SPECIAL COLLECTION

OF THEORY OF CONSTRAINTS

PAPERS (2016-2026)



Discover the inaugural collection of TOC papers and explore the ideas, research, and practical applications that are helping organizations and individuals achieve better results through the Theory of Constraints.

THEORY OF CONSTRAINTS
TOCICO
INTERNATIONAL CERTIFICATION ORGANIZATION

Special Collection

of

Theory of Constraints

Papers

(2016 - 2026)

Richard E. Zultner
editor



Copyright © 2026 by TOCICO

All Rights Reserved.

No part of this book may be reproduced, distributed, or transmitted in any form by any means, including photocopying, recording, or other electronic or mechanical methods, without the prior written permission of the TOCICO. Except in the case of brief quotations embodied in critical reviews and certain other noncommercial uses permitted by copyright law. Any claim, controversy, dispute or cause of action shall be governed by construed in accordance with the Laws of the United States of America and the State of New York. For permission, please contact the TOCICO at ADMIN@TOCICO.ORG.

Note that the author(s) of each contributed paper retain the copyright to their own paper.
Their papers are included here, with their express permission.

TOCICO
14518 NE 169TH ST
WOODINVILLE WA 98072
USA

Contact us at admin@tocico.org

Library of Congress copyright registration:
Special Collection of Theory of Constraints Papers (2016 - 2026)

ISBN: ebook 979-8-9974179-1-8

print 979-8-9974179-0-1

Introduction

Theory of Constraints International Certification Organization (TOCICO) is pleased to introduce this *Special Collection of Theory of Constraints Papers (2016 – 2026)* — a curated publication featuring historic papers form the Modern (post-Goldratt) era of Theory of Constraints (TOC). This collection highlights significant contributions from many diverse segments of the TOC community, and demonstrates the breadth and impact of "constraint thinking" across global industries.

This *Special Collection of ToC Papers (2016–2026)* serves as the foundation for our long-term vision of establishing a dedicated TOCICO focus on high-quality research, practical insights, case studies, and innovative applications from around the world.

Overview of the Collection

Scope: Covers research, practical insights, and innovative implementations from 2016 through 2026.

Purpose: Serves as a foundation element for the new *International Theory of Constraints (ToC) Journal* initiative.

Core Themes: Encompasses key ToC domains like supply chain logistics, project management (Critical Chain), production (Drum-Buffer-Rope), the logical Thinking Process tools, and Throughput Accounting.

Key Focus Areas Included

Operations & Production: Drum-Buffer-Rope (DBR) and Simplified-DBR applications.

Management & Strategy: Strategy and Tactic (S&T) trees and Jonah-level Jonah/thinking tools.

Cross-Disciplinary Integration: Merging TOC with methodologies like Agile, Lean, Six Sigma, and Demand Driven Material Requirements Planning (DD-MRP).

Acknowledgments

This *Special Collection of Theory of Constraints Papers* (2016–2026) brings together significant contributions from across the Theory of Constraints community. Through these papers, readers are invited to explore the ideas, research and practical applications that continue to expand our understanding of TOC and its potential to help organizations and individuals achieve better results.

The collection reflects the efforts of many people over many years.

TOCICO gratefully acknowledges the volunteers of the TOCICO Body of Knowledge Committee who contributed their time, knowledge and experience to the continuing search for and evaluation of new knowledge in the Theory of Constraints.

We thank the many authors who submitted their work for consideration and who have generously contributed their thinking to the wider TOC community.

We also recognize the TOCICO Bridge to Academia Committee and its Academic Stream at the annual TOCICO Conference for providing an important forum for the presentation, discussion and development of TOC research and scholarship.

Special appreciation is extended to the many committee members who devoted countless hours over many months to reading, reviewing and evaluating submitted works. Their commitment helped identify and preserve contributions worthy of broader recognition and continued exploration.

Finally, we thank the TOCICO Board of Directors, staff and volunteers who supported the creation of this inaugural collection, with particular appreciation to:

Richard E. Zultner, Editor
A member of the Bridge to Academia's Special Projects team
and a Lifetime Member of TOCICO

Pauline J. Ross — TOCICO Bridge to Academia Committee Chair
Jennifer Eckman — TOCICO General Manager
Simon M. White — TOCICO Board of Directors Chair

This collection is the product of a community committed not only to preserving the knowledge of the Theory of Constraints, but also to extending it, challenging it and putting it to work.

