Why have so few organizations adopted Theory of Constraints?

...despite delivering impressive results for over 30 years across such a large range of organizations and applications...

By Dr. Alan Barnard and Eli Schragenheim

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Executive Summary.

Dr. Eli Goldratt, creator of Theory of Constraints[1] (TOC) and best-selling author of THE GOAL, wrote in the foreword of THE GOAL that making a break-through in any field required only two steps – the courage to face inconsistencies and the willingness to challenge basic assumptions. For many TOC practitioners and implementers that have seen, first-hand, the incredible operational and financial improvements that can be achieved in relatively short time and with low investment from applying TOC in their own organizations and/or those of their customers, there has for many years, been a glaring inconsistency. Why is the adoption rate of TOC still so low?

This article explores various theories about this inconsistency, the assumptions of TOC practitioners and implementers that might need to be challenged, and the implications of this on the way they can help organizations move from ignorance to adoption and value realization from TOC. Two main theories are explored. The first, proposed by Prof. Russel Ackoff, a pioneer in Systems Thinking and Operations research, aims to answer why so few organizations adopt a holistic approach to problem solving and managing organizations despite most managers agreeing with the merits of a holistic approach. Prof. Ackoff claimed that there are two main reasons – one generic and one specific. The generic reason is that any change that is a major departure from the status quo and/or claim high rewards is immediately perceived as high risk. It is simply much safer to make small changes or not make any change at all. The specific reason is that few managers will support any change they do not fully understand. Practitioners of methods such as Systems Thinking and TOC tend to write, speak and teach using language and concepts that few outsiders understand, making these methods appear complicated and difficult to apply. Practitioners therefore need to show, not only the reward of implementing Systems Thinking far outweigh personal and organizational risks, they must develop ways to write, speak and teach in a language that their target audience understand.

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[1] Appendix 1 of this article offers a brief explanation of "What is Theory of Constraints"?

The second theory is based on the application of Dr. Goldratt's 6 Questions that aim to answer why any powerful technology – defined here simply as the practical application of knowledge to solve real-world problems - would not deliver the expected value and therefore, have much lower adoption rate than expected. The 6 questions are based on two premises. Firstly, that any Technology *can* bring benefits, *if and only if*, it diminishes a *limitation*. Secondly, that long before the availability of this technology we *developed* modes of behavior, policies, measurements and *rules to help us accommodate the limitation*. The limitation that TOC helps managers diminish, is the challenge in making consequential decisions and predictions despite the increased complexity, uncertainty, conflicts and constraints they face. TOC provides a simple framework and practical mechanisms for helping managers decide how to set ambitious but realistic goals, where to focus their limited attention and other scarce resources to achieve more with less in less time, how to judge or predict the impact of internal or external changes on the whole system (not just on parts of the system), what rules to use to optimize the system or not just sub-system performance and when to change these "global optima" rules.

To live with the above limitations, and the fear of being blamed for bad choices, managers developed coping or protection mechanisms based on local optima rules – rules that enable them to make decisions and predictions while only considering information and knowledge available to them locally and/or only considering the local impact of their decisions. If these "local optima" rules are not replaced when TOC is implemented, it will be as if the limitations still existed. Also, these local optima rules and behaviors will likely directly clash with the TOC rules and desired behaviors - causing confusion regarding what to do and measure and what not - severely compromise the value TOC can bring and the rate at which TOC will be adopted within organizations and industries.

TOC practitioners and implementers, interested in helping organizations move from ignorance (of what TOC is and how it can help managers) to realizing the value TOC can bring, have a responsibility, to not only show the new global optima rules and measurements needed to bring benefits - and how these can be implemented quickly with very low cost or risk - but also to help identify and abolish the old local optima rules and measurements that helped managers live with the previous limitations they faced.

Human evolution and the development of new and powerful ideas, has always been about trial-and-error; learning from both our successes and especially learning from our failures. After more than 30 years, TOC practitioners and implementers have enough successes and failures to know what works and what not.

It is time to apply the lessons we've learned (or should have learned) to help more organizations move from ignorance of TOC to adoption and realization its full value by showing how TOC helps managers make better faster and lower risk decisions, despite the complexity, uncertainty, conflicts and time constraints they will always face.

Introduction

The Goal, co-authored by Dr. Eli Goldratt, the creator of Theory of Constraints (TOC) and Jeff Cox, was published in 1984. Since then it has sold more than 6 million copies around the world. It has been voted by TIME Magazine as one of the 25 most influential business books of all time[2] and still feature in the top 1000 books sold on Amazon. More than thirty years later, it is also still the most common way that people first learn about Theory of Constraints. They might read it as part of an Operations Management course or MBA program. Or they might receive it from a peer or often a manager with the advice that it will help them understand how to improve processes and organizations.

Today, Theory of Constraints is recognized by many business leaders and academics as a powerful set of ideas and applications that can unlock significant value for any organization.

> "*The Goal was a bible for Jeff Wilke and the team that fixed Amazon's fulfillment network*", Jeff Bezos, CEO of Amazon

As an example, Jeff Bezos, CEO of Amazon, said[3] that Jeff Wilke – recently promoted to CEO of Amazon Worldwide Consumer - used the ideas from THE GOAL to build their highly efficient distribution network and that THE GOAL is still used annually by him and his executive team as a framework for sketching out the future of Amazon[4].

Considering such praise from one of the most well-respected CEO's in the world, the many case studies[5] showing the step-change in operational and financial performance that TOC can unlock for many different types of organizations, the need that exists in the market for such step-changes in performance, and the fact that even after more than 30 years, THE GOAL is still one of the most read Business Books of all time, it is disappointing that the adoption rate of TOC has not been much higher.

