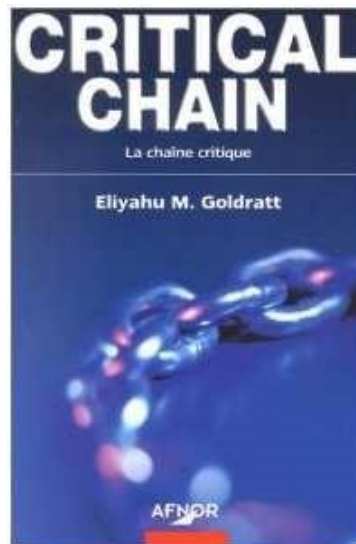


Critical Chain

Eliyahu Goldratt

Summary Book



Critical Chain, , is one of the many books written by Eliyahu Goldratt, who became famous for his worldwide bestseller, The Goal, with over 3.5 million copies sold in 29 languages. The Goal introduced the concept of the Theory of Constraints (TOC) for the first time.

In **Critical Chain**, Goldratt uses the same foundational concept and maintains the elements that contributed to his success. He employs a business novel to explain how the Critical Chain methodology addresses the current shortcomings of traditional project management approaches, which often lead to budget and cost overruns, and compromises on initial functional specifications.

To achieve his goals, Goldratt introduces three groups of characters: employees of a company, MBA management professors, and university administrators. Through various chapters, he unveils the principles and benefits of the Critical Chain methodology.

Published in 1997, this book holds the distinction of being the first to introduce ideas related to Critical Chain Project Management (CCPM). However, as is often the case in Goldratt's writings, it can be challenging to grasp the implementation process for these innovative concepts.

To facilitate the reading of this summary and the book itself, we have taken a critical look at the work, evaluating the relevance of each chapter using the following dual code: :

- – *without interest or --,*
- – *low interest or -,*
- – *average interest or +,*
- – *strong interest or ++.*

1. Chapters 1 to 5 : The author sets the general context of his novel

1.1. Chapter 1 (--)

Genemodem, a company with excellent financial results, needs to rethink its fundamentals in terms of new product development if it wants to continue growing and satisfying its shareholders.

This is the main concern shared by Daniel Pulman, Chairman of the Board, and Isaac Levy, Vice President in charge of R&D studies, following a recent board meeting, despite the prevailing optimism. They observe that their products have increasingly shorter life cycles, currently around 6 months, while the development duration, which currently stands at 2 years, is tending to extend. They question how long their company can fulfill its commitments under these circumstances.

As a result, they decide to launch an ideas lab, giving full creative freedom to three of their employees: Mark Kowalski, Ruth Emerson, and Fred Romero..

1.2. Chapter 2 (--)

Richard Silver, a non-tenured teacher with unorthodox teaching methods, is offered a wonderful opportunity by Jim Wilson, Director of the Executive MBA program at a management university. Jim proposes that Richard takes charge of the course on project management within a continuing education program designed to enhance the management skills of current executives.

This opportunity could finally help Richard achieve the much-desired tenure..

1.3. Chapter 3 (--)

Three university directors, including B.J. von Braun, the current head of the institution where Richard is assigned a course, discuss the decline in enrollments in their various programs and the somewhat bleak future that looms after 10 years of growth.

1.4. Chapter 4 (--)

Immersed in the first day of Richard's class, we discover that the three Genemodem employees who have been tasked with finding new ways to reduce the product development cycle are present.

A general consensus among all participants is reached regarding a major observation that will serve as the starting point for further reflection: the common problems faced in all projects are budget overruns, delays, and compromises on content..