Table of Contents

Preface to the Special Collection **1**
Richard E. Zultner, editor

1. "Agile" CCPM: Critical Chain for Software Development (2016) **5**
Koichi Ujigawa & David Updegrove

2. Solving that Problem… That's Plagued You Forever (2018) **35**
Alan Barnard

3. Cash Constraint -- Identification, Corrective Actions, and Prevention (2018) **67**
Ravi Gilani & Ira Gilani

4. Unique Features of Government and How Governance Could be Assisted by ToC (2018) **75**
Alfredo Mycue & Eli Schragenheim

5. Implications of the Theory of Constraints for Sales (2018) **89**
Justin Roff-Marsh

6. Goldratt's Six Questions for Assessing the Value of a New Technology (2018) **97**
Eli Schragenheim

7. Systematic Learning from Significant Surprising Events (2018) **103**
Eli Schragenheim

8. The ToC Pillars (2021) **117**
Humberto R. Baptisa

9. Mystery Analysis (2021) **125**
Yuji Kishira

10. Magic Druids: A Thinking Process tool (2021) **127**
James Powell & Peter Cronin

11. Using Throughput Economics to make better and safer business decisions (2021) **143**
Eli Schragenheim, Henry Camp, and Rocco Surace

12. The Origin of the Goal Tree (2022) **153**
H. William Dettmer

13. Justice in Time: A theory of Constraints Approach (2023) **163**
Shany Azaria, Boaz Ronen, Noam Shamir

14. Conditional Reality Tree (2023) **179**
Abeer Youssef & Victoria J. Mabin

15. Renovated Change Matrix+ (2023) **205**
Richard E. Zultner

16. The Fundamental Structure of the Theory of Constraints (2024) **223**
Eli Schragenheim & David Updegrove

17. Reno 6QT+ => Customer Value Framework: Canvas & Chains (2024) **263**
Richard E. Zultner

18. The Theory of Constraints: Core Assertions and Their Scientific Foundations (2025) **287**
Guido Bacharach

19. The Goal of Government: Applying the Theory of Constraints to Government (2025) **307**
Alfredo J. Mycue, Micheal S. Giles, and Guido Bacharach

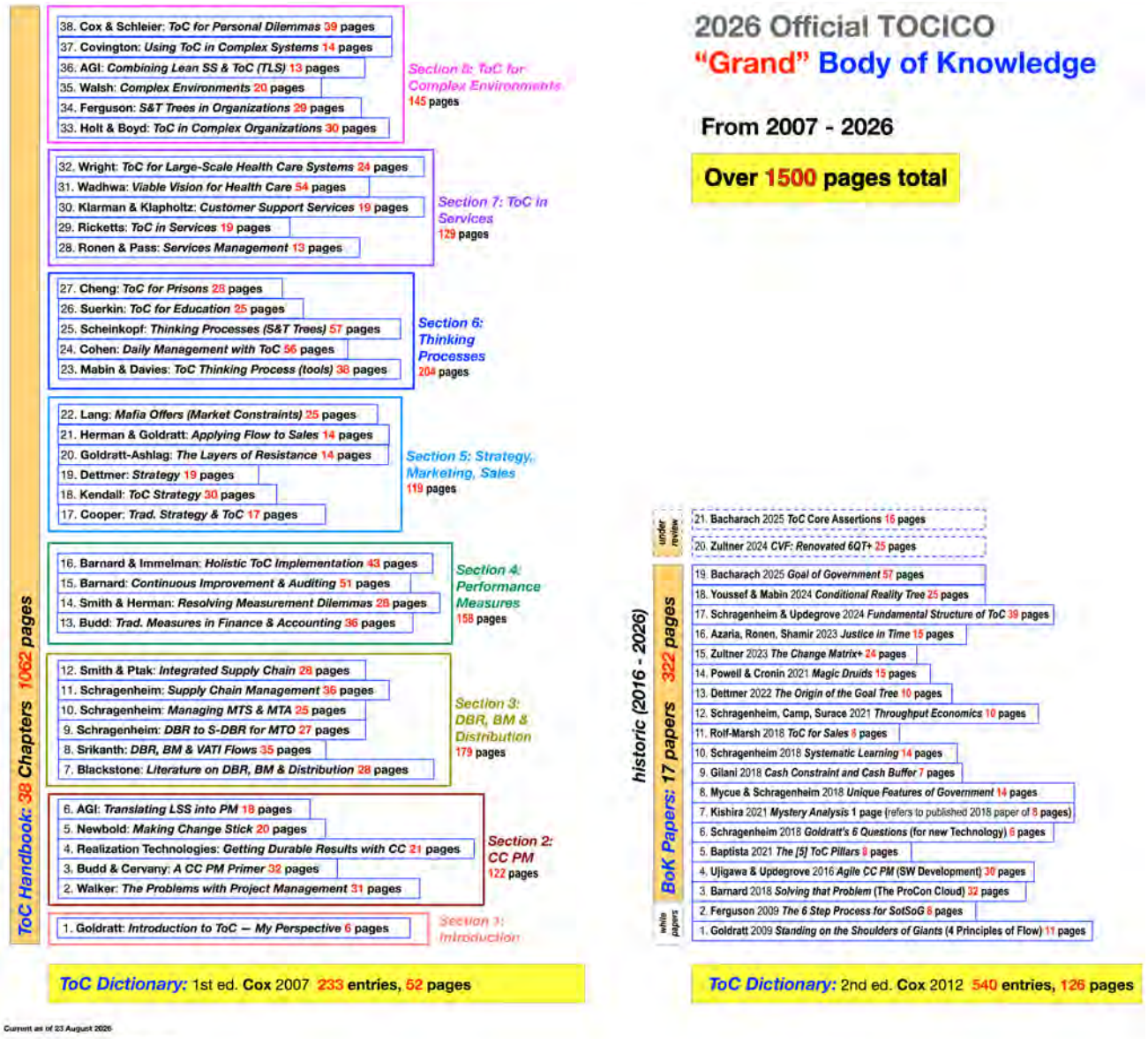
20. The Six Step Process for Standing on the Shoulders of Giants (2026) **365**
Lisa Ferguson