So why, after more than 30 years of delivering significant operational and financial performance improvements across such a wide range of organizations and applications, is there still such a low adoption rate of TOC and why, for those that have adopted it, does it not spread within these organizations as a best practice and/or not spread to more strategic applications to unlock even more value?

These are also questions that troubled Dr. Goldratt until he passed away in 2011.

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[2] http://content.time.com/time/specials/packages/article/0,28804,2086680_2086683_2087672,00.html

[3] Stone, Brad (2013-10-15). The Everything Store: Jeff Bezos and the Age of Amazon (p. 363). Little, Brown and Company. Kindle Edition.

[4] https://www.linkedin.com/pulse/20130925133311-291225-amazon-ceo-jeff-bezos-had-his-top-execs-read-these-three-books

[5] http://www.tocico.org/?page=ref_bank1

Over the years, he wrote a number of articles to share his own frustration, analysis and recommended actions to close the large expectation gap. For example, in an internal article he wrote in 2010 titled "*Where is the rush on TOC?*", Dr. Goldratt stated that despite TOC being more recognized and respected and despite the much more practical

> *TOC is now much more recognized and respected than in the eighties or the nineties. But this progress should not blind us to the fact that the original question still remains unanswered. As a matter of fact, considering the vast expansion in TOC knowledge that led to the reality of paybacks of just few days the question today is more puzzling than ever before: Where is the rush on TOC?*
>
> - *Dr. Eli Goldratt, 2010.*

availability of the TOC knowledge in the form a number of Strategy & Tactic trees showing how to implement TOC within a range of organizations, there is still no rush on TOC. Why?

The aim of this article is to try answer this question by developing a hypothesis that can be tested empirically using both the research of others exploring the low adoption related to similar methods to TOC and the framework created for answering such questions by Dr. Eli Goldratt himself – the Six Questions for ensuring that any new Technology is both Necessary and Sufficient to bring real value to its users.

Why do few organizations adopt new ideas like Systems Thinking, Design Thinking or TOC?

The low adoption challenge faced by TOC is not unique to TOC.

Several other methods, that also aimed to apply the methods and mindsets from the "hard" sciences to the "art" of innovation, analysis, improvement and management of organizations has faced a similar challenges of a *relatively low adoption rate despite many agreeing that there is value to these methods*. This includes methods like Systems Thinking, LEAN Thinking (as opposed to LEAN Manufacturing) and the more recent Design Thinking[6].

Some Insights worth sharing from reviewing research papers that explored possible reasons for their relatively low adoption rates included:

1. "*Experience shows that adopting lean thinking requires abandoning deeply engrained mainstream management thought routines, and this is never easy.*" [7]
2. "*Each of Systems Thinking's various manifestations demands some degree of subscription to an orthodoxy (a particular view of just what Systems Thinking is). And each requires that the user master a large number of related ideas and techniques, most of which are not particularly useful on their own. These requirements are at odds with how we tend to*

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[6] http://www.fastcompany.com/1291598/lessons-learned-why-failure-systems-thinking-should-inform-future-design-thinking

[7] http://ackoffcenter.blogs.com/ackoff_center_weblog/files/Why_few_aopt_ST.pdf

acquire new knowledge. Rather than accepting a new idea because we must, we like to try it out. A new skill is most likely to interest us if it contributes to both short-term and long-term learning objectives. And the easier it is to try out parts of a theory, the more likely we are to jump in. The opposite is also true.

3. *The drive to nail "Design Thinking" down has the same normative flavor that has restricted the spread of Systems Thinking. The urge to create a (full) framework that specifies what and how a design thinker proceeds seems not just futile but dangerous to the survival of a movement aimed at expanding the kinds of thinking that managers, policy makers and citizens engage in."* [8]

In 2001, Prof. Russel Ackoff, one of the pioneers in Systems thinking and Operations Research, wrote an article titled "*Why Systems thinking are not adopted by more organizations?*". He claimed that there are two reasons why organizations don't adopt methods like systems thinking, even when they agree on its value. The first is a generic reason why any organization change is resisted, and the second, is a specific reason why the change to adopt Systems Thinking specifically is resisted.

Ackoff claimed the generic reason is that there is a deep fear within managers that they will be blamed if any radical change they actively supported failed. And any change that is a major departure from the status quo and/or claim high rewards is immediately perceived as high risk and therefor "radical". It is simply much safer to make small changes or not make any change at all. To overcome this obstacle, Ackoff encouraged organizations to keep a decision record of all important decisions – whether to do something or not – and the assumptions on which this decision were based that

> *Until we communicate to our potential users in a language they can understand, they*
> *and we will not understand what we are talking about. It is easy to hide the ambiguity and vagueness in our own thinking behind jargon, but almost impossible to do so when speaking or writing in ordinary language – Prof. Russel L. Ackoff.*

should be checked from time-to-time. This should also be applied when a decision is made not to try a potentially powerful idea, method or technology which could have been tested through a low risk and cost proof-of-concept pilot.

Ackoff claimed that the specific reason why so few organizations adopt a new approach like Systems Thinking is that practitioners and experts of such new approaches develop and use language that can make it appear overly complicated and even risky to support because, as a manager, if you don't yet understand it and try to explain it to others in a way that do not make sense you might be exposed as a non-expert in your field – one of the worst things that can happen to any professional. Practitioners need to develop ways to write, speak and teach in a language that their target audience will understand and present concepts in a way that makes it

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[8] https://en.wikipedia.org/wiki/Lean_thinking

clear which parts are important and which are not for the challenges their audience are currently facing.