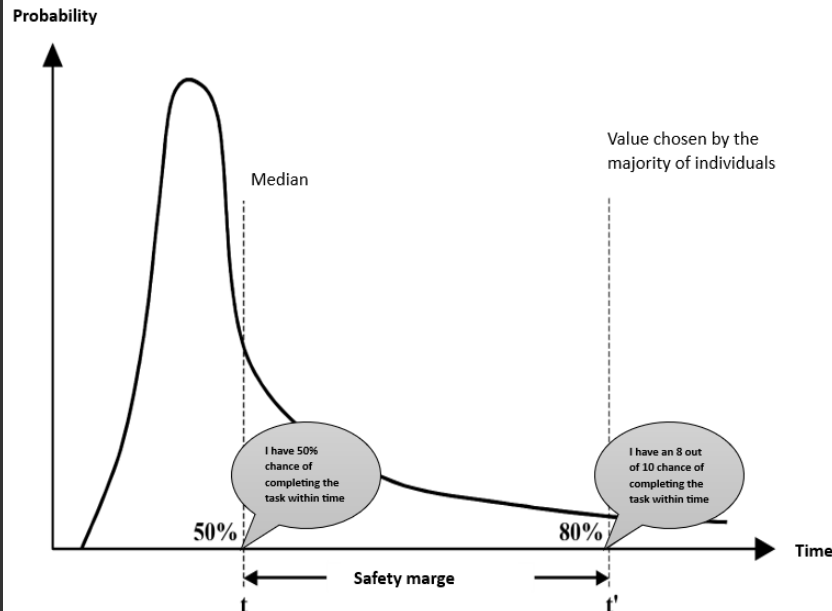
1.5. Chapter 5 (--)

Anticipating a gloomy near future, B.-J. von Braun expresses her intention to Dean Page to build a cautious budget for the upcoming year and requests that no new tenure appointments be made for this purpose.

2. Chapters 6 to 12 : The author establishes the foundational principles of the Theory of Constraints (TOC), the basis of Critical Chain.

2.1. Chapter 6 (++)

On the new day of the course, the students come to the realization that the problems encountered in various types of projects often stem from common causes: difficulties with suppliers, overloaded and frequently reassigned work teams, excessive coordination meetings that hinder actual work, and unrealistic deadlines imposed by management, ...



A common factor in many of these causes is the weight of the unpredictable and random events to which individuals respond by **adding time buffers to each activity as a form of protection**. In theory, this buffer is intended to ensure that the task is completed within the planned deadline in 8 out of 10 cases..

2.2. Chapter 7 (--)

A new conversation takes place between B.-J. von Braun and one of her fellow university directors, discussing the major cause of the decline in enrollments, which is the mismatch between the offered programs and the expectations of employers who do not believe that their managers who have completed the curriculum have gained a real advantage. The need to quickly make budget cuts becomes evident to both of them.

2.3. Chapter 8 (-)

Jim and Richard engage in a discussion based on their observation of numerous projects regarding potential topics for an article on project management. Richard puts forward an important thought: **companies are so immersed in the cost-cutting mindset that they forget the primary objective of a project is not to save money but to generate profits.**

2.4. Chapter 9 (+)

On the third day of Richard's course, he focuses on revisiting the three basic concepts of project management: **PERT**, **Gantt charts**, and **Critical Path**. The students raise two interesting points regarding the dilemma of starting activities on branches that are seemingly outside the Critical Path either as early as possible or as late as possible:

- *by starting these tasks as late as possible to avoid committing financial resources too early, there is a risk that any unexpected event or delay occurring during these tasks could ultimately impact the Critical Path and, consequently, the final deadline of the project;*
- *by starting these tasks as early as possible, we introduce additional complexity in project management and a strong risk of project manager's dispersion.*

The participants also come to the conclusion that project managers do not have good tools to track progress, as it :

- *is measured based on the amount of work completed compared to what is left to be produced, **without distinguishing between Critical and Non-Critical Paths;***
- *does not "see" that the progress made on one branch compensates for delays on others, knowing that any progress made on a branch is lost because one still has to wait for the branches that are delayed.*

2.5. Chapter 10 (--)

New reflection from Jim and Richard on possible topics for upcoming articles that could address the challenges faced by project managers in discerning the essential to avoid getting scattered, as well as the current systems for measuring project progress that only divert the project manager from what truly matters.

2.6. Chapter 11 (+)

Introduction of a new character, Johnny, who is a professor at the same university as Richard. During a conference gathering business professionals and professors, Johnny presents the key lessons learned from his year at Unico Company. Through this experience, foundational paradoxes of the author's thinking begin to emerge:

- ***managers are constantly torn between a cost control logic, especially at the beginning of each month (where they seek to control expenses), and a revenue protection logic (or Throughput) that emerges in the last few days of the month (where they strive to produce what has been sold to ensure revenue);***
- ***the global optimum of a company results from local optima, which implies taking action in multiple areas to maximize the overall result. It's important to note that improving the strongest link in a chain does not strengthen the entire chain, meaning that most local improvements have no effect on the global optimum..***

