Critical Chain

Book abstract

05/2020

INTRODUCTION

- Why are the projects often late?
- Why do some of them never succeed?
- How to successfully complete projects while respecting costs, deadlines and client specifications?

Through an MBA class in project management, Doctor Goldratt seeks to answer these questions and proposes a new method of project management. The summary below explains the approach used by Dr. Goldratt but does not go into the history of the book.

ANALYSIS OF PROJECTS DELAYS

An analysis of several projects shows that most of them do not finish on time because of the uncertainties inherent in the progress of a project (suppliers, weather, etc.). These uncertainties are unpredictable and cannot be controlled. However, the example of the U2 project, given by Goldratt, proves that it is possible to succeed in a project in a shorter time, a lower budget and identical specifications, despite the ups and downs: “The U2 was developed in a surprisingly short time. Eight months after the start of the project, the plane was already flying […]” (extract from the book p. 27)

He deduces from this that the delays in the projects are not due to these uncertainties but to them being mismanaged. An analysis of the task durations estimates and the project monitoring allows a better understanding of these dysfunctions.

What is the process of estimating the task durations?

One of the first difficulties encountered by any project manager is to assess the duration of each elementary task. Dr. Goldratt argues that the probability distribution curves for completing tasks in a given time generally follow the following pattern:

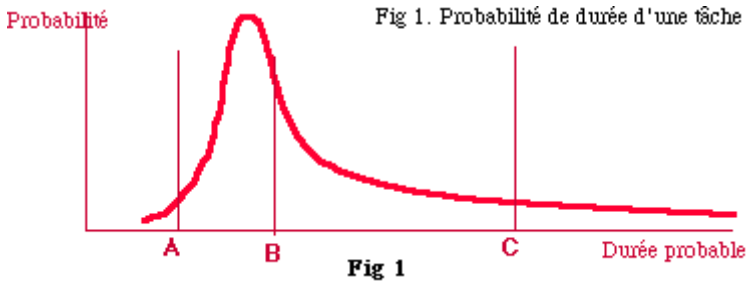


Fig 1. Probabilité de durée d'une tâche

Fig 1

- If there is no issue completing the task, its duration will be A: it’s unlikely,
- If there is a “normal” level of uncertainties, its duration will be B: it’s highly likely,
- If there is a lot of uncertainties, its duration will be C: it is again unlikely.

Knowing there are uncertainties, the resources will make a commitment over time B because they know that they will have an 80% chance of completing the work before this date.

To this is added a "time" security margins from management: each manager recovers the task durations from his collaborators and in order to protect his team, increases the time taken to complete a set of tasks. Thus, the more prioritized a project, the greater the management's safety margins.

Finally, to anticipate the arbitrary decisions of the hierarchy (time reduction), the resources extend the safety times. They will increase their initially scheduled duration by 20%, to then undergo an authoritarian decrease of 15%.

With such an extended task duration, resources should be able to finish 90% of the tasks before the set date. However, looking at the tasks completion dates, 80% of them end on the planned date but rarely in advance, which does not correspond to the results previously found.

Why do projects run late, in spite of all these considerable safety margins?

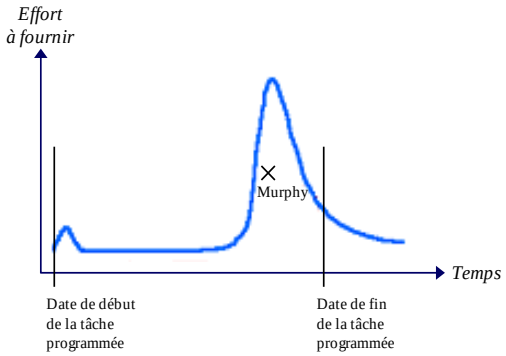
Dr. Goldratt explains this observation by several phenomena:

- **Parkinson's law**

Regardless of the time allocated to a task, the resource will use the entire defined time.

