Cutting Edge

INTRODUCTION TO CRITICAL CHAIN

BY

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PRELUDE

One does not need to be a Darwinist to recognise that organisations must evolve and adapt in order to survive. This was never truer than in the 21st century, when even thinking about the rate of change causes the mind to spin, and when that rate continues to accelerate.

So when an organisation decides to undertake a project, it does so with a view to taking the organisation forwards – forwards towards creating ever better value propositions for its stakeholders. This does not necessarily have anything to do with profits. Humans undertake projects to protect endangered ecosystems, to improve the aesthetics of their gardens, and to accelerate the delivery of life-saving emergency services.

In the TOC community we talk about *goal units*. No matter what an organisation's goal units are, there is typically a need to deliver them faster, with ever improving quality, and with an increasing degree in efficiency with regards to the resources used to create them.

Unfortunately, project management's track record of project execution is poor to say the least, a fact which *competition* has made increasingly apparent and of increasing concern. One recent KPMG study, for example, reported that 56 percent of firms have had to write off at least one IT project in the last year as a failure. The average loss incurred as a result of these failures was about €12.5m, with single biggest write-off costing almost €210m.

Whilst the results vary from industry to industry, the general message is the same: Projects are failing at an alarming rate and this is costing organisations and economies around the world billions or even trillions of dollars annually.

So given the consistency of failure it is perhaps tempting to believe that there is something fundamentally intractable about project work. The weather, for example, has been shown by chaos theory to be intrinsically unpredictable beyond very short time-spans. Are we therefore fighting a losing battle when we engage in project planning?

Thankfully, since the invention of Critical Chain Project Management (CCPM) by Dr. Eli Goldratt, we can answer this question with a resounding *no*. Whilst no project can be delivered on time and within budget with one hundred percent certainty, CCPM has demonstrably enabled us to increase the probability of successful delivery from between zero and fifty percent to ninety-five percent plus. For profit seeking organisations, such a decrease in project risk has a direct impact on project value – and subsequently profits. For organisations seeking other goal units, the potential gains can be literally anything, including the saving of more human lives as previously thought possible.

Over the coming weeks, we shall present a series of short articles which explain how CCPM achieves this radical reduction in project risk. With this introduction, we hope to inspire the reader to find out more about Critical Chain such that he or she will consider introducing this powerful technique in their organisation. The parts are organised as follows:

Part I: Process efficiency (follows this prelude); in which we describe what we mean by an "efficient process";

Part II: Managing duration uncertainty; in which we distinguish two different types of variation, note that traditional project management makes no such distinction, and then describe the unique way in which critical chain addresses this shortcoming;

Part III: Multitasking, Resource Levelling and Resource Buffering; in which we complete describe the negative impact of multitasking, and what to do about it.

Welcome to the exciting world of TOC and Critical Chain…

PART I: PROCESS EFFICIENCY

Before we can begin our discussion of project management, we need to begin with an understanding of some basic facts about processes. We shall build upon this foundation in the following articles.

THE PROCESS

A business process can be defined as a series of value-adding tasks that are linked together to turn inputs into outputs. This statement applies regardless of whether the output is a product or a service. Business processes can be defined at many different levels and with various boundaries and interfaces. Furthermore, processes:

- are co-ordinated activities that involve people, procedures, technology and infrastructure
- have a beginning and an end
- interconnect
- constitute a significant portion of organizational costs

It is safe to say that an organization is only as effective as its processes.

An ideal process will comprise of three main attributes:

- Efficiency: minimizing the resources used to achieve a desired level of throughput
- Effectiveness: producing the desired results
- Adaptability: ability to adapt to changing customer and business needs

Efficiency will be our main focus in this introduction to critical chain project management.

PROCESS EFFICIENCY

Let us consider what determines the average throughput of a given process. Figure 1 presents a simple process consisting of five sequentially connected activities.

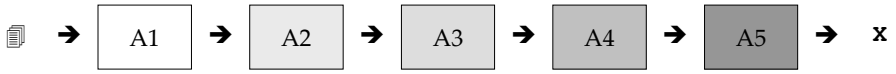

Figure 1: A Simple Process

This process takes some inputs and is responsible for producing X's. The process's *throughput* is defined as the number of artefacts (results, products etc.) produced or processed in a given timeframe. Now let us consider the timeframe of a single day. What determines the average number of X's produced daily?