The presentation by Johnny serves as a support to recall other key principles of the Theory of Constraints, particularly in terms of the working approach:

- ***identify the system's constraint or weakest link,***
- ***exploit the capacity of the system's constraint through targeted improvement actions since it determines the flow of production and the company's revenue,***
- ***subordinate the production to the capacity of the constraint, thereby refraining from producing on non-bottleneck areas that are already over-capacity, producing more than the constraint can handle,***
- ***go back to step one through successive iterations.***

2.7. Chapter 12 (-)

Still drawing on Johnny's feedback, the author concludes his crusade against local cost optimizations, using the devastating effects of evaluating performance based on a tons-per-hour indicator in a steel mill as an example.

Also highlighted is a concept dear to E. Goldratt, that of the mental process (or cloud) of cause and effect in TOC (or Current Reality Tree).

3. Chapter 13 to 14 The author presents the causes of project time overruns

3.1. Chapter 13 (++)

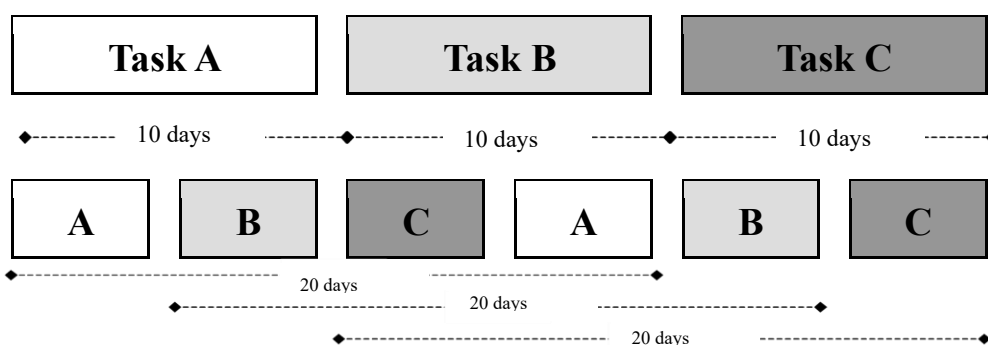
Returning to a session of Richard's course, new major observations are made regarding project planning and the three main mechanisms through which safety margins are taken by different project stakeholder:

- *the task duration estimates are mostly based on past bad experiences, including those of project managers, which leads to a need for self-protection by incorporating safety margins;*
- *the more levels of management involved in the project, the higher the final estimation becomes, as each one adds their own safety margin;*
- *To protect against the management's habit of systematically and authoritatively reducing the project duration (to achieve a good cost), each individual inserts an additional safety margin from the initial estimation.*

It is discovered that a delay has a full impact on the subsequent task, whereas any progress made on a task is generally lost because no one acknowledges it, for fear of not being recognized (in terms of value) and having to lower their future time estimations in upcoming projects.

It is understood that the majority of safety buffers serve no purpose because in the case of parallel tasks (which are the majority in a project), it is the largest delay that affects the subsequent tasks, and any progress made elsewhere does not count. Finally, three very important concepts emerge:

- *the Student Syndrome: an attitude where individuals often start their work at the last moment, which wastes the safety buffer allocated to the task and, in case of unforeseen events, leads to a delay in meeting the scheduled deadline,*
- *Multitasking: a logic that involves shared resources, especially bottleneck resources, working on multiple projects simultaneously under the pressure of project managers, completing a small portion of each task at a time. This mathematically increases the duration of each task (see figure below));*



- *Parkinson's Law: a behavior in which an individual tends to use up all the time allocated for a task, even if the task could be completed in less time.*

3.2. Chapter 14 (--)

Richard meets with B.-J. von Braun and tries to convince her that he can attract additional students to the MBA program with his expertise in project management.

