



# Project Scheduling According to Dr. Goldratt

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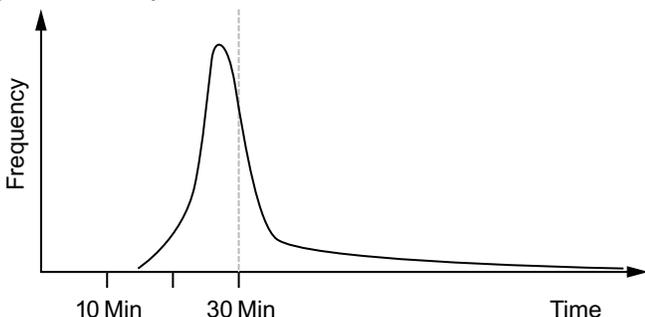
*Schedule overruns are more common than meeting projected dates. What can be done to improve? Dr. Eliyahu M. Goldratt provides insight as to how a great amount of schedule safety is incorporated into project plans, yet teams succeed in wasting the safety until they experience schedule overrun. By eliminating or minimizing the causes of schedule waste, the probability of achieving the originally planned project completion date increases.*

We are all familiar with the common maladies of cost and schedule overruns that inevitably plague projects, including projects that run long. If they do not, the extended schedule includes enough slack time that considerable waste occurs at each step as idle time. With all the emphasis on process improvement and metrics, why does this still happen? In chapters 6 and 13 of his book *Critical Chain* [1], Eliyahu M. Goldratt offers some ideas regarding the causes of schedule overrun.

Uncertainty regarding one's ability to accomplish a given task within a given time period results in schedule uncertainty. If someone were asked how long it takes for her to drive to work, she may say the average time is 25 minutes. On a good day, perhaps the day after Thanksgiving, she may make it in 15 minutes. If there has been an accident or if it is bad weather, it may take more than an hour. If we were to collect data over a period of time and graph it, the result would be a distribution curve skewed to the right. The area under the curve is the probability of completing the trip within the given time. This is illustrated in Figure 1. The curve shows that the probability of arriving at work in zero time is zero. The probability remains at zero until 15 minutes is reached, increases at a rapid rate, then drops off gradually. Even at the extreme right, the probability is not zero.

Normally when driving to work, we are willing to accept the median travel time unless we are aware of accidents or bad weather. However, when this curve is applied to project scheduling, we are reluctant to agree to a completion estimate near the median, i.e., a probability of 0.5. We usually deal with the uncertainty of achieving the scheduled completion of a project by adding a safety factor that includes the majority of the area under the curve. This increases our probability of completion within the associated time from a probability of 0.5 to 0.9 or higher, much further to the right. (Figure 2) Note that adding this safety factor about doubles the estimated schedule duration. Even with an expanded schedule including a safety margin with a probability of 0.9, organizations seldom deliver on time.

Figure 1. *Probability of drive-time to work*



## Safety Mechanisms

Few organizations consciously use the curve below in determining schedule. Goldratt lists three mechanisms they do use to insert safety into time estimates for almost every step of the process. First, time estimates are based on a pessimistic experience, i.e., they select a completion time near the right end of the curve. The reasoning is that there is generally little recognition for early or on-time completion, but there are usually severe repercussions for being late. For self preservation, the right end of the curve is chosen.

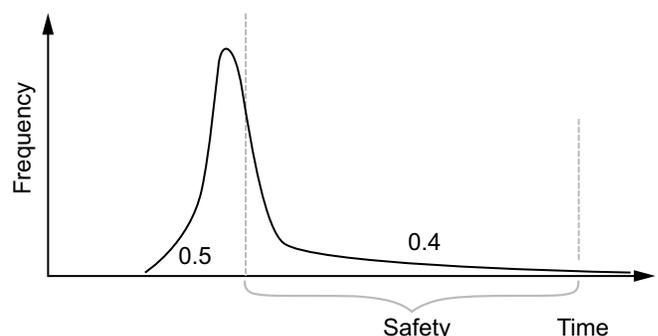
Second, the larger the number of management levels involved, the higher the total estimate. Each level adds its own safety factor for the reasons cited in the first mechanism.

