
Bringing Discipline to Project Management

by Jeffrey Elton and Justin Roe

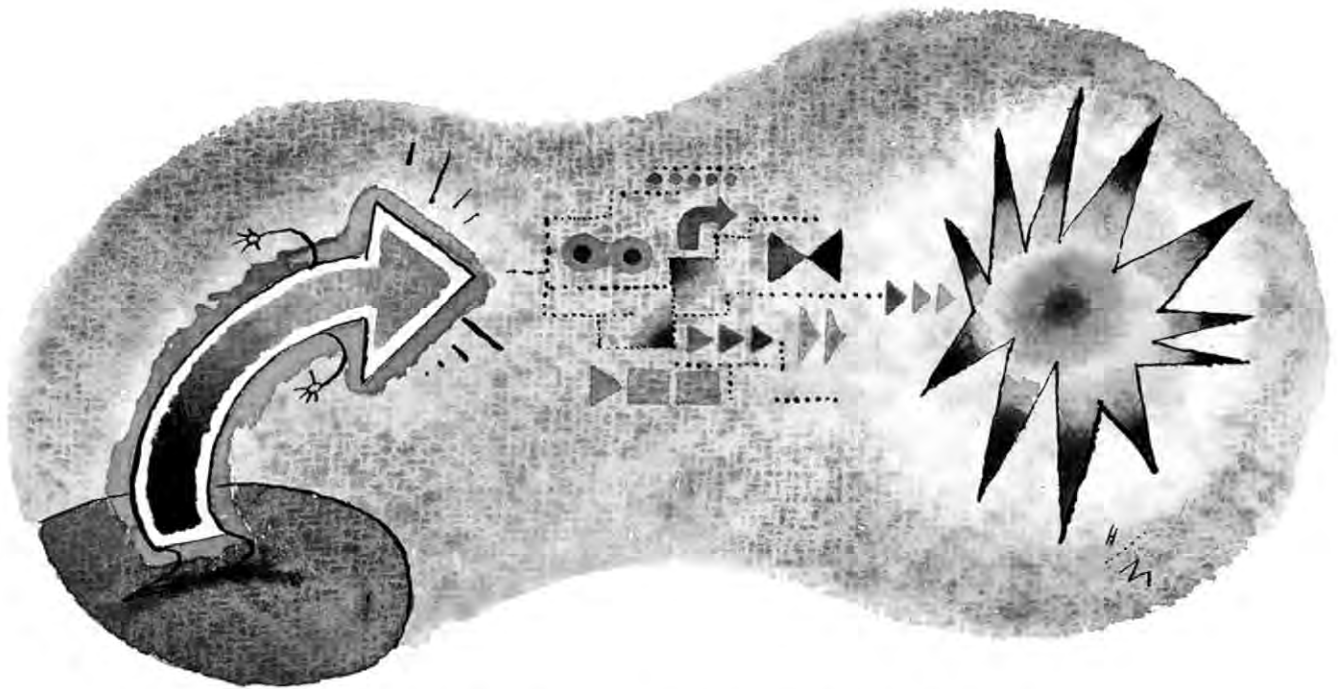


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*Eli Goldratt's first novel,
The Goal, shook up the factory floor.
Will Critical Chain do the same for projects?*

BRINGING DISCIPLINE TO PROJECT MANAGEMENT



BY JEFFREY ELTON AND JUSTIN ROE

Critical Chain

Eliyahu M. Goldratt
Great Barrington, Mass.
The North River Press, 1997

How many projects in your organization have come in on time and on budget? If you are like most senior managers, the answer is likely none. And that despite using a plethora of project-management software tools, management processes, data management systems, team-training programs, and assorted “best prac-

tices.” Every manager has an excuse for why a given project comes out poorly, but attempts to plan ahead to allow for unexpected problems rarely succeed.

Are these difficulties inescapable? One business thinker who says no is Eli Goldratt, a pioneer, if not the originator, of the *theory of constraints*. As introduced in his widely read novel *The Goal*, this theory provided a persuasive solution for factories struggling with production delays and low revenues. In his

third novel, *Critical Chain*, Goldratt applies the framework to managing the development of new products and other projects.

Project management is a mature area that has systemic problems similar to many found in manufacturing processes, and the theory of constraints works well when deal-

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ing with individual projects. The book falls short, however, in explaining how companies can best manage a portfolio of projects, so senior managers need to supplement it with other advice. Still, its focus on constraints may be useful for dealing with one of the most difficult and pressing of management challenges: developing highly innovative new products.