As such, there is a responsibility on those promoting a new idea or method to simplify and even standardize the way the various parts of the new method are explained, how these parts relate to each other, which are most important (based on the challenges being faced) and how it can be practically implemented so that it is easy for new-comers to understand and apply it to deliver consistently good results within their own environment.

Could the same two reasons also explain why more organizations have not adopted TOC?

Do many managers, after being introduced to TOC, simply, because of the promise of very high rewards, perceive it as too high risk – too high personal risk to adopt or actively support the adoption of TOC, despite their knowledge of TOC's past successes and common-sense approach?

And/or, do many managers feel TOC is simply too complicated to understand and/or implement within their environments or perhaps view it as a threat? Such views can amplify their fears further.

If these perceptions could be true, anyone that wants an organization to adopt TOC, will need to:
1. Find a way to help the organization see that testing TOC - possibly through development of a simulation model and/or Proof-of-Concept Pilot – can be a very low risk way of validating the assumption that TOC will (or will not) bring benefits that far outweigh the cost or risks in their environment.
2. Find a way to really simplify TOC so that it does not appear so complicated and even confusing to novices.

Internal and external TOC practitioners and consultants that want organizations to get the full value from TOC, also share the responsibility to ensure that their TOC implementation will be both necessary AND sufficient to bring value.

What mistakes can cause the TOC implementation at an organization not to be sufficient to bring the full value that TOC can and should unlock?

Why TOC might not be necessary and sufficient to bring value?

In 1998, Dr. Eli Goldratt co-authored "Necessary but not Sufficient" with Carol Ptak and Eli Schragenheim. In the foreword to this business novel about the challenges managers of an ERP software company, its implementation partner and customers faced in getting the full value from their powerful ERP software, Dr. Goldratt listed six questions that could be used to discover why any technology did not deliver its full potential value and/or be used to guide the development of a "message-to-the-market" and implementation approach to ensure faster adoption by more of the right users – those users that could gain most from their technology.

These six questions of enquiry were based on two principles:
1. Technology *can* bring benefits, *if and only if*, it diminishes a *limitation*.
2. Long before the availability of this technology we *developed* modes of behavior, policies, measurements and *rules to help us accommodate the limitation*.

Goldratt asked - as a thought experiment - what benefits will we gain when we use a technology that can diminish a current limitation, if we "forget" to change the "rules" that allowed people to live with that limitation before?

The answer is obvious. As long as the rules that helped us to accommodate the limitation are obeyed, the end result is the same as if the limitation still exists. In other words, we should not expect to see any significant benefits.

The six questions that can help us understand how any technology and its related implementation approach can be adapted to be both necessary AND sufficient to bring value are:

1. **What is the real power of the technology?**
2. **What limitation does this technology diminish?**
3. **What rules helped accommodate the limitation?**
4. **What are the rules that should be used now?**
5. **In light of the change in rules, what changes are required in the technology (**without triggering the typical resistance and/or fears associated with any significant change)
6. **How to cause the change** (to get more and more users to adopt the new technology and switch from the old to the new rules)?

Before we start the journey of answering these questions for Theory of Constraints, let us start with a few definitions.

What is "technology"?
Technology is the application of knowledge and information for practical purposes. More specifically, *Technology* is the collection of any set of techniques, skills, methods and processes used in the production of goods or services or in the accomplishment of objectives, such as solving real-life problems or create new knowledge.

What is "limitation"?
A *limitation* is any condition that limits or restricts the performance of a system.

For readers interested in Dr. Eli Goldratt's answers for these six questions in relation to ERP Software, see Appendix 2 to this article.

In the next section, we share our views on possible answers to the 6 questions when applied to Theory of Constraints – a technology, in our view, with the aim of applying the methods and

mindsets of the "hard" sciences to the "soft" science of managing organizations with the practical purpose to enable managers to solve problems and make decisions that continuously improve the value their organization delivers to all stakeholders.

1. What is the real power of Theory of Constraints?

Dr. Eli Goldratt often described TOC as *an overall framework for helping businesses determine: what to change —not everything is broken, what to change to —what are the simple, practical solutions, and how to cause the change — overcoming the inherent resistance to change*".

Dr. Eli Goldratt[9] stated in "Introduction to TOC - My Perspective", the opening chapter he wrote for "Theory of Constraints Handbook", that TOC can be summarized in one word - *FOCUS*.

But why is FOCUS so important for managers?

Focusing does not only mean what to pay attention to, it also means knowing what not to pay attention to.

Herbert Simon, the Nobel Prize winner, known for his work on Bounded Rationality, already concluded in 1973, in his ground break paper titled "Applying Information Technology to Organizational Design" that limited managerial attention (rather than access to information) was the scarcest resource in organizations.

> *The information-processing systems of our contemporary world swim in an exceedingly rich soup of information. In a world of this kind, the scarce resource is not information; it is processing capacity to attend to information. Attention is the chief bottleneck in organizational activity, and the bottleneck becomes narrower and narrower as we move to the top of organizations.*
>
> *– Dr. Herbert Simon*

Simon[10] went further and noted that many designers of information systems incorrectly represented their design problem as information scarcity rather than attention scarcity, and as a result they built systems that excelled at providing more and more information to people, when what was really needed were systems that excelled at filtering out unimportant or irrelevant information. The organization's management systems (not just its information systems) should help managers decide what to focus on and what not.

This is the real power that TOC can provide. The real power of the various parts of TOC - the 5 Focusing Steps, the TOC Applications, Throughput Accounting and Thinking

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[9] Goldratt, Eliyahu M. Theory of Constraints Handbook – Chapter 1, McGraw Hill, 2010
[10] (Simon, Herbert, 1996, Models of my Life, MIT Press, pp. 143–144)

Processes - is that it provides managers with practical mechanisms to know what to focus on and (as importantly) what not.