Note: All authors retain the copyright to their papers.
Their papers are included in this collection, with their express written permission.

Preface to this *Special Collection*

Richard E. Zultner, editor
Princeton, NJ USA

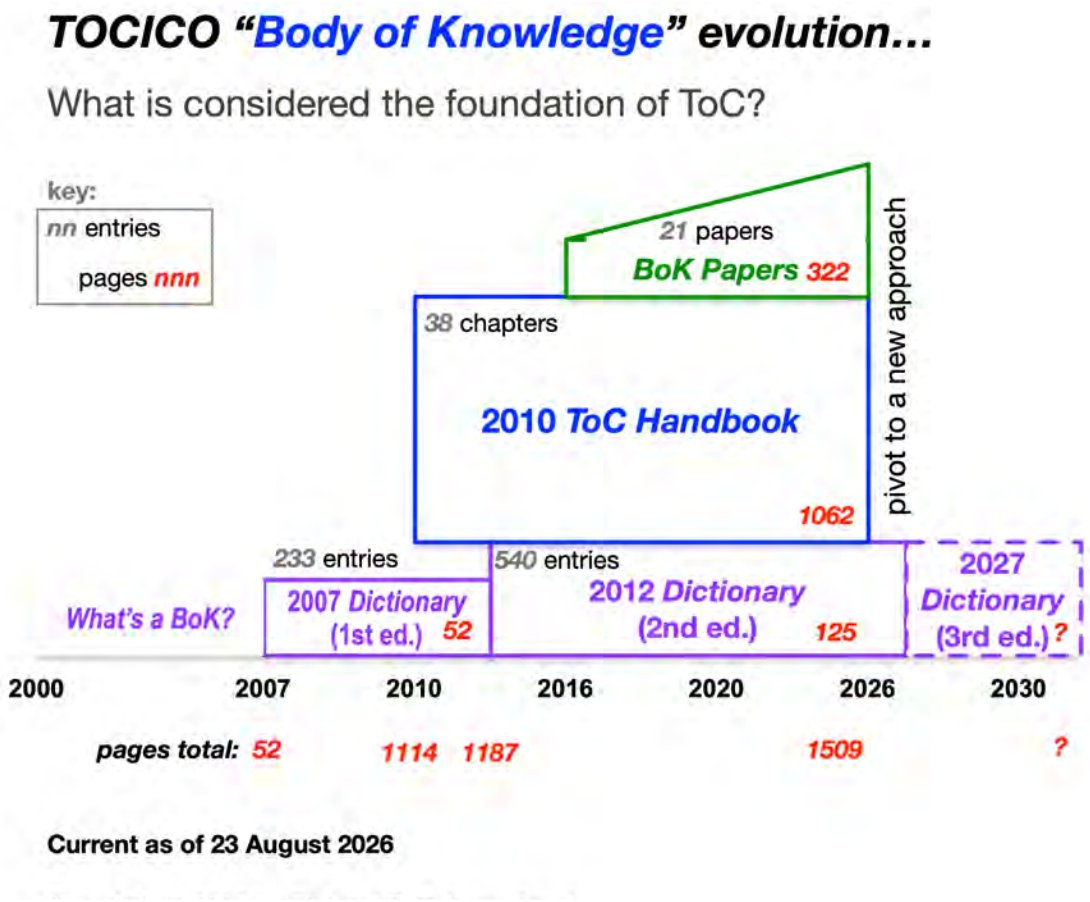
In early 2026 the TOCICO Body of Knowledge (BoK) Committee decided to pivot from this:



… to a different approach where the ToC Body of Knowledge is not defined in terms of over 1500 pages of content: including over 1000 *Handbook* pages, and over 400 total pages of *BoK Papers*.

Copyright © 2026 by Richard E. Zultner, *Jonah*
All Rights Reserved.

So in mid 2026, the TOCICO Bridge to Academia (B2A) Committee was asked to capture the history of the BoK Committee, from 2016 to 2026, in an archival document, In effect, a snapshot of the TOCICO Body of Knowledge, at this turning point in its evolution.



The understanding of what is "the body of knowledge for ToC", has changed over the years. And now, with the pivot to a new approach, the TOCICO Bridge to Academia (B2A) Committee was asked to capture this evolution.