4. Chapters 15 to 17 : The author presents the principles of the Critical Chain

4.1. Chapter 15 (+)

Richard, along with Jim, Johnny, and another colleague, revisits the key principles discussed during the previous colloquium (Chapter 11) and attempts to derive good management practices for both production and projects. They delve into the fundamental principles of the Theory of Constraints (TOC), starting with the concept of Just-in-Time and the natural limitation of work in progress that arises from it. They particularly draw inspiration from the example of a platoon of soldiers, where each soldier is connected to others by a rope, symbolizing the interconnectedness of workstations in a production line or tasks in a project:

- *there is a bottleneck in the platoon, represented by a soldier named X, who walks the slowest,*
- *the soldiers who can potentially walk faster than Soldier X represent the non-bottlenecks,*
 - *the pace of the platoon's progress is inevitably determined by the speed of the bottleneck soldier,*
 - *if a soldier wants to move faster, the rope that connects them becomes taut, limiting their speed to that of the slowest soldier, Soldier X.*

the instructors also discover the necessity of protection:

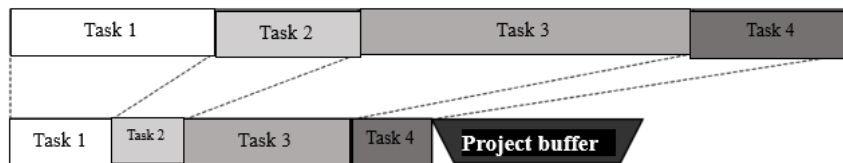
- *workstations by work-in-progress for production,*
- *tasks by time for a project.*

The purpose of this safety is to avoid jeopardizing the bottleneck and ensure its maximum utilization. However, the question remains of identifying the bottleneck in a project and how to find it..

4.2. Chapter 16 (++)

The three students from Genemodem have convinced Richard to come to their company to help convince others of the validity of the identified principles and to address lingering questions. A new step forward is taken by considering that:

- *finally, the constraint of a project is none other than its Critical Path,*
- *the best way to protect it is to place a time buffer at the end of this path,*
- *this buffer of days is created by reclaiming a portion of the safety margins typically allocated to each task,*
- *the reserve thus built does not lengthen the duration of the project or shift its end date.*

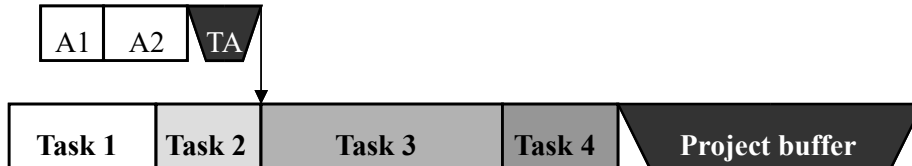


Based on the statistical curve illustrating the chances of project success, and considering that on average the sum of all time safeties taken by team members, project managers, and executives equates to a 200% overall project margin, it has been decided to :

- *reduce the duration of tasks on the critical path by half, leaving them with a 50% chance of being completed within the planned timeframe,*

- combine all these time estimates and divide the total by 2.,
- assign the obtained total of days to the project buffer, which is actually 25% of the entire initial project duration, and therefore shorten its deadline.

The interest should also focus on the secondary branches of the schedule, those that are not on the Critical Path and whose activities are primarily responsible for problems that impact the Critical Path. The idea is to apply the same reasoning as for the project buffer to these secondary branches:



- divide the initial estimates of tasks outside the Critical Path by 2,
- allocate half of these reductions as intermediate buffers at the end of each secondary branch connected to the Critical Path.

4.3. Chapter 17 (+)

Mark and his two colleagues from Genemodem present to the class their application of everything they have learned in the recent sessions of the course. **The most interesting part for them is the change in people's behavior**, with:

- the absence of false alarms or pressure when they have nothing to do at a certain point, and the natural decrease in multitasking.

A discussion is initiated on project management around 2 concepts:

- **Measuring project progress by the percentage of the critical path completed** (where the critical path represents the duration of the project),
- **The resource buffer, which involves ensuring in advance** (sending a message 7 days prior, then 3 days prior, and finally the day before) **that the resource required for the next task on the Critical Path will be available.**

The discussions lead to contemplating the most appropriate way to track the progress of tasks outside the critical path, although no solution is identified at this stage.

5. Chapters 18 to 25 The author concludes his reflection on the Critical Chain approach

5.1. Chapter 18 (-)

During yet another class session, the sensitive topic of selecting subcontractors for a project is discussed, emphasizing the need to choose them based on their ability to meet or even reduce deadlines, rather than solely on the cost/price variable. To achieve this, it is suggested to compare the additional benefit gained from choosing the lowest-cost supplier to the costs incurred by their inability to meet deadlines and potentially delay the project.

