system project.