

Critical Chain and Critical Path – What’s the Difference?

By Gerald I. Kendall (www.tocinternational.com)

Introduction

I have some good news and some bad news. The bad news is that Critical Chain is a paradigm shift in project management practices. What I mean by “paradigm shift” is that the required change in project behavior is *so* radical that you cannot use your experience to predict the outcome. Therefore, the bad news is that paradigm shifts create fear in top management. The implication of this statement is that in comparing Critical Chain to Critical Path, it is vital to remember that Critical Chain is about much more than the mechanical differences in how a project plan is created¹.

The good news is that after more than 40 years of Critical Path experience, most projects are still failing to meet their goals – on time, on budget and within scope². This is NOT a criticism of Critical Path. It is good news because management is motivated to look for an approach to give them much better results – not 10 or 15% better-- more like 50% or 100% better. To yield this kind of result, Critical Chain’s starting point is eliminating some of the treasured rules (sacred cows) that hurt project performance.

In this article about Critical Chain and Critical path, the approach I am taking is to first explain the overall philosophy and methodology of Critical Chain. From that explanation, I hope you will draw the conclusion that while Critical Chain uses all of the good features of Critical Path thinking, it is quite different in its focus and approach. Following this overview, I summarize the major differences.

¹ These concepts are more fully explained in two books by Gerald Kendall, *Advanced Project Portfolio Management and the PMO*, J. Ross Publishing, 2003 and *Viable Vision*, J. Ross Publishing, 2004.

² See Jim Johnson, *Turning Chaos into Success*, Software Magazine, Dec. 1999. The Standish Group reported the results of a study of 23,000 projects and claimed, in 1999 that only 26% of projects finished on time, on budget and within scope. For IT projects, the figure was 14%.).

The Executive Dilemma

With the poor project performance statistics quoted above, it is no wonder executives have a huge problem today in accomplishing improvements quickly and predictably enough to meet their goals. Statements such as, “We lost 9 months of product sales because the project was late” or “Our stock price slid by 30% because we failed to meet our promise for launching the new plant” are very common. Shareholders and boards of directors are not very forgiving of ugly surprises from projects. CEO credibility is badly damaged not just by project overruns, but by poor project analysis. For example, many of us have heard the story of a 2 year project that was 95% complete and took another year to finish!

Executives are not alone in project management problems. It is intriguing that the words that project managers use to describe their problems, in all countries and in all industries, are almost identical. You hear statements like, “We don’t have enough resources” and “The executive pushed us to start the project before the requirements were properly defined. Now we have a lot of rework.” Another frequent complaint is “Priorities are constantly changing.”

These complaints suggest that many project managers believe that the problem is out of their hands. As long as this belief continues to exist, executives are not likely to see a huge improvement. The very fact that the identical project manager complaints existed 20 years ago and are still not resolved suggests that we need a new approach. This article explains why it takes so painfully long to get the chosen projects completed, and what to do about it.

The #1 Problem in Project Management

In Project Management, there is a horrible practice – holding people accountable to finishing each project task according to its estimate. *Today’s common belief is that the best way to ensure that a project will finish on time is to try to make every task finish on time.*

The problem begins with the way people develop a task estimate. Most people today are involved in more than one project. Many people also have some operational responsibilities. And there are emergencies – an email that must be responded to immediately, rework from a previous project, a special assignment from the boss’s boss, an unplanned meeting. So it is not unusual that a task involving 3 days of dedicated work effort is given an estimate of 2 weeks to complete. Even then, the person giving the estimate will hedge with comments such as, “But it depends on what happens with such and such” (other work they already are in the process of doing). *People react this way because they know, from experience, that as soon as you give a manager an estimate, it becomes a commitment.*

However, if most project task estimates have such significant extra time imbedded, how can we possibly explain why so many projects finish later than planned? An examination of human behavior on projects shows that this safety imbedded in task estimates is often misused.

In juggling work on different projects and operational responsibilities, the project team member must decide what to work on *right now*. People, knowing that they have safety in their estimate, often delay starting work on a given project task until much later than they had originally planned. Instead, they choose the most urgent tasks. Dr. Eli Goldratt, the founder of the methodology called Theory of Constraints, from which Critical Chain is derived, terms this behavior “Student Syndrome”. This refers to the behavior of students who have three weeks notice of an exam, but wait until the night before the exam to start studying. When a team member starts a task much later than originally planned, and Murphy does occur, the task finishes later than its estimate.

The effect of Student Syndrome is made worse by the dependencies between tasks on a project. While the team member delays the completion of *their* task, all following tasks,

dependent on this task, are waiting. If some of the following tasks are also subject to Student Syndrome, the delay in getting a project completed is substantial.

Another common behavior further delays vital project work. Project Managers are under tremendous pressure from executives to show progress NOW, so they push very hard on team members to cut task time estimates. As a result, when a team member puts up a tough fight and wins a concession on a task estimate, the team member and Project Manager both consider that estimate a committed due date.