To demonstrate that this line of reasoning can be applied to all suppliers, Richard agrees to accompany one of his most skeptical students to visit a subcontractor. During this visit, he shows that it is always possible to find a win-win agreement and successfully negotiates a shorter and guaranteed deadline with this key supplier, in exchange for a selling price that provides three times more profit margin to the supplier.

5.2. Chapter 19 (--)

During a meeting at Genemodem, Isaac Levy and the group of collaborators from the idea laboratory discuss the operational implementation of the new project management concepts. Despite being very satisfied with the results achieved, Isaac raises the question of how these concepts would perform when applied to multiple projects simultaneously. He tasks the team with exploring this question and authorizes them to seek guidance from their instructor, Richard, who will accompany them as a consultant.

The rest of the chapter, which is not relevant, discusses Richard and his wife's future.

5.3. Chapter 20 (--)

Richard is approached by both Johnny and a student regarding how to create a win-win relationship between a subcontractor and a client. The question is how to persuade the supplier, who may not necessarily be inclined, to shorten their delivery times. The objective is to find the gains that each party can derive from this change. A lengthy demonstration ensues, focusing on a specific case in the construction industry.

5.4. Chapter 21 (--)

Richard delivers a presentation to the Young Executives Circle on the new project management principles developed in his course. With the help of a successful leader who has implemented these principles, Richard's intervention is highly appreciated. B.-J. von Braun, who managed to secure an invitation, seizes the opportunity to persuade the attendees of the value of the MBA program's teachings and the benefits for their managers to attend. Although skeptical, the executives agree to establish a commission to articulate their training content expectations.

5.5. Chapter 22 (++)

During a discussion, one of the students raises a problem encountered in their project while applying the concepts learned in class. It involves a situation where the same resource is required to work simultaneously on different tasks belonging to various secondary branches outside the Critical Path. This scenario consumes the auxiliary buffers of those branches and impacts the Critical Path.

From this observation, the group draws a key lesson : **the longest chain in the project consists of dependent parts due to chronological necessity (task sequence) and other dependent parts due to the use of common resources. Therefore, considering both task constraints and resource dependencies simultaneously allows for a shift from the traditional Critical Path to the Critical Chain.**

5.6. Chapter 23 (--)

Jim, Dean Page, and B.-J. von Braun engage in a discussion regarding the report submitted by the Young Executives Circle, which outlines their expectations and training needs for their managers, and consequently, the future content of the MBA courses.

B.-J. is willing to propose a reimbursement of tuition fees to these companies if what their managers have learned in the courses does not bring them more than \$100,000 in savings within 18 months.

Meanwhile, Johnny convinces Don Pederson, CEO of Unico, to invest in the new version of the redesigned MBA program focused on TOC (Theory of Constraints).

5.7. Chapter 24 (+)

Richard takes advantage of his last class of the year to invite Johnny and ask the 3 students from Genemodem to provide an update on their implementation of the new project management principles and the unforeseen challenges they have encountered.

How to address the problem of resource overloads shared across multiple projects (or multitasking), and the pressure from project managers to prioritize their project for resource allocation?:

- *by prioritizing the understanding that projects can wait since they have buffers on their Critical Chain and auxiliary branches,*
- *by identifying the common bottlenecks across these projects and subjecting them to special monitoring,*
- *by protecting these bottlenecks through scheduling the work passing through them with a two-week advance.*

The provided response is only partial, as it doesn't explain any clear rules on how to choose the project that will be assigned the bottleneck resources first. Is it based on the project with the closest end date, the project that has consumed the most of its project buffer, the project that is most delayed, or something else?

This final session is an opportunity to emphasize the importance of implementing a planning software that integrates the concept of Critical Chain and resources to manage projects effectively in the Critical Chain methodology.

5.8. Chapter 25 (-)

Reunion between Don Pederson, Jim, and the MBA faculty to discuss the tools that enable:

- make decisions among multiple investments or projects,
- calculate their profitability

The author "buries" the two most common methods, the payback period and the net present value, in favor of **a new concept of dollars per day, which is only partially discussed and not directly related to project management.**

One can see this as a last-minute attempt to complete their reflection by addressing the issue of project portfolio management and the previously unaddressed question of how to avoid launching too many projects, or only selecting the best ones, within the same period.