Practical Schedule Risk Analysis

DAVID T. HULETT, PhD

GOWER

CHAPTER 1

Why Schedule Risk Analysis? Looking Beyond the Critical Path Method

Project Scheduling is Required for Good Project Management

Project scheduling is a required tool of project management. Every project must be managed to a schedule (PMI 2004). Most large projects employ project schedulers and even small projects have a schedule of some sort. The schedule predicts the completion and milestone dates of the project. It is also used to manage daily activities and resources and to record status. Scheduling has been around a long time and is one of the most widely practiced and accepted project management disciplines (Archibald and Villoria 1967).

Project scheduling is perhaps the most common discipline of project planning and control. Scheduling is practiced by thousands of individuals, with more or less training and experience, in every industry, country and organizational arena. Scheduling software abounds and the sponsoring companies are more than happy to train schedulers in their newest versions.

Projects Often Slip their Schedules

With all of this practice in project scheduling, one would think that all projects are well-scheduled and that they finish on time. However, experience tells us that projects often, even usually, overrun their schedules.[1] The degree of schedule 'slippage' is often dramatic, sometimes adding more time than has elapsed since the last status review. For instance, a real project recently added two months between monthly schedule reviews. At other times, or on other projects, schedule slippage occurs in small increments but accumulates over time resulting in substantial time delays.

Schedule delays cause problems for the project owners and contractors. Delay claims for equitable adjustments can amount to millions of dollars. Commercial windows of opportunity are missed, or made only with products that are below-standard and with incomplete functionality. Delays in completing continuous process industry projects, such as oil well or platform projects or integrated circuit fabrication lines, can cause millions of dollars of foregone income per day. Satellite lift-offs are often planned well in advance and

1 It is possible that since the author is involved with analyzing project schedule risk he is exposed to a biased sample of projects, mostly those that are in some kind of trouble meeting their time commitments.

if the payload is not ready it may miss the launch or launch as an 'experiment' instead of the fully functioning item. Almost all experienced project personnel have slipped a schedule at some time in their careers and some have had most of their projects slip. This is common knowledge.

In addition to slippage of the overall schedule or major milestones, the critical path often changes during project execution. In the baseline schedule a critical path is identified using typical Critical Path Method (CPM)[2] scheduling. At the end of the project, however, the path that ultimately delays the project may not be the critical path identified in the baseline, but another one. The critical path changes are often the result of some risks that have occurred to cause a previously slack path (path with positive total float) to become critical. The common experience of project personnel is that CPM scheduling does not always reliably identify the path that ultimately determines the project's completion date.

Project schedules slip and critical paths change. These are two reasons project managers establish the common practice of statusing the schedule—inputting changes that have occurred since the last time—on a frequent basis, often weekly, throughout the project.

Slippage and changes in the critical path also lead to the practice of project risk analysis. Risk analysis can address these two weaknesses in CPM scheduling.

What Causes Weaknesses of CPM Project Scheduling?

Schedules slip because of at least four problems that are commonly associated with project scheduling (Cashman 1995):

- Project scheduling is difficult. It is clear to anyone who has dealt with projects that scheduling is a demanding discipline that is not mastered by all those who are assigned scheduling responsibility.
- The rules of project scheduling—usually referring to the use of logic, constraints, resources, calendars and activity durations—are not always clear to the scheduler, nor are they followed in practice. Poor scheduling practice can lead to imperfect and sometimes dangerous project schedules. Most project schedules, even those produced by experienced schedulers, need to be debugged before they can be considered professionally competent.
- Management or the project's owner will often insist on unrealistic deadlines. The scheduler often is not permitted to produce the schedule that can be accomplished with the resources at hand. Professionalism in project scheduling would argue against many of the schedules imposed on projects today.
- Project schedules are built using single-point (deterministic) estimates of activity durations. When the uncertainty of future durations is taken into account, the duration of a schedule path is likely to differ from that computed by CPM scheduling and by CPM scheduling software.

2 Some information about CPM scheduling techniques that are crucial to the success of project scheduling and the conduct of schedule risk analysis is presented in Chapter 4.

Project Scheduler's Job is Difficult

Project scheduling is a demanding and exacting process. The scheduler has to keep many activities, resources, calendars, logical relationships and constraints correctly, completely and currently stated in the schedule. A scheduler is typically assigned to gather from the project teams all of the team schedules and combine them with the correct logic into one overall integrated project schedule and computer file. The scheduler must interact with both the team members and management to make sure that the schedule correctly represents the current plan and any changes therein. This means in particular that activity durations, logical relationships and the resulting critical path and total float values are examined for their realism.