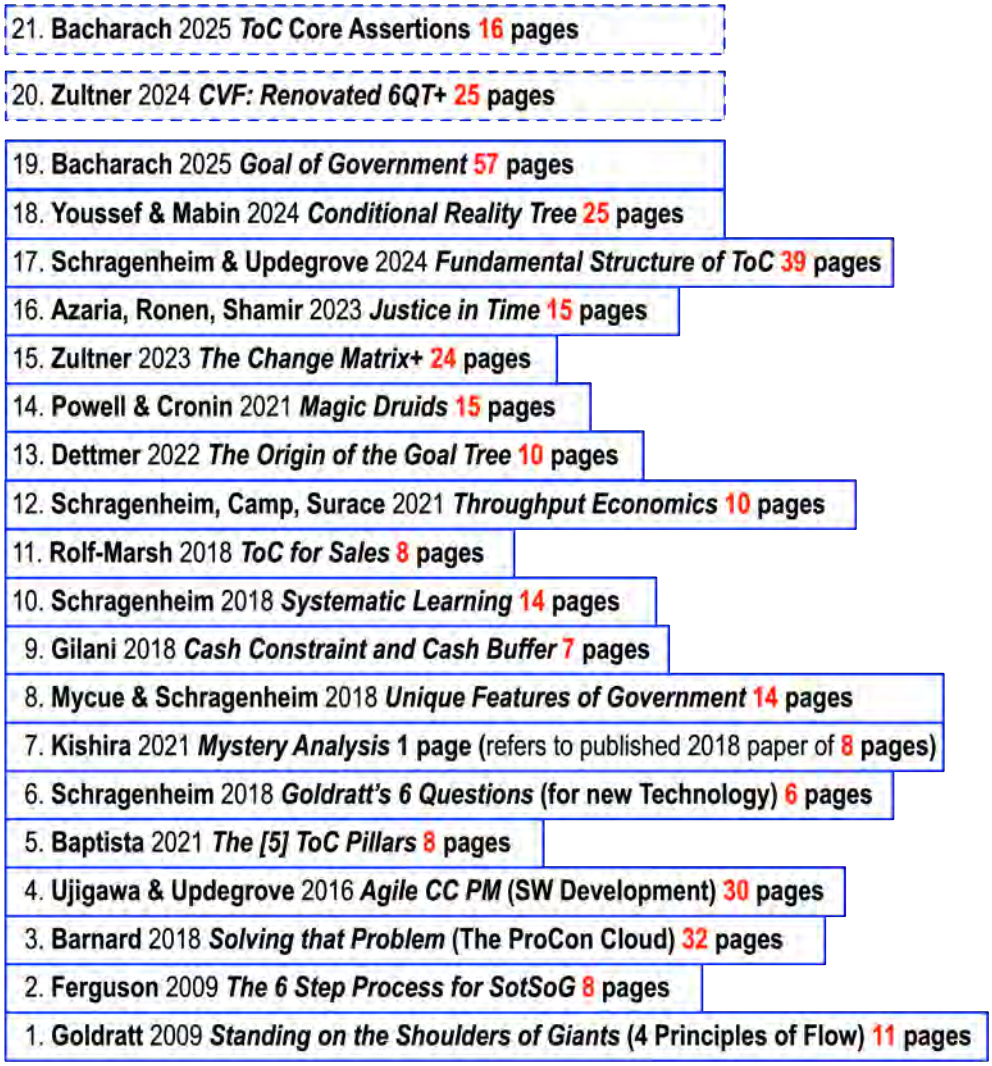
The result… a this historic *Special Collection of Theory of Constraints Papers (2016 - 2026)*.

These BoK papers, spanning a decade, along with the ToC *Handbook*, and the 2012 *Dictionary* (2nd ed.) will always have an important place in the history of the Theory of Constraints. And with this *Special Collection*, we finally have a permanent record of many important works from many leading ToC professionals, in the Modern ToC era…

Copyright © 2026 by Richard E. Zultner, *Jonah*
All Rights Reserved.

What do these papers cover?

Here is a list of the papers, in the order they were reviewed, from 2016 to 2026:



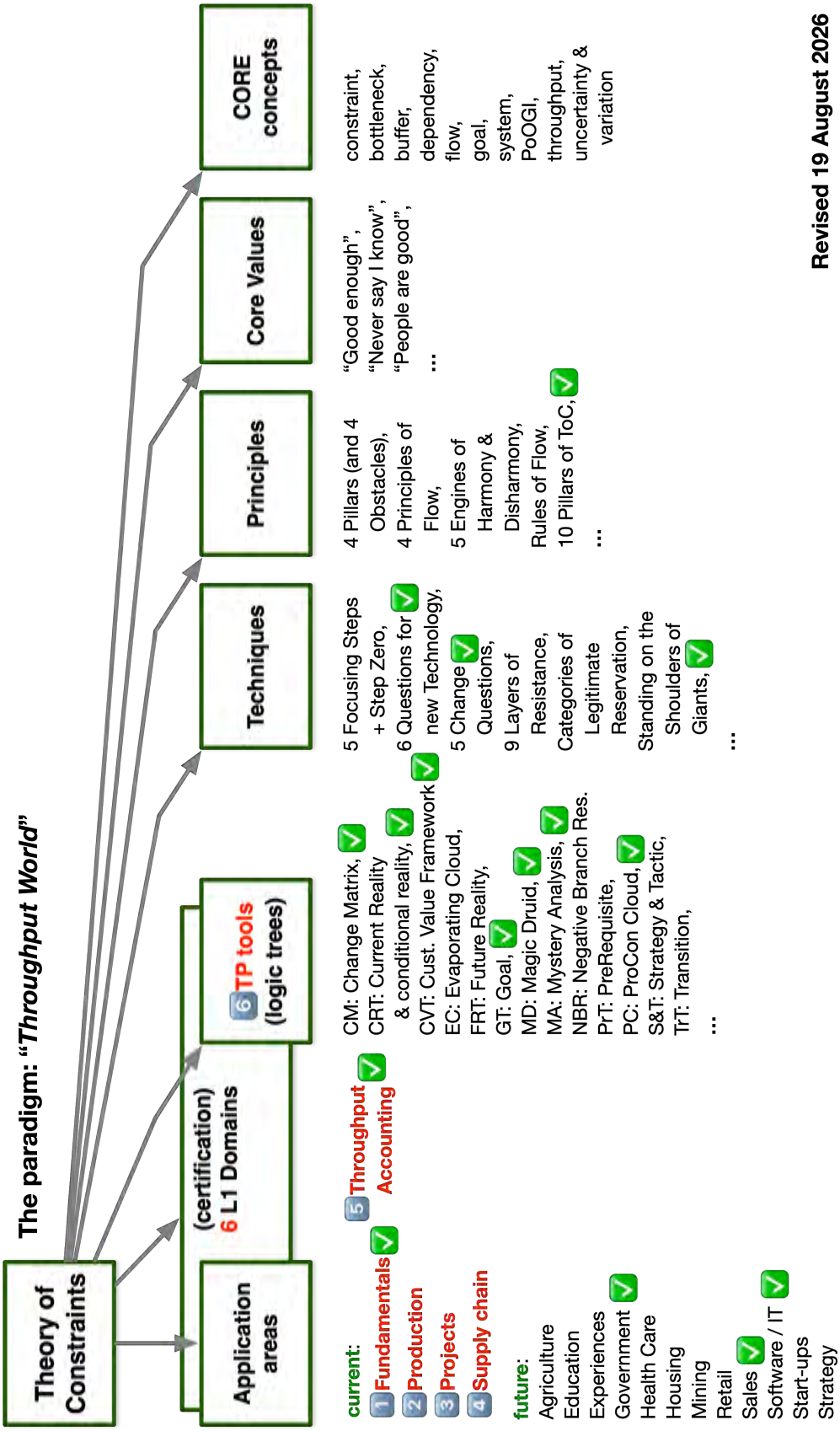
The papers in this *Special Collection*, in review order

The check marks on the next page, show the specific topics that these *Special Collection* BoK papers address…

Copyright © 2026 by Richard E. Zultner, *Jonah*
All Rights Reserved.

What is the 'Theory of Constraints' (ToC)?

There are many answers to the question, "what is ToC?". For this *Special Collection*, the papers were mapped to this "intrinsic order" — the ***inherent categories*** of ToC. [see Goldratt, 2014, *The Goal* 4th rev.ed., chapters 35 and 37] Think of this as a map, of "what ToC *contains*"… the *essence*.



"Agile" CCPM:
Critical Chain for Software Development

Koichi Ujigawa

Director of TOC System Development Division, Being Co., Ltd.

Japan

David Updegrove

Theory of Constraints Consultant, Owner, Clearview Solutions

705 SW Oak Road

Port Orchard, WA 98367

United States of America

TOCICO White Paper Series

Editor: Victoria J Mabin, PhD
Professor of Management, Victoria University of Wellington, New Zealand
Vicky.mabin@vuw.ac.nz

Table of Contents

Executive Summary 3
Background 4
Can CCPM meet the needs of developers? 6
SOG Step 1 – Identify a giant 7
SOG Step 3 – Get on the giant's shoulders 9
SOG Step 4 – Identify the conceptual difference between the reality that was improved so dramatically by the giant, and the area untouched 10
SOG Step 5 – Identify the wrong assumption 12
SOG Step 6 – Conduct the full analysis to determine the core problem, solution, etc. 13
Brief case study of "Agile CCPM" as applied in software development 26
Conclusion 28
References 29

Table of Figures

Figure 1 A cloud with CCPM ramifications often present in software development organizations 13