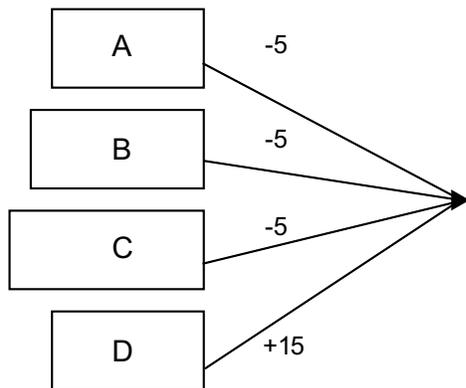
Third, because most individuals have experienced global *peanut butter spread* project cuts, estimators protect their schedule estimations by a large factor. When cuts come, the result is close to the originally desired schedule. But what happens to all this included safety? Why are projects so often late?

There are three basic ways that schedule is lost. First, advantage is seldom taken of early completions. Why? Early finishes are seldom reported because "We will then be expected to finish early on all subsequent projects. Because we cannot guarantee early finishes, we will not report the early finish but use the time to polish the product or add a bell or whistle." However, even if early finishes are reported, the subsequent step may not be prepared to begin. Sometimes the rationale is: "According to the master schedule, we are not to start until a week from Thursday, and we will not be ready until then, even though you have completed the predecessor task today." So the time is wasted. The rule can be stated as: "A delay in one step is passed, in full, to the next step. An advance made in one step is usually wasted."

While the foregoing rule applies to serial processes, parallel processes experience a similar phenomenon. For example, take the case of four parallel steps that are scheduled to end on the same

Figure 2. *Schedule Safety*



Figure 3. *Parallel Tasks*

date. Three of the four finish five days ahead of time while the fourth is 15 days late. (Figure 3) Statistically, we are on time. In reality, we are 15 days late. The rule for parallel steps is: “The biggest delay will be passed on to the next step. All other early finishes do not count at all.”

Second is the *students' syndrome* of lost schedule. Think back to when you were in school. You were given an assignment to hand in a report four weeks hence. When did you begin working on the report? The typical student doesn't get right on it because there is plenty of time. It usually is not until a week before it is due that you start working on it. Only then do you discover that the resource material you counted on is not available, or in our time, the network is down or e-mail is not working. All the safety provided by the instructor has been wasted, and now you are going to be late. This syndrome is alive and well in our projects today.

Third is the multitasking syndrome. Suppose you have tasks A, B, and C to accomplish and each requires 10 days to complete. These tasks do not have to be performed sequentially. You must complete these tasks before others can work on subsequent tasks. These tasks are not necessarily all for the same project. If worked sequentially, task A would complete after 10 days, task B after 20 days, and task C after 30 days. In fact, the schedule that includes each of these tasks has allocated 10 working days for the accomplishment of each of them (see Figure 4). In your effort to please everyone, you decide to work five days on task A, then five days on task B, then five days on task C, and then repeat the entire process to complete. Task A does not finish until 20 days after initiation, task B finishes 25 days into the effort, and task C finishes 30 days into the effort. Did you notice that task A finished 10 days later than if you had worked serially, and task B finished five days later? The entire time from start to finish of each task doubled from 10 days to 20 days. Thus, if subsequent tasks were planning to start 10 days after the initiation of a task, each subsequent task would have experienced a 10-day delay. These delays may be sufficient to cause noncritical paths to become critical paths or to cause a 10-day slip in a critical path.

Multitasking can take the form of meetings, emergencies, other tasks, etc. The impact is that lead time increases for all tasks and completion time is later for all tasks except the final task.

No one wants to finish late. To avoid this, we add considerable safety time to the project. We then succeed in wasting the safety time by not reporting or not taking advantage of early finishes, by embracing the students' syndrome, and by multitasking.

This is not to say that bona fide problems do not occur, but such problems rarely account for all the schedule time lost.

## All Paths Are Critical

Some may say that they are not concerned because the schedule lost was not on the critical path. However the three ways mentioned above by which schedule is lost occur just as readily on the critical path as on noncritical paths. In fact, given sufficient occurrences of the above ways, a noncritical path may become the critical path. The goal of the project manager should be to maintain or advance the planned schedule rather than to allow schedule float to be consumed to the point that several former noncritical paths now have high likelihood of becoming the critical path.

Our metrics can also mislead us. Goldratt offers two criteria for measurements [metrics]:

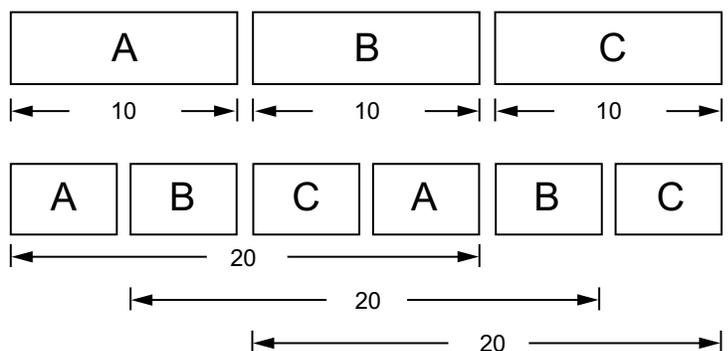
- Criterion one: Measurements should induce the parts to do what is good for the system as a whole.
- Criterion two: Measurements should direct managers to the point that needs their attention.