The scheduler then sets a baseline schedule and begins to update (status) the current schedule on a regular basis. The scheduler may also be asked to help plan the project with 'what if' scenarios, examining alternative approaches to the project to see which will best serve the project's objectives. All of these are, among other duties, scheduler tasks.

Schedulers must have an encyclopaedic knowledge of the details of the project. They need to know more about the project than the project manager does, who often turns to the scheduler for those details at meetings with the project staff or the customer. The scheduler also must be able to communicate with the teams and their team leaders on the one hand and with management on the other. It can be argued that the technical side of project scheduling is the easiest part of the job. The majority of skills a successful scheduler exhibits involve expertly and effectively dealing with people who do not always agree that the schedule has importance and who sometimes have quite different agendas.

Often insufficient numbers of experienced schedulers are assigned. One scheduler cannot handle the entire schedule of a large project.[3] There are rules-of-thumb about the number of activities, or of open activities, that a single scheduler can handle. Anyone with scheduling or project experience has observed scheduling functions that were under-staffed or staffed with inexpert schedulers. It is no wonder that the quality of the schedule that emerges from such a situation is not the highest.

The Rules of Scheduling are Not Always Clear to the Scheduler[4]

Many schedulers are self-taught or have been initiated into project scheduling by other schedulers who have learned in a hit-or-miss fashion on the job. Many have opened the package of a popular scheduling software product and set out to produce a picture of the project timeline. Without understanding the requirements of logic that underlies a good schedule, the picture may be good on the surface but require manual adjustment each time a fact about the project changes.[5]

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3 One scheduler actually got a deep vein thrombosis (DVT or blood clot) in his knee from sitting at his computer performing scheduling duties day and night. DVT is usually associated with lengthy airplane flights where the legs are kept in the same bent position for hours on end—this is the scheduler's plight as well.

4 See Chapter 4 for a more detailed discussion of project scheduling.

5 A number of schedule pictures have been produced in graphics packages such as Visio®, Corel Draw® and even PowerPoint®. These are not schedules but pictures to hang on the wall to impress visitors about the success of the project.

There are many excellent scheduling standards (PMI 2007), manuals and project scheduling classes available, but schedulers may not have time to attend while their project is underway. Even if they attend such classes, the messages imparted from a scheduling class may not carry over to practice on the real project schedule. Often class attendees will listen and nod their heads during the class, but then in the heat of scheduling they will return to their self-taught ways or ways they have been taught by people who are not scheduling experts. Classroom training does not impart understanding as well as mentoring does on a real project schedule by a scheduling expert.

Management May Require Unrealistic Project Completion Dates

Project schedulers should view themselves as professionals with the responsibility to produce a realistic schedule for the project. Given the responsibility and authority, most project schedulers will produce realistic, competent schedules. A dedication to applying correct best practice project scheduling discipline, when joined with good interpersonal skills, usually leads to a realistic project schedule.

Unfortunately, the environment within which the project is conducted often does not permit proper scheduling. The project sponsor or owner usually wants the project to finish sooner than realistically possible and rejects the realistic date of the project team as being unacceptable. Contractor management may also require a shortened schedule in order to please the customer or to get the bid. Many contractors will propose schedules that are consistent with owner requirements without much regard to whether it is feasible—they count on changes and other events to bail them out of a tight, infeasible schedule. Hence, because schedulers are often required by the customer, management or other important stakeholders to produce schedules that are not feasible or realistic, they will compress the schedule by overlapping parallel activities that should be done in series and shrinking durations below values that are prudent, realistic or even feasible. Faced with such pressure, schedulers will often put together a 'magic schedule' that has little possibility of success and little credibility among the project teams. Schedules such as these are very risky and quite likely to overrun.

Even in an Uncertain World We Need to Estimate Activity Duration

CPM scheduling tools, including both manual and software-based systems, are generally unable to handle the uncertainty that exists in the real world concerning duration of the project activities. This is because these tools assume that the activity durations are deterministic, that is they are known with certainty as single-point numbers. CPM scheduling methods employ simple arithmetic to add activity durations according to the project logic and derive schedule path durations. These packages also compare the exact dates calculated for parallel paths to determine the date of a merge point of those paths.