Figure 2 A cloud for software development teams that have been exposed to both Agile and CCPM. 15

Figure 3 An example of relative size estimation. 17

Figure 4 Setting project parameters. 18

Figure 5 The same project as shown in Figure 4 after Critical Chain Scheduling. 19

Figure 6 Critical chain with integration phase for Virtual Drum staggering 19

Figure 7 Project network showing feeding chain and Virtual Drum. 20

Figure 8 Feature list showing last 15% as scope buffer. 21

Figure 9 How to calculate actual velocity 24

Figure 10 Calculating the duration of remaining features using actual velocity 25

Figure 11 Calculating the remaining project duration 25

Figure 12 Being Company Ltd.'s own completed software development projects, managed according to the process described in this paper 27

Executive Summary

This paper suggests expanding the current TOC knowledge in Critical Chain Project Management (CCPM) by examining a modified network construction process and buffer management method for use in software development. The problem we are seeking to address is the assumption held by many people in software development that CCPM, and by extension TOC, may not offer an acceptable (or good enough) solution for their project management challenges. Therefore, they embrace other methodologies, predominately Agile, as their preferred solution.

Agile project management was introduced as a response to the perceived unreasonable demands of traditional waterfall project management within the context of software development, allowing developers more adaptability, responsiveness, and autonomy over their projects, and creating for them a much more positive work atmosphere. While being a win for developers, Agile is often perceived as a capitulation for the greater organization, who still must manage the customer imperatives of cost, schedule, and scope.

Critical Chain Project Management has repeatedly proven to be an effective method for achieving these customer imperatives and meeting the needs of the overall organization. It is being well-received and is growing rapidly in many project environments. But when introduced in many software development environments, Agile project management tends to prevail because of its perceived benefits for the development team – benefits that such teams will not relinquish willingly.

“Agile” CCPM is designed to create a win-win between developers and their parent organizations via a new proposed set of techniques that allow developers the adaptability, responsiveness and autonomy they desire while giving the larger organization the ability to better manage commitments to customers. While some techniques are borrowed from the Agile and pre-Agile worlds, the solution is fully compliant with the fundamental principles of CCPM and the Theory of Constraints, making “Agile” CCPM a customization of CCPM, as opposed to an entirely new or hybrid methodology.

Background

In many typical software development situations, the traditional waterfall project management method mandated for meeting strict schedule commitments is felt to be intolerable – for example where project task descriptions have not been fully identified, task duration estimates are thought to be highly speculative or even unknowable, and when drastic changes[1] in a project's work content can be experienced in a very short period. To make matters worse, the traditional waterfall method has not been shown to consistently meet such commitments in the first place.[2] Developers therefore often feel they are under great pressure to provide results they believe are impossible to achieve. This has been the primary driver behind finding a different, more workable methodology for project management in software development.

Agile project management has been developed over the past 20 years specifically as a response to this problem. The purpose of Agile methodology is to 1) quickly adapt to changes in software project scope, 2) provide superior responsiveness to those generating the changes, 3) achieve greater speed of execution than traditional methods, and 4) achieve continuous value delivery. Since Agile is believed to be much more adaptable to change than waterfall, and by using sprints and other Agile tools, development teams can be viewed as delivering something of continuous value (both early in and throughout the project) – from the developers' and often the customer's perspective, Agile is usually seen as superior to waterfall.

In addition, and the importance of this must not be overlooked, Agile methodology offers a level of autonomy to the development team that is not present in waterfall.[3]

This autonomy allows development teams greater control over the delivery aspects of projects.[4] It has given developers something they consider to be of great personal value, and thus they wish to retain it. This benefit triad of adaptability, responsiveness and autonomy has

[1] In addition to regular change orders, these changes can be driven by new devices such as smart phones and tablets, progressive infrastructures such as cloud services (SaaS, PaaS, IaaS, etc.) and innovations in the development/programming and operating system environments. In other words, even the rules of the game can change rapidly.

[2] According to a Gartner report roughly at the time where CCPM and Agile solutions began to gain traction (2000), "Roughly 40% of all IT projects fail to meet business requirements": http://www.techrepublic.com/article/it-project-failures-costly-techrepublic-gartner-study-finds/

[3] See the Agile Manifesto: http://www.agilemanifesto.org/

[4] Note that one of the key values of the Agile Manifesto is: "Responding to change (takes priority over) following a plan."

become for software developers what would be referred to, in the terminology from Goldratt's Change Matrix[5], a huge *mermaid[6],* or something that is meeting present needs or desires, giving up on which would be a perceived as extremely negative.