Team members know that if they finish a task in less time and turn their task in *earlier* than the due date, next time they will be expected to finish tasks in record time. Also, their credibility is gone. Therefore, in cases where the team member does finish the specified work early, they prefer to work or hold the task up to the due date, sometimes adding unspecified capability. This behavior is called Parkinson's Law, where work expands to fill the time available.

The devastating waste to the company occurs with the combination of Student Syndrome and Parkinson's Law. These behaviors drive up individual task time durations, resulting in longer projects. But while these negative effects are serious, in the multi-project environment, there is another sinister factor driving project durations through the roof.

The Multi-Project Environment

Most organizations today operate in a multi-project environment – an environment where different projects share one or more common resources. In fact, in real life, managers are not so polite in their description. They usually call it “fighting” over resources rather than “sharing”.

Once again, local optima reign supreme. Functional heads initiate projects, *irrespective of*

the capacity of the organization to do the work. They are doing this for an excellent reason – if they do not meet their goals by the next review period, they may no longer be employed or they may miss a significant measurement. ***Executives assume that the sooner the project is initiated, the sooner it will be completed.***

Bad multitasking occurs when team members split their time between multiple tasks such that the combined duration of all projects is dramatically increased. One negative effect of bad multitasking is that the level of effort for each task increases. Due to effort to regain concentration each time the same task is restarted, 3 weeks of effort can easily turn into 4 weeks for example. Rework is also common in such environments.

The other negative effect is the extended duration of each task. When the effect of multitasking is combined with additional start up time, tasks often take 2-3 times the duration without bad multitasking. In new product development, this means that the company lost or deferred weeks or months of sales, and may have missed a competitive window. For projects bringing internal benefits, it means those benefits were delayed or missed for weeks or months.

The Solution in the Single Project Environment

Many years ago, some brilliant engineers came up with the concept of Critical Path. In every project, there are some tasks that cannot be started until previous tasks are completed. There are often many different paths of dependent tasks within a project. The *longest* path of dependent tasks (determined by the days of estimated effort) is called the Critical Path.

When Critical Path concepts were first applied, it was common practice to have dedicated resources on projects. Therefore, it was valid to consider only logical task dependencies and to ignore resource dependencies when calculating estimated project duration. Resource

dependencies occur when the same resource is working on a task in one part of the project and is simultaneously needed in another part of the project.

Goldratt took this into account, calling the new set of dependent tasks the “Critical Chain”. The Critical Chain of a project is the longest chain of dependent events, considering *both* task *and* resource dependencies. It is *this* chain of events that is most likely to determine how long a project will take to complete.

To overcome Student Syndrome and Parkinson’s Law, we must change the local optima rules which strive to have each task finish on time. The new rules are as follows:

- DO NOT turn estimates into commitments. Estimates are NOT deterministic numbers – they are just estimates. Instead, use estimates that will change Student Syndrome and Parkinson’s Law behaviors. To do this, take current estimates and cut them in half. However, DO NOT hold team members accountable to completing tasks according to their estimate.
- Critical chain tasks are performed with the Relay Runner Work Ethic. Team members start and complete these tasks as quickly as they can (no more Student Syndrome), and pass the work (baton) on to the next resource as early as they can (no more Parkinson’s Law). The team member performs the task in as dedicated a manner as possible.
- Half of the safety that we remove from individual task time estimates is returned to the project and used strategically to protect the project as a whole. This protective Buffer, called a Project Completion Buffer, acts as a shock absorber to holistically insulate the Critical Chain from any variation of task time durations on the Critical Chain tasks.

- In execution, Project and Resource managers use the buffer and a tool called Buffer Management to determine when to take action.

On a single project, we will schedule any work that feeds Critical Chain tasks to be completed a little earlier, so as to not delay the Critical Chain work progress. We accomplish this using a tool called a Feeding Buffer. The Feeding Buffer insulates the Critical Chain from delays caused by any variation amongst tasks on non-critical paths.

The Multi-Project Environment

A permanent solution to overcome bad multitasking requires a new process. For one thing, we must carefully activate projects *only* when the organization has enough resource capital in the bank. However, trying to balance the workload of all project resources is far too complex. In the multi-project environment, Critical Chain determines the organization's capacity according to the capacity of one resource – the “strategic resource”. This is the one resource where projects get stuck the most, or the resource most heavily loaded across the collection of the organization's projects.

Multi-project Critical Chain requires the following step:

- No new project begins any sooner than the capacity of the strategic resource permits. Stagger projects according to the capacity of this resource.

Such a process implies that the senior manager's power to unilaterally *initiate* projects must be subordinated to the organization's capacity to do the work. This conclusion often makes senior management very uncomfortable. Most forms of curtailment of power are seen by executives as unnecessary meddling. This spells out an urgent requirement. To implement high-

value project management within an organization, each senior manager must believe that the new process will not damage the due date for *their* project. When this step is implemented, the executives can have their cake and eat it too. *All* projects will now complete much earlier than before.