- **The student's syndrome**

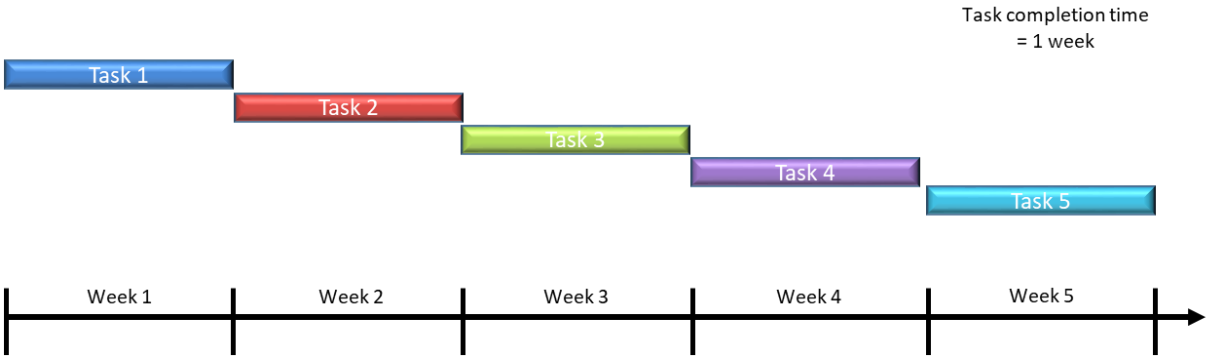
Few students start to work as soon as the subject is delivered, most of them do not start until shortly before the deadline. At this time, any hazard compromises meeting deadlines.



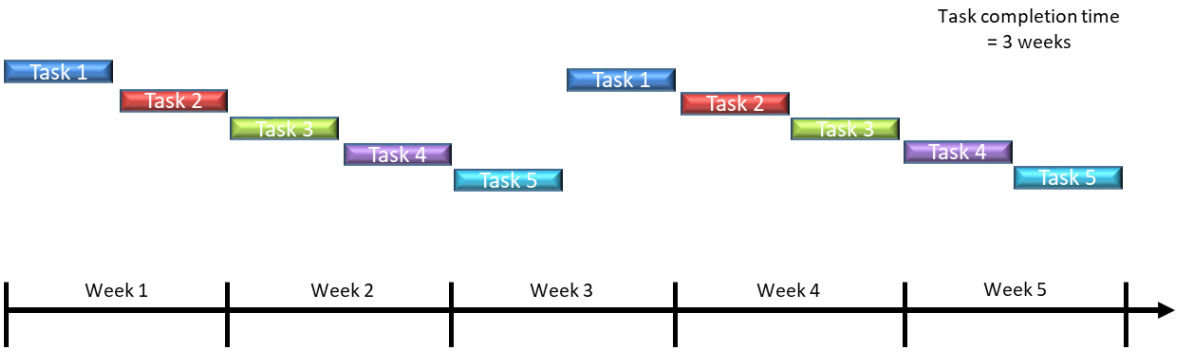
- **Multitasking**

The increase in the task durations leads to multiplying the number of the tasks in progress. As a result, task managers must manage multiple tasks simultaneously.

Let us take the example of a manager having to manage 5 tasks, 1-week long each, simultaneously: common sense would lead him to mobilize all of his resources successively on each of the tasks according to the following diagram:



But, subjected to the pressure of various interlocutors, Dr Goldratt says, it is probable that the tasks execution would rather correspond to the following scheme:

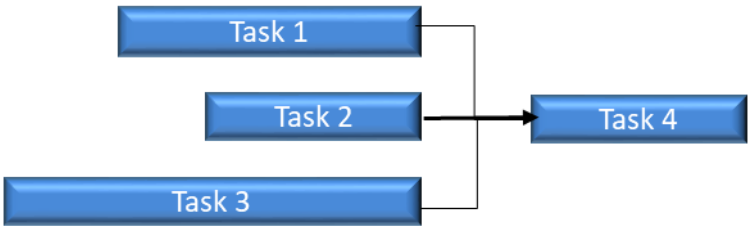


For the task manager, the result is the same: five tasks completed in 5 weeks. For project managers, the situation is quite different: task 1 that could have been finished after a week will not be finished after three weeks in our example.

- **Tasks interdependence**

When tasks are planned in a series, if one task is late, this will further shift the end date of the whole sequence of tasks. But, if one of the tasks goes ahead, the next task will start on the date initially planned and not in advance. The lack of communication between resources and the desire to keep a reserve of time in order to avoid a reduction in the completion time during the next project, explains this phenomenon.

If tasks are in parallel, for instance, the following simple example:



In this slightly caricatural case: if one of the tasks 1, 2 or 3 is delayed, task 4 will be delayed. On the other hand, if one of them gets ahead it will have no effect on the total duration of the project.