However, while Agile may help meet the needs of developers in relation to individual projects, and while there are attempts (such as SAFe[7]) at making Agile more compatible with multiple projects being in execution concurrently, Agile does not necessarily meet the needs of the *company* in terms of project portfolio management, or the needs of its customers, who are often demanding firm commitments on schedule, cost, and scope. This forces Agile organizations either into a less than satisfactory compromise, or into giving up completely on the predictability of firm commitments. Perhaps worse, some Agile techniques—such as time-boxing work into sprints—carry the undesirable consequence of creating frequent stops in the flow of task completions, and often interrupt task owners in the middle of their tasks. Worse still, Agile portfolio management frameworks such as SAFe require the application of Agile for all projects, even those for which it may be ill-suited, without providing a systematic means for improving the reliable throughput of project completions.

Critical Chain Project Management (CCPM) has been developed with the intent of overcoming the problems of traditional project management (projects finish late, projects finish over budget, and quality and/or scope of projects is routinely compromised). CCPM is intended for many divergent project environments, including extremely complicated multi-project environments. It also addresses the entire project portfolio and the holistic projects organization. When properly implemented, CCPM has been shown to consistently succeed in overcoming these problems through the utilization of properly defined and constructed project networks, properly sized and buffered task duration estimates, buffer management to provide early warning of potential problems, and a smooth, balanced and sustainable load on the system via project staggering.

In our experience, when introduced to CCPM, software developers will often acknowledge its advantages over traditional project management. Some will even try it. However, for many, in the end they perceive the focus on delivery and the need for task duration estimates as ultimately being closer to the waterfall model – in their minds an attempt to force certainty on uncertainty. It needs to be recognized that there is always a psychological fear of being forced into commitments in situations where one does not hold all the cards. CCPM is sometimes

[5] "Do people resist change? Isn't it obvious?" YouTube video: https://www.youtube.com/watch?v=hcz1aZ60k7w
[6] For additional information on "mermaids" and Goldratt's Change Matrix, see Barnard, Alan, *The Change Matrix Cloud Process,* Draft White Paper, TOCICO White Paper Series, 2016.
[7] SAFe is an acronym for Scaled Agile Framework® www.scaledagileframework.com

misunderstood to the extent that it is presumed to be a continuation of the traditional waterfall mindset of estimation and commitment.

The desire for adaptability, responsiveness and autonomy by the development team often trumps the benefits offered by CCPM, and they turn to (or continue to embrace) Agile. This is not so much a rejection of CCPM as it is a reluctance to give up their mermaid. Mermaids aren't inherently bad or unworthy. They are the positive of not changing. Therefore, in a solution, it is much more persuasive to show that they get to keep their mermaids – win-win.

In choosing the perceived execution benefits of Agile over the planning benefits of waterfall, they unknowingly reject an opportunity for even greater improvement than is available from *either* waterfall or Agile – an opportunity that is offered by CCPM.

Can CCPM meet the needs of developers?

In response to Agile project management, some TOC practitioners have innovated – incorporating various Agile or Lean methods into CCPM, and have achieved some admirable success, with some developers seeing this as delivering value from both worlds. However, in doing this the methodologies sometimes overlap one another, are not always implemented consistently between practitioners, are not currently part of the accepted TOC BOK, and have the potential for obfuscating the TOC solution within the project management marketplace.

This paper describes an alternative approach for obtaining the adaptability, responsiveness and autonomy of Agile via CCPM – an approach which relies on changes in the way we arrive at task duration estimates and how this corresponds to the project's buffers. The new techniques proposed are fully consistent with TOC philosophy, can be used with existing CCPM software, and for simplicity and ease of use can be incorporated into existing and future CCPM software products. Earlier versions of the proposed solution have been presented at the 2012 – 2014 TOCICO conferences (see references).

It is significant to note that in contrast to pure Agile methodology, "sprints", or arbitrarily defined fixed "time boxes" are not required with the proposed method. In fact, such fixed time boxes can be counter-productive since they *are* fixed. If one has overestimated the size of the sprint, they should finish early and move on. If it is underestimated, one should continue until the objective is met. Therefore, sprints act as milestones, removing flexibility from the project, and they encourage negative behaviors such as Parkinson's Law.

Removing sprints from the solution is an advantage in terms of minimizing project duration, controlling scope creep, and utilizing buffer management to achieve consistent on-time delivery. Since the project team is working to complete story points (defined below) and individual features, the crucial adaptability in developing each new feature and the completed end product is retained.

This eliminates the major reason that organizations reject CCPM in favor of Agile.

The format for presenting the "Agile" CCPM solution is based on the Standing-On-The-Shoulders-Of-Giants (SOG) process introduced by Dr. Eli Goldratt at TOCICO in 2011.

SOG Step 1 – Identify a giant

This white paper stands on the shoulders of Dr. Goldratt and the TOC application Critical Chain Project Management. CCPM has successfully addressed the significant shortcomings of traditional project management[8] in many project environments, including in our experience major assembly, engineering to order (ETO), construction, Maintenance, Overhaul & Repair (MRO), new product development (NPD) and software development.