But what limitation does "managers knowing where to FOCUS their limited attention and where not" help to diminish?

2. What limitation does Theory of Constraints diminish?

Managers are responsible for solving problems and making decisions on when to change, what to change, to what to change, how to cause the change and how to measure and continuously improve. They are also responsible for making predictions about future performance and the likely impact of internal and external changes.

Why are these tasks so challenging?

Managers face several limitations when solving problems, making decisions or predictions which include:
- they will always have incomplete data and knowledge;
- they will never be able to accurately predict the full consequences of their decisions;
- they have limited managerial attention, resources and time,
- the "global optima rules" needed to maximize the performance of complex system (not just the performance of parts of the system) can be VERY counter-intuitive. Even if the first two limitations did not exist, managers might never discover that to finish projects earlier, you should start them later, or that to reduce cost/unit you should have most resources standing idle from time to time.

Then, on top of these limitations they face, as Ackoff and others have pointed out, there is also the reality, that managers will likely be blamed if they make a bad decision or bad prediction.

Asking managers to make better faster decisions and predictions in such an environment, puts significant stress onto them. And we know that when people have to solve problems or make decisions or predictions under stress, they often make avoidable mistakes. They do things they should not do and/or don't do the things they should. Such decision mistakes waste the organization's most precious and scarcest resource – management attention - because these bad decisions or decision delays cause damage which require rework. Rework simply adds to the task load on already overloaded managers giving them less attention to focus on what really matters. This is a vicious cycle we often see in organizations that is difficult to escape from.

The power of TOC is that it provides managers with practical mechanisms that can help diminish these limitations or at least, diminish the impact of these limitations to prevent

these vicious cycles and enable managers to really focus their attention on solving the most important problems for the organization and use the right "global optima" rules for making better decisions and predictions.

3. What rules helped accommodate the limitation?

How do managers live with these limitations and risks? What "rules" do they use for making difficult decisions and predictions?

In 2010, Dr. Goldratt started working on what he called "the science of management". His hypothesis was that it was not the complexity, uncertainty and conflicting objectives that were causing avoidable decision errors or delays, but rather the reaction to these. He claimed that because people fear complexity, uncertainty and conflicts, people develop ways to cope with these. It is these coping mechanisms or local optima rules that was causing most of the avoidable damage and wastage of management attention.

How do managers specifically deal with complexity within organizations?
They try to make complex systems (or problems) simpler. This is achieved mainly by:
a) breaking complex systems or problems into smaller – less complex - sub-systems or problems and
b) using only information and considerations available locally to make decisions or predictions.

But these "coping mechanism" has major downsides. To manage the sub-systems, we need local measurements and rules to ensure the parts do what is good for the whole. It is not easy to translate system objectives into sub-system (local) objectives without creating either too many local performance and compliance measurements and rules or local measurements and rules that are misaligned with the system objectives. These local measurements can cause short-term or local optima (doing what is good for the short-term or partially at the expense of what is good for the long-term or system), fire-fighting and/or bad multitasking (due to the assumption that all gaps and variances are bad and has to be addressed). All of these wastes management attention and can damage the organization's performance.

How do managers specifically deal with uncertainty within organizations?
They try to make the uncertain more certain. This is achieved mainly by:
a) micro-managing
b) asking people to "sign-off" on their estimates or predictions and
c) making uncertain decisions or predictions as infrequently as possible and
d) adding but hiding buffers needed to cope with uncertainty and variability.

But these "coping mechanisms" also has major downsides.

Micro-managing just adds more noise to pay attention to and disempowers subordinates.

Asking people to "sign-off" on forecasts or software requirements or anything else with uncertainty does not help – it only harms as the only way they can add "certainty" is if they result in self-fulfilling prophecies through lowering expectations.

Making decisions less often just increases the time to detect and correct. Why do we do annual budgeting or quarterly reviews or monthly Sales & Operations planning meetings? Surely, we can and should make and correct resource allocation and other decisions much more frequently?

And lastly, when there is uncertainty and variability, we need buffers. These buffers can be in the form of time, inventory, capacity or cash. By not allowing people to explicitly show the buffers they believe are needed and not aggregating these buffers where they can protect the system as a whole in the most effective and efficient way, we waste them and leave us unprotected.

How do managers specifically deal with conflicts within organizations?
They try to find acceptable compromises to local vs. global and short vs. long term conflicts. What do we mean by "acceptable"? We do not mean "good enough" or what is best for the system as a whole. We mean they consider which of the many competing objectives appear to be most important to their manager or customer, what risks could be most damaging and then make decisions that will be "acceptable" to their managers or customer and/or will bring them or their part the most upside with the least downside.

Unfortunately, many of these "acceptable compromises", end up being really bad compromises or lose: lose situations. They can compromise operational and even financial performance of the organization and often cause major disharmony between departments, between levels and/or between stakeholders.

Over time, managers convert these coping mechanisms that enable them to mitigate the fear of complexity, uncertainty, conflicts and being blamed for bad decisions into management rules and measurements. We can summarize these as "local optima" decision rules. We will find them within each main function in an organization that is involved in Planning (decisions made before work is started), Execution (decisions made while work is done) and/or Measure & Improvement (decisions made after work is completed).

Again, we can ask. What benefits will organizations gain when they implement TOC to diminish the limitations managers face when solving problems or making decisions and predictions BUT we "forget" to change the rules that allowed them to live with these limitations?