In conclusion: on all projects, delays accumulate and advances are lost.

A NEW METHOD: THE CRITICAL CHAIN

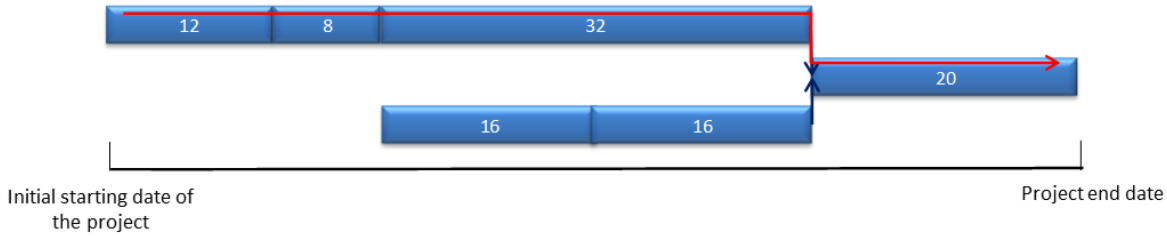
Using Theory Of constraints

To create his new project management method, Dr. Goldratt relies on the steps of Theory of Constraints (TOC):

➢ Identify the constraint

The constraint is what "*determines the project total duration from the start to the end*".
In the case of project management, the Constraint is the critical path. Any delay on the critical path will further delay the end of the project.

Let's consider the following project:



The task durations were classically assessed by each manager in order to obtain, before term, a probability of completion greater than 90%. The diagram highlights the critical path underlined in red.

➢ Exploit the system constraint

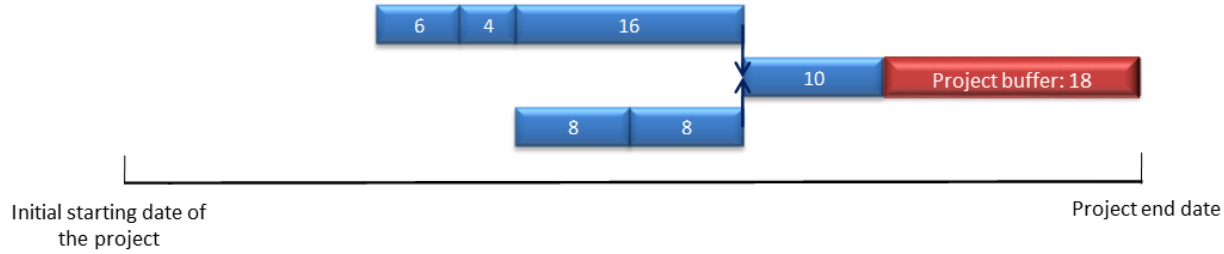
In order to exploit the constraint of the system, meaning, for project management: "do not waste time allocated to the critical path", Dr. Goldratt says that we must stop this habit of putting 200% of time security margins on each task.

Thus, he recommends halving each task duration, their probability of being executed on time remains, however, greater than 50%.

The duration of the project, defined by the "critical path" is therefore reduced by half. It is therefore possible, respecting the initial duration of the project, to program a "project buffer" allowing to mutualize the risks of delay of all tasks.

Dr. Goldratt says that experience has shown that there is no risk in reducing this tampon by half.

The general scheme then becomes:



The buffer inserted is called project buffer, it protects the entire project from uncertainties occurring on the critical path.

➢ Subordinate all activities to the constraint

Thanks to the project buffer, project is protected against uncertainties of tasks located on the critical path. The subordination step consists in: "protect[ing] the constraint from time losses that occurred elsewhere", that is to say, on subsidiary/non critical chains.

For this, Dr. Goldratt recommends placing "feeding buffers" at the points of convergence between the critical path and the adjoining branches. The size of these feeding buffers is calculated according to the same principles as the project buffer.