At this point many people make the error of assuming the throughput of the process as a whole is determined by the throughput of each of the individual activities. However, in the same way the weakest link in a chain determines the chain's overall strength, the average throughput of any given process is determined by the activity with the lowest average throughput. We call this bottleneck the process's *constraint* (see Figure 2).

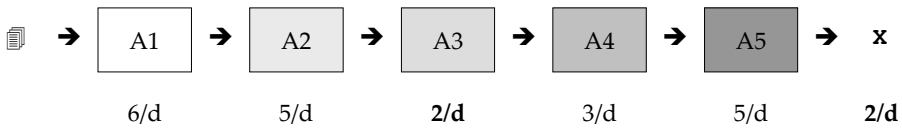

Figure 2: The Constraint Determines the Throughput of the Process

In practice a constraint can take many forms: A limited resource, an underperforming machine or worker, a company policy, or a sequence of indispensable tasks in a project.

In Figure 2 we see that activity A3 limits the overall throughput of the process to 2 X's per day. We can also see that activities A1, A2, A4 and A5 exhibit *excess* capacity – capacity greater than the throughput of the constraint. This beggars the question: Can we improve the efficiency of the system – in the sense of getting the same output for fewer inputs - by removing the excess capacity from the process? In other words, should we perhaps try to "balance" capacity by making it more or less equal across activities?

Again, many people and organisations make the mistake of assuming that a process will become more efficient when capacity is balanced. In fact, nothing could be further from the truth. To understand why, we must consider the impact of variation.

THE IMPACT OF VARIATION

So the average throughput of the constraint ultimately determines the average throughput of the process as a whole. It is therefore imperative to ensure that the constraint is kept busy, because a drop in throughput at the constraint constitutes a drop in throughput of the entire process. In particular, we must therefore strive to ensure that the constraint is *neither starved of input nor blocked from delivering output*.

However, all real-world processes exhibit some degree of statistical fluctuation, of *variation*. Due to a myriad of influences, activity throughput continuously deviates from the average. So in a process comprising balanced capacity, only one of the activities in the process needs to drop below the average for the throughput of the entire process to drop. In other words, the *average throughput of a balanced process will always be less than the average throughput of its activities* (Figure 3).

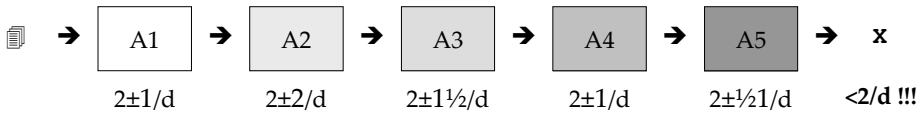

Figure 3: Balancing Capacity Negatively Impacts Throughput

Crucially then, an efficient process *prerequisites* a degree of excess capacity in non-constraints in order to protect the constraint from both starvation and blocking. Unfortunately, the vast majority of today's managers do not consider excess capacity in these terms, instead viewing the excess either as *waste* (a cost-saving opportunity) or as *underutilisation* (to be exploited). Either way, there is a strong temptation to improve the performance of all individual activities – to conduct *local optimisation* across all activities.

To paraphrase Dr. E. Goldratt on this characteristic of processes: *Global performance improvement is not the sum of local improvements* [Gol84]. Goldratt calls this law the *Theory of Constraints* or TOC.

THE CONSTRAINT: BOTH LIMITATION AND OPPORTUNITY

We have now seen that balancing capacity by eliminating excess capacity reduces overall throughput. It should also be clear that attempting to increase utilisation on non-constraints not only does nothing to improve overall throughput, it will in fact increase work-in-process – with partially completed products or results unavoidably building up in front of all of the constraints in the system.

If backlogs continue to grow, alarm bells will eventually sound, which conscientious manager will dutifully concern herself with. *Fire-fighting* cultures originate when an organisation is full of such well-meaning, poorly focused managers. What is more, such cultures are generally self perpetuating because as work piles up, the more hidden the sources of the backlogs become. The over-allocated manager has less and less of a chance to identify the sources of these backlogs.