Our project management metrics do not always meet these criteria.

Take the earned value management system (EVMS) for example. We “earn value” as we gain credit for the tasks that were to have been accomplished by a given date, and lose value if we have expended more resources than estimated to complete the task. The mistake made is in grouping all tasks together. If we make significant progress using less than estimated resources on noncritical path tasks, yet are behind on the critical path, the earned value calculation will tell us that all is well. If we are not careful, we will not notice this until it is too late. EVMS reporting should be structured to emphasize the tasks on the critical path while not forgetting the noncritical path tasks. Noncritical path tasks that are late in completion can, by default, become the critical path.

## Rethink Project Management

Schedules are difficult to estimate, and more difficult to meet. We have discussed three ways that try to protect product schedule and three behaviors that result in schedule being wasted. Also, we have seen that inappropriate application of project management metrics can lead to a false sense of schedule security. Several of you are probably saying to yourselves, “We already know the problem, what is the solution?” The solution is to rethink how

Figure 4. *Multitasking*

projects have been managed in the past, and to apply the results of that rethinking. Rather than leave the rethinking as an exercise for the student, I recommend reading Goldratt's *Critical Chain* and applying the principles to the project you are managing.

Do Goldratt's principles work? An article published in the January 1999 issue of *Midrange ERP* [2] describes how Harris Semiconductor achieved the design and erection of a building, installation of equipment, hiring and training of employees, and ramp-up to 90 percent of designed production rate in 13 months. The typical industry time is 54 months.

**"Applying the management principles suggested by Goldratt can help you achieve your schedule and actually reduce your time to market."**

Habitat for Humanity in New Zealand set a new world record for constructing a four bedroom house in 3 hours 44 minutes and 59 seconds, besting the previous record set in June 1998 in Nashville, Tennessee of 4 hours 39 minutes and 8 seconds.

Better On-Line Systems planned a product release for August 1997. Using the principles in *Critical Chain*, they revised their schedule for a May 1 release. Actual release was in early April, five months ahead of the original plan.

Several providers of project scheduling software, including Scitor's PS8 and ProChain Solutions' ProChain [3, 4] have included *Critical Chain* Project Scheduling as a product feature.

Applying the management principles suggested by Goldratt can help you achieve your schedule and actually reduce your time to market. This reduction in time to market results in a more competitive position as well as cost savings from reduced labor expenses. Try it, you just may like it. ♦

## References

1. Goldratt, Eliyahu M., *Critical Chain*, The North River Press Publishing Corporation, Great Barrington, Mass., 1997.
2. Goldratt Institute Web site ([www.goldratt.com](http://www.goldratt.com)), Success Stories.
3. Scitor Web site ([www.scitor.com](http://www.scitor.com)).
4. ProChain Solutions Web site ([www.prochain.com](http://www.prochain.com)).

## About the Author



**Timothy K. Perkins** has been involved in software process improvement for the past 11 years, ever since he led the effort to initiate the software process improvement effort at the (then) five Air Force Air Logistics Centers. As the Software Engineering Process Group leader at the Software Engineering Division at Hill Air Force Base, he led the division in reaching CMM Level 3. The division has gone on to achieve CMM Level 5. Since retiring from the Air Force, Perkins has been employed by Science Applications International Corp. as a process improvement consultant. He currently supports the Software Technology Support Center at Hill Air Force Base in providing consulting services to Air Force and other Department of Defense and government agencies. Perkins holds a bachelor's degree in electrical engineering from Brigham Young University and a master's degree in business administration from the University of Phoenix.

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## QUOTE

The time it takes to learn a new program may be greater than the amount of time it saves you over the next ten years.

- Anonymous

IT IS EASIER TO  
ASK FORGIVENESS THAN IT  
IS TO GET PERMISSION.

- Grace Murray Hopper

## MARKS

Any software upgrade costing less than \$20 is an admission of guilt.

- Fred Blechman

It seems programs always grow to match or exceed the amount of memory available.



- Richie Lary