Focusing on the Constraints

The theory of constraints explains how to boost the performance of any process that involves a series of interdependent steps. Instead of breaking the process down and improving the efficiency of each step, the theory has managers focus on the bottlenecks, or constraints, that keep the process from increasing its output. Once managers identify the bottlenecks, they widen them by making them more efficient – which often means changing policies that may promote efficiency at other steps in the process but hamper effectiveness at the crucial bottlenecks. Next, they need to limit the volume of production coming from the nonbottleneck activities to the level the bottleneck can handle. Once the overall operation is as effective as it can be at a given capacity, managers can increase output by investing in extra capacity at the bottlenecks. These steps need to be repeated over time because constraints can emerge at other points in the process.

Of course, project management texts have long told managers to focus on constraints. For projects, the constraint is the *critical path*, the series of tasks that determines the minimum time needed for the project. No matter how quickly the other tasks are completed, the project cannot be finished any sooner unless the tasks on the critical path can be done faster. But Goldratt adds an important second constraint to this framework that managers often overlook: scarce resources needed by tasks not only on and off the critical path but by other projects. In

the case of developing a new product, for example, a manager may schedule the different tasks according to the pace of the critical path but still face delays because the computer-assisted design machine needed for several of the tasks is bogged down with other jobs. The *critical chain* thus refers to a combination of the critical path and the scarce resources that together constitute the constraints that need to be managed.

To keep the critical chain flowing smoothly, the book advises managers to use safety buffers similar to the inventory buffers used in production lines to make sure that bottleneck machines always have material to work on. Because managers can't predict exactly when any task will be completed, they need to allow extra time for tasks that impinge directly on the critical path. By inserting a time buffer wherever the noncritical paths feed into the critical path, the tasks on the critical path will always have what they need to proceed. For the same reason, managers need to allow extra time for tasks not on the critical path that feed into the scarce resource. (No buffers are allowed within the critical path.) Once the buffers are in place, managers must tightly schedule the activities of the scarce resource to maximize its use. As the project proceeds, managers need to monitor closely the scarce resources and the expected completion times of tasks on the critical path.

Apart from warning managers about constrained resources, the book also adds a useful discipline to what in reality is often a chaotic process. As the book describes, most managers tend to pay little attention to the needs of a project as a whole. Instead, they start off with a series of dysfunctional negotiations to get the project approved. Project managers pad their resource requirements to buy a margin of safety. At the same time, functional

departments (such as information services) understate their resource requirements so their portion of the work can come in on budget. Then senior managers cut the overall requirements for the project and move deliverable dates up because they assume that estimates for time and resources are inflated.

Project managers generally create a project plan composed of all the interrelated activities of the project, one that ascribes responsibilities and estimates resource requirements. That project plan involves a *work-breakdown structure* that defines individual tasks and then aggregates them into a large plan. The plan is arranged so that items on the critical path can be completed in time to meet milestones. But managers typically make the plan in conjunction with their budget, and they design it to validate some core assumptions related to the project's fiscal requirements. In most organizations, the significance of the plan itself diminishes from that point forward. Project managers know that the plan is only advisory and suggestive of the project's true structure and requirements. They expect to manage the actual project in real time, relying on only a core group of team members and a set of resources for which they will constantly need to negotiate throughout the project's life. As a conse-

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quence, plans are almost always "wrong" in the sense that the resources used and the time actually taken to complete tasks rarely correspond to those projected in the original project plan.

To get a sense of how imperfectly this process works, imagine that we managed corporate finances as we

do projects. Pro forma income statements would mix together expenses and revenues, results from one division would be inextricably intertwined with those of another, and the timing of specific events would be so unpredictable that cash flow projections would be little more than wall art.

The most successful organizations, fortunately, have begun to bring order to this chaos. Project teams at those companies are placing particular emphasis on coordination and communication. Advances in project management software that can function over extranets are making such an approach possible. And in many industries, continual communication and coordination are becoming mandatory as the time allocated for project development shrinks dramatically, the members of the development team become geographically displaced, and the projects increasingly involve external partners and resources.

To this emerging discipline of coordination made possible through technology, Goldratt essentially adds a discipline for understanding what drives project performance and therefore what the focus of a project manager's attention should be. Goldratt does not discourage the use of plans, but he implicitly warns managers that elaborate plans should not distract them from focusing on constraints. By his analogy to production bottlenecks, he indicates to managers that most projects have only one essential constraint – and at most two – and that what they should be doing, therefore, is looking for and addressing this primary constraint.

Part of the discipline Goldratt offers involves the proper use of measurements. He reminds managers of two criteria: measurements should induce the parts to do what is good for the whole, and measurements should direct managers to those parts that need their attention. Many managers rely on milestones to monitor a project's progress (and individuals' performance),

but that practice violates both of the above principles. Following the maxim, How you measure people is how they'll behave, the book points out that management by milestone motivates members of project teams and their managers to insert safety time before each milestone. Once safety time has been added to each task, various mechanisms arise that waste that time. So, Goldratt concludes, the fewer the milestones, the fewer the delays. We have found such dysfunctional behavior occurring when the milestones are set as artificial review points tied to the end of a development phase or task stream.