None of these arithmetic calculations using numbers assumed to be correct admits vagueness or uncertainty in the durations. Durations in the schedule must be precise, even in an imprecise world. Scheduling software packages, and manual methods, usually

require the scheduler to supply activity durations, that is, the number of days the activity *will* take to complete. These duration estimates (for example, 'Activity ENG0230 *will take 17 days'*) are used by scheduling software as if they are known with certainty. In this way, as an example, durations are added when activities are in a path of activities linked with finish-to-start logic to calculate the duration of a schedule path.

The estimates of activity duration make a curious pilgrimage from uncertain estimates to rock-solid commitments. They are at first the product of duration estimating methods used by the organization. In this estimating process certain assumptions are made about resources, productivity, external events, management and the work to be done. These assumptions may be well- or ill-founded, but they soon become set and are used to calculate durations. Often the assumptions are then forgotten. The schedule dates are presumed to be exactly correct, rather than conditional statements based on the correctness of the assumptions. The durations, or at least their implied results for milestone and project completion, become targets and commitments of the performers, project teams and even team members.

Targets and commitments for completing an activity within a specific number of days lead to serious efforts to be successful and punishment for overrunning the schedule. Durations, that at the beginning of the planning process are understood as estimates, evolve into something more definite: commitments and how long the activities will really take. People who would agree at the outset that these estimates cannot be perfect often end up claiming that the estimates are engraved in stone, that 'we have no choice'.

Project Schedule Risk Analysis: Another way to Determine when Projects Finish

With all of the experience overrunning CPM schedules, we have to ask some questions:

- Can these overruns be predicted for specific projects with some degree of accuracy?
- Can the causes of project risk be identified before they become problems, possibly enhancing the project management's ability to forestall their occurrence by effective risk mitigation?
- Can we determine the causes for projects' often overrunning their initial schedules?

The answer to these questions is: 'Yes. The method is practical schedule risk analysis.' Subsequent chapters develop this message, that schedule risk analysis assists us in answering questions that CPM scheduling cannot answer (Hulett 1995, 1996; Hulett and Whitehead 2007).

Project risk analysis addresses head-on the fact that we do not know how long the activities will take. Even if an activity has been done before in a prior project, there is no assurance that it will take the same amount of time in a new project. Nor is there any assurance that adjusting it for the circumstances (for example, size, complexity) of the new project will be accurate. No two activities are exactly the same between projects. The situation will be different in the new project, with different resources and/or different productivity to be expected. Management may be different. The work may really differ from the earlier example. And, importantly, risks in the work that occurred in the prior

project may not be exactly duplicated in the new project, or risks that did not occur in that prior project may occur in the new one.

In fact, it is generally impossible to know with certainty how long each activity will take or which risks will occur. Duration estimates are just that, estimates. The activities will occur in the future and 'there are no facts about the future' (USDOE 1977).[6] Even with the complete absence of management or customer interference and the use of the best estimating techniques, the actual activity durations will differ, sometimes dramatically, from those planned and included in the schedule.

Chapter Summary

Success in managing a project requires a complete and realistic project schedule that represents the project plan. Project scheduling is one of the most important skills one needs on the project team. Yet, projects often overrun their scheduled completion date. Why is that?

Scheduling is a difficult discipline and individuals thrust into scheduling are not necessarily suited to its demands nor are they always effectively trained and supported. Also, in many instances, project schedulers are not permitted to develop realistic schedules since their management and the competitive customer-contractor environment lead to optimistic—sometimes magical—schedules. These schedules sometimes lead to late delivery.

One of the most important issues facing project scheduling is the inability to incorporate uncertainty of activity durations into the typical CPM schedule. Activity duration estimates are of necessity based on assumptions that may prove untrue in fact, and the durations will differ from those estimated in many cases.

Schedule risk analysis at its most fundamental will allow us to investigate the uncertainty in activity durations and to derive their implications for the project schedule. We will be able to answer questions not possible in traditional CPM scheduling. These include:

- How likely are we to make our schedule dates?
- How much contingency time do we need to provide the degree of certainty acceptable to our organization?
- Where is the greatest risk in the schedule?

In subsequent chapters the practice of schedule risk analysis is developed from the beginning concepts and building blocks to the most sophisticated aspects of the commercial risk analysis tools now at our disposal.

6 Quotation is from the report's foreword written by Dr. Lincoln Moses, Administrator of the USDOE Energy Information Administration and a Professor of Statistics at Stanford University.

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