The answer (now) is obvious. As long as the rules that helped managers live with the previous limitation are still followed, the end result is the same as if the limitations still exist. In other words, we cannot expect to see any significant benefits from TOC.

4. What are the rules that should be used now?

What are the new rules managers should be using for problem solving and making decisions and predictions that must be used now to fully capitalize on the power of TOC?

As mentioned before, the decision and predictions managers at all levels have to make, can be classified into Planning decisions, Execution decisions and Measure and Improve decision. Although the details, for example, on how planning decisions should be made to ensure global optima within managing operations, projects or distribution, are different, they do share common principles.

How do we find the specific decision rules?

In the Dr. Goldratt's groundbreaking article, "Standing on the shoulders of Giants"[11], he showed the difference between generic concepts or principles and specific applications. He showed that the breakthroughs by Henry Ford and Taiichi Ohno all were based on the same four generic concepts or principles. Their applications of these, created applications that were specific to the unique complexities and uncertainties they faced within their organization.

The four concepts that can be used for managing and improving operations or even supply chains include:
1. Improving flow (or equivalently lead time) is a primary objective of operations.
2. This primary objective should be translated into a practical mechanism that guides the operation when not to produce (prevents overproduction).
3. Local efficiencies must be abolished.
4. A focusing process to balance flow must be in place.

Having a clear goal (such as improving flow) is not necessary, but can be sufficient to help managers identify what rules (processes, measurements and/or behaviors) are not helping but harming the organization and what should be used instead. It provides a simple and practical mechanism for checking the impact of changing a rule. Will this help us improve the total flow time (reduce lead time from demand to supply) and/or improve flow rate (increase throughput)? If not, this rule should not be changed.

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[11] http://www.goldrattconsulting.com/webfiles/fck/files/Standing-on-the-Shoulders-of-Giants.pdf

It is not within the scope of this article to go in more details regarding how the above concepts can be used to help identify what rules should be abolished (local efficiencies and other local optima) and what should be used instead. Suffice to say that within organizations, the primary objective of improving flow, should be translated not just into practical mechanisms that guides operation when not to produce, but should be translated into practical mechanisms for making better and faster decisions and predictions within Planning, Execution as well as Measure and Improve functions.

The table below summarize the major decisions within Planning, Execution and Measure & Improve, the common Local Optima Rules used to live with limitations managers face, rules which result in avoidable decision and prediction errors and wastage of management attention and damage to performance, and lastly, the generic TOC recommended Global Optima Rules.
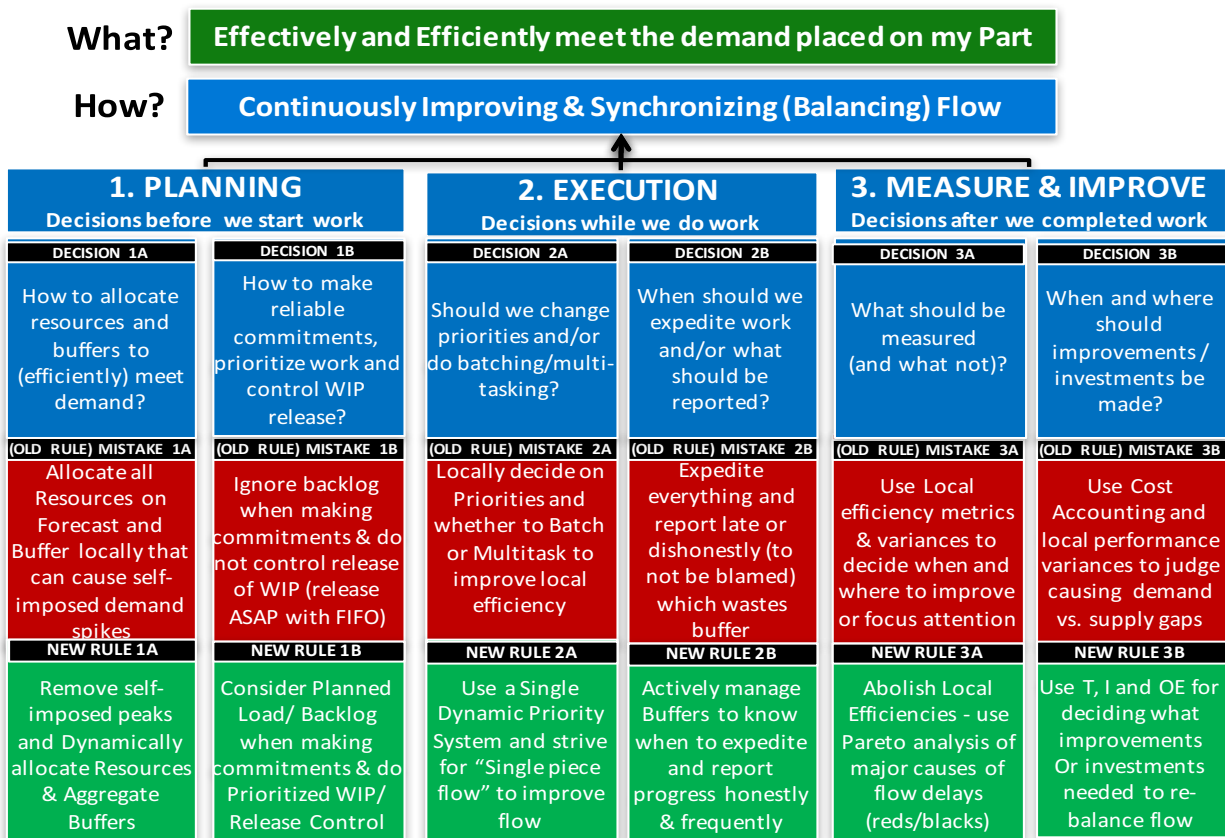
What?	**Effectively and Efficiently meet the demand placed on my Part**				
How?	**Continuously Improving & Synchronizing (Balancing) Flow**				