Goldratt weaves these lessons into the story of an executive M.B.A. class at a business school struggling with declining enrollment. The class's professor, who is himself battling to get tenure, is teaching a course in project management for which he seems woefully unprepared. Along the way, he hears about the theory of constraints, and he and his students feel their way through it by applying the theory to various problems that the students are having with their own projects at work. The novel displays a genuine understanding of the experiences of project managers across organizations in all industries.

As in *The Goal*, this fictional approach makes for easy reading. But while the factory setting in *The Goal* established a realistic context in which to develop and test the theory, *Critical Chain's* academic environment does not sufficiently bind together the various real-world vignettes. As a consequence, the reader is presented with hearsay evidence rather than given the opportunity to work through a full application of the theory during the course of the book.

The book is valuable to two main audiences: project managers and senior managers. Project managers and their teams will appreciate its main message: remain focused on a

few critical areas and do not divide your attention among all of a project's tasks and resources. Project phases do not matter, milestones

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are largely meaningless, and building large project plans out of streams of concurrent or sequential activities is not useful. Instead, the book suggests, we need to "design" a project in the same way we design a product. The project design needs to identify the potential sources of failure – critical-path tasks and critical resources – and then insert resource and work buffers to ensure maximum throughput.

The book addresses the concerns of senior managers in a brief discussion at its conclusion. Those managers need to know how to juggle a portfolio of projects, and the book's only advice on that subject is to make sure to allocate resources carefully across projects to minimize the constraints on the shared resources. But in our experience, managing project portfolios is far more complicated – and many of the delays in individual projects arise from problems at the senior management level rather than from mistakes made by project managers. The book is both accurate and useful in discussing the theory of constraints as it applies to individual projects, but it may not give senior managers enough insight to enable them to handle multiple projects. To attain substantial improvement there, senior managers will likely need to extend Goldratt's systematic perspective to the level of multiple, concurrent projects and add some elements that *Critical Chain* either ignores or gives short shrift.

Advice in this area is all the more important now, as the pace at which markets change in all industries quickens, the increased use of stan-

standard components and processes accelerates the rate of technological innovation, and expectations about customer service and product performance continue to rise. In response, companies are spending more time on projects and less time on routine activities. The number of books and articles on project management, especially for developing new products, is burgeoning. Most major consulting firms have significant practices in this area, and the number of M.B.A. courses on this topic is increasing. Yet the success stories are few and often based on the same corporate examples, and the performance of project teams remains generally lackluster.

Managing Projects as a Portfolio

Focusing on individual projects allows Goldratt to give us useful and well-illustrated advice, but it does not allow him to examine some important drivers of project performance: namely, how well new initiatives align with strategy and how successfully an organization balances its overall capacity and capabilities with its portfolio of projects. Managers cannot isolate and control different projects as easily as they can handle different factory-production processes.

What senior managers need is the wider perspective of aggregate project planning, which Steven C. Wheelright and Kim B. Clark defined in "Creating Project Plans to Focus Product Development" (HBR March-April 1992). Too often, projects fall short of resources or lose direction because of a lack of agreement among senior business and functional managers. This misalignment of goals can lead executives to make a number of mistakes. They may slow a project down by failing to take necessary actions or by limiting the available resources. They may fail to kill a project (the "undead") in order to avoid disappointing another executive or project team. The net effect is that most organizations have too many projects

relative to their available capacity, and those projects, when viewed as a set, only distantly resemble the company's strategic intent.

Even if the right projects are picked, the way the projects relate to one another, coupled with pressure to get the highest return from the investment in development, can easily lead to an excess demand on limited resources. And even when resources seem to be adequate, projects can still fall short because the company doesn't have adequate skills for some parts of the product development process. Rapidly shrinking product and technology cycles make it increasingly difficult for companies to excel at all aspects of a project, so many of them are allying with outsiders. Senior managers need to balance the requirements of their projects with their company's capabilities and those of their partners.

As a result, the progress of any individual project is limited by factors outside an individual manager's control. Goldratt would have presented a richer prescription for project management had he fully extended the theory of constraints to the portfolio level. He does so when he considers the issue of scheduling the resource bottleneck, but he does not address the issue of stagnation caused by running too many projects at the same time. Reducing the overall number of projects relieves constraints on common resources; companies can then give remaining projects the resources they need and stop managers from wasting their energy in negotiations aimed at overcoming the constraints.