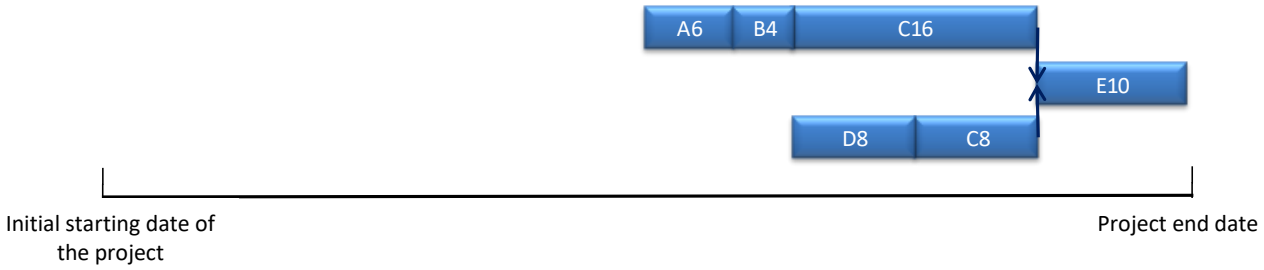
This principle is interesting but only takes into account task durations, it does not highlight the possible existence of critical resources which, mobilized simultaneously by several tasks, become bottlenecks for the entire project and does not solve the problem of multitasking.

Management of critical resources, the notion of "critical chain"

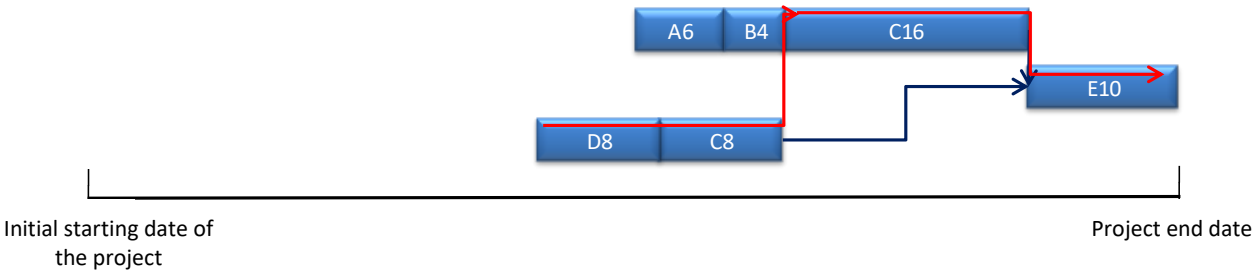
➢ Identify the constraint

Based on this observation, Dr. Goldratt repeats the stages of TOC but by modifying what his constraint is.

Let's call A, B, C, D and E the resources mobilized on our example project, they are allocated as shown below:



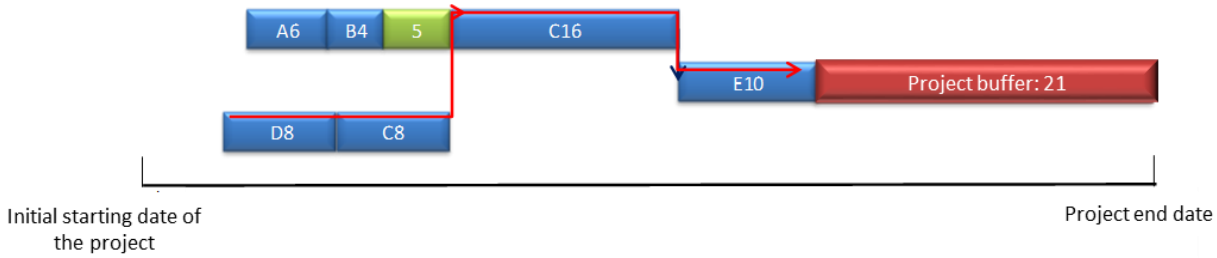
To manage the conflict, we choose to favor the critical path and specify the order of processing tasks for resource C according as shown in the diagram:



The project constraint is no longer the "critical path" but the "critical chain" in red on the diagram. “Constraint is the longest chain of dependent tasks. […] The dependencies between tasks can result from a logical branch sequence, but also from the need to use the same resource. »(Extract from the book p 230-231).

➢ Exploit the system constraint and subordinate all the activities

The feeding and project buffers are still pertinent to protect the critical chain and the respect of project deadline:



The buffers are no longer positioned in the same place and no longer protect the same tasks. A new calculation of the buffers size therefore necessary.

This is done as before:

- Project Buffer: sum of duration of tasks on the critical chain divided by 2
- Feeding Buffer: sum of duration of tasks on subsidiary path divided by 2

How to monitor projects with Critical Chain?