1. PLANNING Decisions before we start work		**2. EXECUTION** Decisions while we do work		**3. MEASURE & IMPROVE** Decisions after we completed work	
DECISION 1A	**DECISION 1B**	**DECISION 2A**	**DECISION 2B**	**DECISION 3A**	**DECISION 3B**
How to allocate resources and buffers to (efficiently) meet demand?	How to make reliable commitments, prioritize work and control WIP release?	Should we change priorities and/or do batching/multi-tasking?	When should we expedite work and/or what should be reported?	What should be measured (and what not)?	When and where should improvements / investments be made?
(OLD RULE) MISTAKE 1A	**(OLD RULE) MISTAKE 1B**	**(OLD RULE) MISTAKE 2A**	**(OLD RULE) MISTAKE 2B**	**(OLD RULE) MISTAKE 3A**	**(OLD RULE) MISTAKE 3B**
Allocate all Resources on Forecast and Buffer locally that can cause self-imposed demand spikes	Ignore backlog when making commitments & do not control release of WIP (release ASAP with FIFO)	Locally decide on Priorities and whether to Batch or Multitask to improve local efficiency	Expedite everything and report late or dishonestly (to not be blamed) which wastes buffer	Use Local efficiency metrics & variances to decide when and where to improve or focus attention	Use Cost Accounting and local performance variances to judge causing demand vs. supply gaps
NEW RULE 1A	**NEW RULE 1B**	**NEW RULE 2A**	**NEW RULE 2B**	**NEW RULE 3A**	**NEW RULE 3B**
Remove self-imposed peaks and Dynamically allocate Resources & Aggregate Buffers	Consider Planned Load/ Backlog when making commitments & do Prioritized WIP/ Release Control	Use a Single Dynamic Priority System and strive for "Single piece flow" to improve flow	Actively manage Buffers to know when to expedite and report progress honestly & frequently	Abolish Local Efficiencies - use Pareto analysis of major causes of flow delays (reds/blacks)	Use T, I and OE for deciding what improvements Or investments needed to re-balance flow

Figure 1: Source: Dr. Alan Barnard, TOCICO 2015 presentation "Managing & Improving Flow"

5. In light of the necessary change in rules, what changes are required in Theory of Constraints, the way it is communicated and/or implemented?

When first presented with TOC – what is the general perception of an outsider? Does it look like as simple as it is claimed by TOC?

There are several elements in the current TOC Body of Knowledge and the way they are frequently presented can make TOC look very complicated and often overwhelms the audience. TOC consists of four main parts.
1. The general philosophy or concepts on which TOC is based (the pillars).
2. The five focusing steps.
3. The specific constraint-focused applications or Planning, Execution and Improvement rules like DBR and CCPM and measurements to judge the status of the system or impact of changes on the system.
4. And lastly, the Thinking Processes like the Evaporating Cloud, Current and Future Reality Trees and Strategy and Tactic Trees (S&T).

To ensure it is not overwhelming to new-comers, TOC Practitioners have to show the clear links between these parts, and provide a simple and relevant answer to "What is TOC?" and how can it help managers better cope with the complexity, uncertainty, conflicts and fear of being blamed they face.

Certainly, to reach the main stream market, it means not only simplifying the way we explain and teach TOC, but also continuously reviewing every case where the outcome falls below expectations to analyze what went wrong and how to learn from these failures. This approach should also lead to continuing efforts to develop the missing linkages between the parts, add new knowledge, improve the effectiveness of parts that are difficult to use or contribute less than its potential. Some TOC tools might be discarded because their contribution is too low. Others like Throughput Accounting, that can help managers make difficult decisions, will need to get much more attention.

There should also be a real effort within the TOC community to not just report successes but also failures so we can learn from these failures on what works and what not and more possibly, to discover the boundary conditions of TOC solutions.

This last insight is connected also to the work of Prof Nassim Taleb, best-selling author of Black Swan and his latest book Antifragile. In it, Taleb introduces a simple but powerful classification for measuring the fragility of systems and even ideas. Fragile systems are harmed by volatility; Robust systems or ideas are not harmed by volatility. Antifragile systems and ideas benefit from volatility. They get stronger over time.

Fragile systems have limited gain from successes or upturns while they can suffer unlimited pain during failures or downturns. Robust systems have limited pain from failures but also have limited gain from successes. Antifragile systems also have an asymmetrical response to success vs. failure. But the asymmetry is in favor of the system. It has mechanisms to limit pain from failures or downturns AND (different) mechanisms

that enables it to fully capitalize on successes or upturns. TOC's applications have such Antifragile mechanisms built into it.

For example, when Critical Chain Project Management (CCPM) is implemented in a company, there is only limited pain when murphy strikes. The project might be a few days or weeks late or a little over-budget. However, when things go well, it is not uncommon that projects are completed in 15-30% less time than planned and with significant budget savings without compromising scope.

This is in stark contrast to companies that use Critical Path based rules. When everything goes well, the project might finish on time. When anything goes wrong, the project will be very late, way over-budget and/or have to cut significant scope. There are many other examples. Just think about how the common but very harmful "spend-it-or-lose-it" rule can cause any organization or government to become fragile. Over time, even if they have more good years than bad years, they will build up a deficit and/or will have to significantly cut the scope of their services.

TOC is now over 30 years old. It has certainly proven its robustness. It also has many of the characteristics that can make it Antifragile. But it will not happen by itself.