Putting Flexibility Where It Counts

Goldratt's narrower focus, interestingly, may be ideal for certain kinds of new-product development. While many companies excel at understanding current customers' requirements and at integrating es-

tablished technologies into their new products, they often do poorly when they tackle technologies that represent a fundamental change in a product's design or purpose – what Clayton Christensen called *discon-*

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tinuous technologies in *The Innovator's Dilemma* (Harvard Business School Press, 1997). When the degree of change involved is great, managers need to approach projects differently. Projects incorporating discontinuous technologies involve much more risk and require managers to apply stringent and individualized criteria for determining how to proceed.

Because it focuses on eliminating constraints, which are necessarily unique in every project, the book does not show managers how to establish a detailed product-development process. But for projects involving discontinuous technology, the less managers try to lay out beforehand, the better. Projects incorporating discontinuous technologies by definition involve work outside a company's experience. In such cases, a detailed project plan would give managers a false sense of security, but if they pay attention to the constraints, they will be on their way to capturing and consistently managing the essential risks of their project. They need to rely on their intuitions about where the pressure points are likely to arise and focus on managing those sources of risk. The book's highly intuitive approach may help in this area. Nor can senior managers help the project managers much in such cases: discontinuous projects tend not to require the same kinds of resources that more conservative projects need.

Nevertheless, even innovative

projects may require more structure than the book describes. Given the high degree of uncertainty involved, such projects usually need some milestones, not to act as arbitrary checkpoints but to serve as opportunities to reassess the project's viability. Fundamental to Goldratt's recommendation to eliminate milestones is the assumption that all projects that are begun should be completed. But in many industries, especially those in which most of the investment takes place at later stages of product development, companies may do well by starting many more projects than they expect to finish and then culling them along the way. And in some cases, milestones are not just self-imposed deadlines, they are hard stops. For instance, in the pharmaceutical and medical-products industry, the milestone may be the completion of a regulatory filing required for approval by the Federal Drug Administration, which must be obtained before the project can move forward. Between milestones, which are often years apart, managers can still run the projects by concentrating on the constraints.

The scheduling of milestones that mark the phases of a project may need to change, however. When it comes to products for the Internet and other fast-emerging technologies, customers' needs are changing so rapidly that traditional, sequential product-development processes run the risk of generating products that are already obsolete by the time they are released. As Marco Iansiti and Alan MacCormack pointed out in "Developing Products on Internet Time" (HBR, September-October 1997), companies in those industries have responded by modifying the traditional sequential development process to allow changes in product design right up to the last possible moment. Their managers employ a rapidly iterative product-development process that involves successive rounds of customer feedback, development, and testing in order to integrate the latest knowledge of markets and technologies into their

new products. Goldratt's flexible approach may be more easily applied to products that need to or can be frequently modified than to capital-intensive or mission-critical products, such as aircraft engines. For these latter products, milestones play a crucial role as checkpoints that guard against making changes that can cause great expense or may have possible catastrophic consequences.

Finding the Ultimate Constraint

Ultimately, the parallels between process and project management give way to a fundamental difference: process management seeks to eliminate variability, whereas project management must accept variability because each project is unique. That is especially true for new-product development, which involves taking a vague concept for a new service or product that a particular market or customer segment will find valuable and turning it into an actual ongoing business proposition. Multiple individuals, functions, and increasingly even separate companies contribute to the concept's realization.

A significant weakness of *Critical Chain*, therefore, is that it leads us to believe that project management can be successfully accomplished largely through the same rational approach that works for production management. But projects involve much higher levels of uncertainty than processes do and depend much more on the contributions of individuals. For example, the book advises managers to work with the different individuals and functional departments involved in a project to set estimates for lead times so that they meet the needs of the critical chain. But anyone who has worked on a project, been a manager of key personnel on a project, or been a senior manager mediating a resource conflict among

a number of projects knows that it is a rare organizational culture indeed that is capable of such an impersonal, rational approach to setting lead times. Organizations with an open, team-oriented environment at all levels, that tie the way they compensate individuals and measure their performance to the realization of common goals, are the ones most capable of this form of collaborative management.

Essential to fostering the necessary collaboration are project managers who can handle the political, as well as the technical, aspects of their projects. But when we ask executives to give us the names of all the people in their companies who are qualified to serve as the manager for the next major project, we are fortunate to get a list of three. Project performance is often less a matter of understanding the constraints of the project and more a function of the personal skills and capabilities of the potential leaders available. The skill to lead a team through unknowns depends not just on acquired but on inherent capabilities. Managers of product development projects also need unique leadership skills, such as the ability to perceive customers' future requirements before customers themselves can articulate those as-yet-unrealized needs. In our experience, the potential number of such leaders in almost all organizations is limited, usually fewer than ten. *Critical Chain* starts

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with a set of talented and driven project managers and assumes the resource constraints are inside the work of the project, not in its leadership. In truth, leadership may be the larger constraint.

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