In addition to reduced project durations, the new approach provides much better project execution management, with less time spent in review meetings. In Critical Chain, two parameters are used to determine when intervention is required. We expect to see work completed on the Critical Chain on a regular, progressive basis. We also expect that we will use up the Project Completion Buffer (the safety net protecting the entire project) on a fairly regular basis as the project progresses.

If, upon review, we have only completed a small amount of the Critical Chain work, but we have eaten up a lot of the Project Completion Buffer, we know we have a serious problem. Similarly, if we have completed a large part of the Critical Chain, and still have a lot of our project protection in tact, the project is in great shape. Therefore, the likelihood of finishing any project according to the promise date is easier to predict. Buffer management requires a Critical Chain project manager to monitor the trend of Critical Chain percentage complete compared to the percentage of the project protection (completion buffer) used and take action when negative trends occur.

Some Cases

There are many documented success stories with Critical Chain. See www.tocinternational.com for a free download of Theory of Constraints reference stories from around the world. These few cases just scratch the surface of what is possible:

- Israeli Aircraft Maintenance Division cut the average aircraft wide-body conversion time from 3 months to 2 weeks. This gave them a huge competitive advantage, with their customers clamoring to book them a year ahead of time.
- Seagate Technologies cut new product development times in half
- Lord Corporation's I.T group went from completing 100% of their projects late to completing 85% early or on time.
- U.S. Marine Corps Naval Depot more than tripled workload completed using the same resources

Specific elements of the Critical Chain Approach, which are not part of Critical Path.

1. Team members are asked to dedicate themselves to a project task, to complete it as quickly as possible and to periodically (typically weekly) report how many days are remaining.
2. Task due dates are not given nor monitored.
3. When planning a project, task times allotted in a project are much closer to how long the task would take with dedicated resources using aggressive estimates, rather than elapsed times assuming the organization's current practice of assigning resources to work on several tasks at once.
4. Bad multitasking (multitasking that extends the duration of a collection of projects without compensating benefit) is significantly reduced, permanently.
5. In executing a project, people are not measured and are not held accountable for completing their tasks on time.
6. People are asked to pass on their outputs to the next resource as quickly as possible.

7. Use of intermediate due dates is limited.
8. By taking resource dependency, as well as logical task dependency into account, the longest sequence of dependent tasks can be seen more clearly. This longest sequence, the Critical Chain, may *cross* logical paths in the network.
9. Project completion and feeding Buffers are a key part of the schedule and how it is managed. The ability to increase the certainty of project completion dates is closely related to the use of buffers and trends during execution.
10. Critical Path uses a concept of slack time or float to determine how much flexibility there is in non-critical path tasks. Critical Chain does not recognize slack time.
11. Critical Chain demands that non-critical tasks be scheduled at their latest possible start times to discourage costly early investment of work in process and conflicting priorities. This also significantly reduces behaviors called “student syndrome” and “Parkinson’s Law”.
12. Often, the Critical Path changes during execution because there is no buffer to absorb the variation in task times. If implemented correctly, the Critical Chain plan and the Critical Chain itself do not change throughout the life of the project, because the buffers absorb the uncertainties in task duration.
13. Critical Chain recognizes that there are multi-project environments in which projects have resource-based interdependencies. In other words, projects share a common resource pool, for at least some tasks.

14. The Critical Chain Approach identifies the strategic resource across a collection of projects. When overloaded or not available, this resource is the one most likely to impact the project duration of all projects.
15. The staggered introduction of projects into the system is used to improve the flow of projects, to increase the predictability in each project outcome and to increase the effectiveness of critical resources by minimizing the effect of bad multitasking.

Summary and Next Steps

Today, project durations are much too long because of a common management practice – holding people accountable to their task estimates. This local optima measurement distorts human behavior on projects to such an extent that project durations are often more than doubled. When projects are late, executives do not meet their goals. So executives try to push *more* projects into the system, irrespective of the capacity of the resources to do the work. This exacerbates the already difficult situation, introducing bad multitasking and making the project durations even longer.

The Critical Chain frame of reference puts team members, project managers and resource managers in the same relay race, focused on critical chain tasks and far fewer active projects. The results show reductions of 25% or more on project durations. Critical Chain ensures that each project finishes on time. Further, we can complete more projects without adding resources.

Gerald I. Kendall, PMP, Principal TOC International, is the author of three books - *Advanced Project Portfolio Management and the PMO*, *Viable Vision* and *Securing the Future*. He is the author of the chapter on Critical Chain in Dr. Harold Kerzner's text *Project Management, A System's Approach*, 8th edition. For further information on Theory of Constraints, see www.tocinternational.com. You may contact Mr. Kendall at Gerryikendall@cs.com.