All the Logistical Applications of TOC, when applied at the strategic level to provide "for-profit" organizations with a decisive competitive edge or non-profit organizations with the ability to better meet demand at lower cost, have built-in Antifragile mechanisms.
It is relatively easy to build dynamic simulation models using generic or even specific data from a company to show that switching to the TOC rules will bring the organization asymmetrical payoffs. To accelerate the adoption rate of TOC, TOC practitioners and implementers should learn how to use simulation models to show the asymmetrical pay-offs – benefits that far outweigh the costs or risks - that TOC can offer organizations during times of demand and supply volatility.

The criteria of fragility can also be applied to a technology or set of ideas such as TOC. To transform TOC from Robust to Antifragile, will require that those ideas or tools that do not contribute significant value, should be either discarded or significantly improved. At the same time, those ideas and tools that have been proven to deliver significant value, should receive much more attention to further improve, simplify and/or standardize their use.

We have to find practical ways to address the real fears managers have in adopting a new approach like TOC. We have to show that TOC is the least risky option to achieve step-change and continuous improvement within organizations simply because of its "in-built Antifragile mechanisms. Simulations and Proof-of-Concept pilots can dramatically reduce the risks of implementing TOC". But even if it fails, because of its Antifragile mechanisms

like "always exploit before you elevate", the pain will be limited. However, if it succeeds, the short and especially long-term gains could be massive.

6. How to cause the change?

Considering the insights from this hypothesis of why TOC has not seen a significant and sustained growth in its market awareness, adoption and value realization over time, how can we capitalize on these insights.

What can and should we do now to increase the awareness, adoption rate, and value that organizations can realize from TOC?

The concept of Antifragility can also apply to TOC itself. To accelerate the adoption rate of TOC, practitioners and implementers should continuously learn from experience on which parts of TOC really delivers value and which parts do not. Those parts that do not, need to be improved or discarded.

Human evolution and the development of new and powerful ideas, has always been about trial-and-error; learning from both our successes and especially learning from our failures. After more than 30 years, TOC practitioners and implementers have enough successes and failures to know what works and what not.

It is time to apply the lessons we've learned (or should have learned) to help more organizations move from ignorance of TOC to adoption and realization its full value by showing how TOC helps managers make better faster and lower risk decisions, despite the complexity, uncertainty, conflicts and time constraints they will always face.

We are interested to hear your views.

Did we miss something important that could help explain the relatively low market awareness, adoption and value from TOC?

Please contact us at:

Dr. Alan Barnard: alan@goldrattresearchlabs.com

Eli Schragenheim: elischragenheim@gmail.com

Appendix 1

What is Theory of Constraints?

To answer the question posed by this article on why the awareness, adoption and value realized from TOC is still much below the expectations of most TOC practitioners, we should first define what is meant by TOC and what is meant by adoption of TOC. Neither of these questions have a simple answer as there is probably not aligned on these answers even between TOC experts. This section aims to achieve "good enough" answers - good enough to answer the question posed.

So, what is TOC? In the past, people called anything created by Dr. Eli Goldratt "TOC". Since he passed away, it is more difficult to decide what is TOC and what not. As a start, it might be useful to think of TOC as made of concepts, applications and thinking or analysis tools. The main TOC concepts include the assumptions of Inherent Simplicity; that every conflict can be removed; that People are good and to Never Say I know. The main TOC applications consist of solutions like Drum-Buffer-Rope (DBR) + Buffer Management (BM), Replenishment + Dynamic Buffer Management (DBM), Critical Chain Project Management (CCPM) and Throughput Accounting (TA) - basically any application with a clear set of Planning, Execution and Improvement Rules and compliance and/or performance metrics). TOC Thinking or Analysis Tools include the 5 Focusing Steps, the 6 Necessary but not Sufficient Questions and the Thinking Processes.

Why is it important to separate TOC into these three?
We can easily measure the "adoption" of TOC rule(s) by checking the level of compliance to the TOC rule(s). It is a bit harder, but still possible to measure the adoption of a TOC thinking or analysis tool by checking how often it is used, if it continues to be used. But how do we measure the adoption of a TOC concept or principle?

Maybe the question posed on the article should have been more specific. Why has the adoption of the TOC applications been so low? Put differently, why have those TOC applications that bring significant value when implemented correctly (to reduce shortages/surpluses, reduce lead times and improve due date performance, increase throughput etc.) not become best industry/application practice?

When asked like this, we could come up with another hypothesis. TOC applications have relatively "Simple" rules. These rules are simple but not easy. Each of the applications can have a lot of details (e.g. decision about how much protective capacity to keep, how frequently to resize buffers and by how much etc.). Also, many of the rules, although they are conceptually simple, are relatively difficult to implement in "manual" mode. There are lots of computations required and some level of uncertainty on assumptions to use.
As such, when you leave it up to people, it can be so overwhelming they are not willing to try it or when they do, they often don't implement the rules correctly to get maximum value from them.

TOC compliant software helps to make it easier to implement many of these simple TOC rules in "automatic" mode.

Appendix 2

Dr. Goldratt's answers from the foreword to *Necessary but not Sufficient*[12] to the Six questions for ERP systems:

In the last years almost every organization has invested a lot of money in computer systems (many invested tens of millions and some even hundreds of millions). In spite of those large investments I'm unaware of even a single organization that came forward and stated that its investment in computer systems had dramatically improved the bottom line. As a matter of fact, most organizations regard the investment in computer systems as a necessary evil. That is the biggest damage. Computer systems can revitalize organizations, can lift their performance to new levels. Provided that...