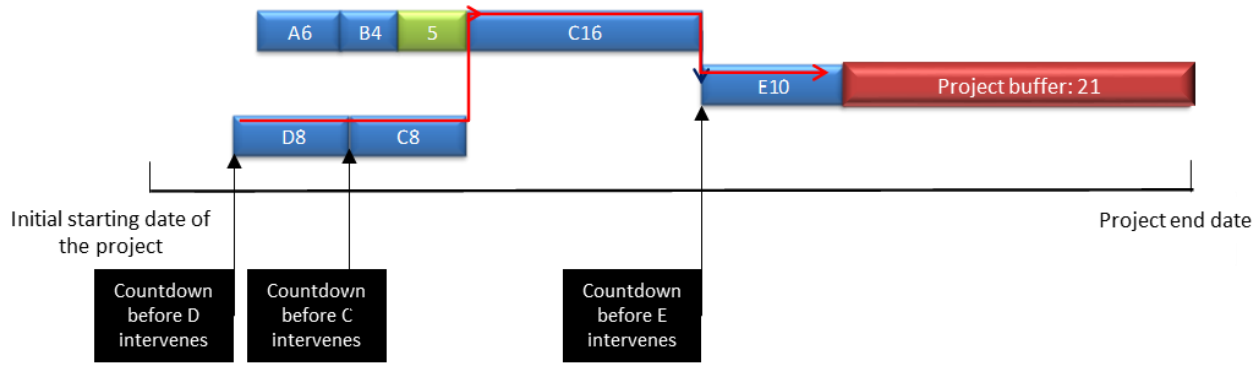
Very often, managers do not have the right indicators to effectively manage their project and thus focus on the essentials. The progress of the projects is calculated according to the "completed" versus the "remaining to be done". This measurement is made without differentiating the tasks located on the critical path and those located on the secondary paths.

This method favors starting tasks as early as possible. Consequently, the project manager disperses to follow more tasks than necessary and does not see the drifts of the project.

Dr. Goldratt proposes to monitor the progress of projects via the control of project and feeding buffers and to launch tasks with countdowns (or resource buffers).

➢ Implementing countdowns

The tasks on the critical chain have been clearly identified. To mobilize resources and avoid delays, a countdown warns each of the resources concerned of its next intervention on the critical chain according to the following principle:



➢ Buffers monitoring

Any delay on a critical task (task on the critical chain) results in a consumption of the project buffer. The principles to be adopted are as follows:

• If consumption remains less than a third of the buffer: no action
• Consumption between one third and two thirds: stay alert and prepare corrective actions
• Consumption greater than two-thirds: action

The same principles are used for feeding buffers. This management mode allows to say that the project will be late when the entire project buffer is consumed.

How to integrate suppliers in the Critical Chain?

The choice of a supplier is an important moment in the construction of the project. Of course, the cost of the service is a significant element, but the delays in delivery from a supplier have a much stronger impact on the total budget of the project.

Dr. Goldratt suggests integrating the supplier into the critical chain approach. For this, he recommends negotiating with them a significant bonus in the event of delivery of the product before the scheduled date, and an equally significant penalty in the event of delay. This method reduces the intervention time of the subcontractor.

To pilot or manage suppliers, the required method is identical to that of resources. One of the main problems of subcontractors is to recover all the information and to be informed of the intervention date. For example, Dr. Goldratt recommends warning them several days in advance and providing them with all the necessary data before starting their task.

How to manage multi-projects?

Multi-project management can be done with the critical chain going through the steps of TOC.

- **Identify the constraint**

In this case, the question to ask is: "What is the constraint that determines the success of all of the company's projects?" This is a common resource for all projects. It will give the pace of projects and define the quantity of projects that can be carried out in the company.

- **Exploit the constraint**

To avoid wasting time on the constraint, you must start by planning the work of the strategic resource and then organize the various projects around this resource.

- **Subordinate all activities**

This step consists in creating a new kind of buffer: "the capacity buffer". This aims at protecting the constraint from delays from other projects.

OBTAINED RESULTS:

Using this method, Dr Goldratt argues that:

- Resources start working only when necessary.
- The student syndrome disappears: with the reduction of task durations, people know that they risk not finishing their work on time and start their task when the signal is given.
- Multitasking is less important thanks to the reduction of on-going tasks. This greatly contributes to the reduction of project completion times.