Focussing management effort on protecting constraints not only enables the throughput of the process to match that of the slowest point in the process, it also has the potential to eliminate much, if not all backlogs – and hence fire-fighting.

Let us also note that, whilst a constraint presents us with a limiting factor, it also provides us with an exciting opportunity – namely to increase process throughput with relatively little effort. Rather than expend effort and resources on trying to maximise utilisation, the manager should focus on those points in the system, which are going to positively impact throughput. In other words, she should focus on the constraints.

A PROCESS OF ON-GOING IMPROVEMENT

One of the many remarkable consequences of TOC is a very natural and intuitive process for continuous improvement, namely:

1. Identify (next) process constraint
2. Decide how to maximize constraint usage
3. Subordinate all other decisions to maximising constraint usage

4. Elevate the constraint (increase capacity at the constraint)
5. Avoid complacency: Return to 1

Contrast this approach with traditional process improvement methods. For example, in software development we have Capability Maturity Model Integration [CMMI], which is interpreted by many – implicitly at least – that process optimisation is the pinnacle of organisational maturity.

Implications for Operational Strategy

We have seen that by focusing on a few leverage points in the system, we can significantly increase system throughput. We could call this throughput-focused strategy *process-efficiency*. How does this strategy compare with another well known – and to-date predominant – strategy *cost-efficiency*?

Executives must understand that the strategies of process-efficiency and cost-efficiency are *fundamentally incompatible*. As we have seen, achieving process-efficiency (maximising average throughput for a given set of resources) prerequisites excess capacity both prior to and following constraints. Yet to achieve cost-efficiency (cut operational expense) the manager seeks to eliminate all the excess capacity from the system and to maximise resource utilisation. There is no resolution for this conflict other than dropping one strategy in favour of the other. So which should we choose?

Note firstly that the benefits achievable by cutting operational expenses are strictly limited. Clearly a minimal operational expense is required for the process to run at all. Additionally, whilst both strategies potentially have positive effects on bottom-line numbers like net profit, cash flow and ROI, because of the lack of management attention to constraints, cost-efficiency does nothing to reduce the capital consumed by work-in-process. On the contrary, the lack of attention to the causes of backlogs means it is likely to increase. And when options to further improve cost-efficiency inevitably run out, the policy can scarcely avoid eating into salaries, bonuses and jobs. A negative impact on employee morale ensues, which to-date has yet to manifest itself as an increase in productivity.

In contrast, throughput increases are limited only by our ability to identify and eliminate constraints. Does a process-efficiency strategy have any *disadvantages*? In practice the approach does indeed face a very serious challenge: it typically requires managers and staff to operate in accordance with a very different set of priorities. A switch from cost-efficiency to process-efficiency cannot be undertaken without revisiting the organisation's decision rights, performance measurement and reward systems.

Now, we do not claim that a cost-efficiency strategy is inappropriate in all situations (emergency measures to save a company from immanent bankruptcy might constitute such a situation). However, if the goal is to experience the quality and throughput improvements enjoyed by the manufacturing industry over the past 30 years, then executives must, at the very least, explain how they intend to avoid the conflicts of interest associated with cost-efficiency.

Summary of Part I

- TOC shows us that the maximum throughput of a given process is determined by the process's constraint.
- Maximising average throughput the constraint must be protected from starvation as well as blocking.
- To maximise throughput in the presence of statistical fluctuation we must protect the constraint with additional capacity prior to and following the constraint.
- Increasing utilisation on non-constraints does not result in improved process performance. On the contrary, it increases backlog, which results in more work-in-process, which translates into firm capital.
- Whilst constraints represent limitations, they are also potential leverage points.
- Process-efficiency and cost-efficiency are fundamentally incompatible strategies.
- Switching from a cost-efficiency to a process-efficiency strategy requires a thorough review of organisation's decision rights, performance measurement and reward systems.

For book recommendations, references and links, check out http://www.cuttingedge.ch/resources

References

[Gol84] E. Goldratt, *The Goal*, The North River Press, 1984