Provided that we will be able to answer the following questions:

1. What is the real power of the computer system technology?
I believe that the power of computer system technology is in its ability to handle data. It has incredible power to store data, transfer data between silos and retrieve data. In each one of these three categories computer systems perform many orders of magnitude better than the technology we employed before, the paper technology. To prove that point let's do a thinking experiment (gedunken experiment). Imagine using the old technology to store your company data, which means please print all the data stored in your company's computers. Now facing the resulting mountain of paper search for one specific data element. How much time will it take? Compare it to retrieving a specific data element through a computer system. Most users, if they have to wait more than a few seconds, start to complaint about a slow system.
No doubt, the power of computer systems is impressive. But let's not forget that not all managers in companies are technology freaks and most are rightfully interested in only one thing, in benefits, in the impact this technology has on their company's performance.
How can technology bring benefits? Only in one way. Technology can bring benefits if and only if it diminishes a limitation. So, what we actually have to do is to stop admiring the power of this technology and ask the next, disturbing question:

2. What limitation does this technology diminish?
In my opinion the limitation is: the necessity of any manager (in any level, in any function, in any organization) to make decisions without having all the relevant data. Think about it. Remember that before computer systems, data generated in one silo was almost never available, in a timely

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[12] **Goldratt**, Schragenheim and Pak. 2000. **Necessary But Not Sufficient, Great Barrington, MA, North River Press**.

manner, at another silo. From my experience I would not hesitate to say that for almost all decisions at least part of the relevant data is generated in another silo and therefore the decision has to be made without all the relevant data.

And I'm not talking only about earth-shattering decisions. Take for example the case of a worker standing by a machine having in front of it some inventory. The foreman has to make a decision whether or not to instruct the worker to process this particular inventory. A vital data for such decision is whether or not there are significant clots in the flow between this machine and the end customer. If there is such a clot, we know (from JIT and TOC) that it will be a mistake to now process that inventory. The worker should wait even if he has nothing else to do. If the clot is outside the department of that foreman, what is the chance that he will be timely notified about it? The decision has to be made without all the relevant data.

In an ordinary organization, do you know about many limitations that are bigger than the one we are dealing with here? Bigger than: all mangers are forced to make most decisions without all the relevant data?

A technology that diminishes such a huge limitation should bring enormous benefits. But wait a minute. If that is the case, how come that we don't hear of many companies claiming that by installing computer systems they have ten-folded their bottom line results? How come we do hear about so many companies that are less than thrilled with their computer system?

Since it is apparent that usually computer systems do not bring significant bottom-line improvements there must be something that is missing in our analysis. What is it? Well, maybe we have to start earlier. We managed organizations before computer technology was available. How did we do it? It must be that long before the technology was available we developed modes of behavior, measurements, policies, rules that helped us accommodate the limitation (from now on I'll refer to all of them as just "rules" even though in many cases those rules are not written anywhere).

What benefits will we gain when we install the technology that removes the limitation, but we "forget" to change the rules?

The answer is obvious. As long as the rules that helped us to accommodate the limitation are obeyed the end result is the same as if the limitation still exists. In other words, we cannot expect to see any significant benefits.

So, it is vital that we be able to answer the third question:

3. What rules helped accommodate the limitation?
In our case of computer system technology, the limitation is the need to make decisions without all the relevant data. The data that is missing is the data that is not generated in the local vicinity. No wonder that the rules that were developed to by-pass the limitation are rules that helped to make decisions based on the existing data, they are "local optima rules". Since the limitation existed for every manager, it is no wonder that we find these "local optima rules" in every corner of the organization (readers of my books are aware of plenty examples of such local optima rules in production, finance, marketing and project management and this book will point to many more).

Here is the place to highlight that identifying the old rules is not yet sufficient to determine the new rule. We, therefore, must proceed and ask the fourth question:

4. What are the rules that should be used now?
In the case of computer system technology this was, probably, one of the most difficult questions to answer. For example, we all know that all of cost accounting is based on local optima, but what should we use instead? Some will say Activity Based Costing. I will say Throughput Accounting. But, how many of the computer systems are still providing the old "product cost" data? All of them, if I'm not mistaken.
How come?
Because many times the people who designed the computer system were not aware that some of the rules they observe in reality are an outcome of the limitation their technology is about to diminish. Due to that they design the technology according to the old rules and by that cast the old rules into iron, damning the possibility of their technology bringing real benefits. This, in my opinion, is exactly what we witness regarding computer system technology. This is the reason why software providers are talking about "better visibility" rather than about startling bottom line benefits.
To make computer systems bring what they are definitely capable of delivering, a huge jump in organizational performance, we must proceed and answer the next question:

5. In light of the change in rules what changes are required in the technology?
In the case of commercially available computer systems my estimate is that we have to replace about 1-2% of the code. And we should erase about an additional 30%. I hope that within the next years we'll see more commercially available systems that are based on the new rules. As for the time it will take until the redundant code will be erased I'm much less optimistic.
And then of course we still have to answer the biggest question of them all:

6. How to cause the change?
We all know that changing from an old technology to a new one is not simple. Now we realize that changing the technology is the smallest part of the challenge. To get benefits we must, at the same time, change the rules - rules that are cast into modes of behavior, into culture.
This is probably the reason for the reluctance of most software companies to push systems which are based on the new rules. They rightfully consider their companies as not qualified to change the way organizations are managed. Talking to many of the executives of software companies it is obvious that they will rush to satisfy whatever the market demands. So, the key is in the hands of the individual organizations.

What is needed is that enough companies will realize that if they want to succeed they must address their biggest constraint. And right now, the biggest constraint that most companies face is the fact that so many of their rules are based on devastating local optima.