SOG Step 2 – Identify the enormity of the area not addressed by the giant

As stated above, in our experience (and in that of many colleagues and client organizations) CCPM is an effective solution for the problems plaguing project organizations in many divergent work environments. However, particularly in software development, CCPM is perceived by

[8] Including claims that projects are often late, over budget, and/or must reduce scope to accommodate schedule or cost; lack proper planning, lack communication, and lack synchronization, especially in multi-project organizations.

some as being deficient, or at least the superiority of standard[9] CCPM cannot be clearly claimed. Since we have accumulated personal experience with marketing and implementation of CCPM in software development, the solution outlined in this white paper addresses this industry specifically.

Development of new software or new features within existing software is often subject to one or more of the following attributes:

- Characteristics / features are not deterministic and are non-linear
- Major changes often occur during execution
- New ideas can emerge through project execution
- The sequence in which things needs to be done can be very flexible (success may sometimes be sensitive to sequence)

Although the process steps for creating new software features may be well-defined, due to the above attributes the time it takes to execute these steps is highly variable. When asked for task duration estimates, a common response in software development is, "We have no idea." Furthermore, it is often felt that the task descriptions themselves (and therefore the level of effort) cannot be fully determined until they are discovered in execution.

The pressure and mandate at company and portfolio levels to create precise project networks (which may even have to be pre-approved by the customer), and to meet pre-determined completion dates creates resistance to the idea of detailed planning, numeric task duration estimates and project completion dates. This resistance has been a primary impetus for the development of Agile project management.

Since using established CCPM implementation techniques typically involves solid project networks, clearly defined task descriptions and absolute[10] task duration estimates, this resistance often surfaces, even when we insist that variability is accounted for in the buffers and estimates are not commitments. For software developers, such requests recall the pain encountered in waterfall. It can be extremely difficult to complete the paradigm shift that CCPM is adaptable, responsive, and liberating enough for software developers to consistently choose it over Agile.

[9] For the purposes of this paper, "standard" CCPM is defined as the present widely-accepted form of CCPM where task duration estimates are gathered as absolute numbers (see footnote 10) and buffers are managed in relation to the extent of consumption of these absolute-numbers in aggregation from all tasks in a chain.

[10] 'Absolute' means we are asking for a single, real number, even if this number is understood not to be a commitment and is protected by buffers.

The current reality for many TOC implementers and practitioners is that CCPM is not being adopted as extensively as it should be in IT environments, and we consider this as an area not (adequately) addressed by the giant of CCPM.

It is important to note that we are not claiming that CCPM does not work in software development or is incapable of handling such scenarios. On the contrary, we have personal experience of success in CCPM for software development. However, we do claim that the traditional implementation techniques of CCPM are not necessarily the most effective techniques for addressing the factors listed above, and that the established CCPM approach is empirically not effective in changing the perception that Agile is a better (more credible and effective) solution for the management of software development organizations.

SOG Step 3 – Get on the giant's shoulders

CCPM is a tested and proven method to consistently deliver on three valuable advantages for projects organizations – on-time delivery, within-budget performance, and maintenance of scope. Since these strengths bring so much value to a projects organization in terms of reputation, sales, and competitive advantage, they should not be relinquished easily.

When the considered use of CCPM is abandoned by organizations in lieu of Agile or other methods, it is a tacit admission that on-time delivery, within-budget performance, and scope maintenance are for practical purposes impossible – it is a surrender of sorts. We feel that such capitulation is not only unnecessary, it also contributes to the organization's failure to realize its potential in terms of profit, reputation, and competitive advantage.

Therefore, in the proposed application enhancement, we climb upon the shoulders of the full established CCPM application and begin from there. All the benefits and attributes of CCPM are maintained while building in the adaptability, responsiveness and autonomy of some of the practices adopted by Agile. None of the fundamental rules or benefits of CCPM are sacrificed.

For this reason, the application enhancement is truly CCPM. It is agile (small "a"), not in the sense that it is a hybridization of Agile and CCPM, but in the sense that it makes standard CCPM more adaptable to change. Other ways to describe this method could be "Responsive", "Adaptive", or "Flexible" CCPM. But for clarity and concept recognition among those familiar with the software development community, we have titled this method "Agile CCPM."

SOG Step 4 – Identify the conceptual difference

Projects are undertakings designed to produce a specific product, service or result.[11] They are temporary or transitory in nature, having a discernable beginning and end. Although they may to varying degrees share some characteristics with various forms of manufacturing or production, projects can also differ from these in several ways.

Whereas manufacturing tends to be highly repetitive, with production runs often consisting of hundreds or thousands of identical items, projects are often non-repetitive, producing unique end items or results. In situations where projects are repetitive and produce fewer discrete end items, even then the end items tend to have greater customization between them.

Manufacturing also tends to have lower process variability in its operations steps, and the individual steps usually require minimal management attention. Projects, on the other hand, tend to contain steps (or tasks) with much higher variability and uncertainty, sometimes requiring significant management attention when problems arise. Finally, in manufacturing, touch time is normally a small percentage of lead time (the largest contributor to lead time is the waiting time *between* tasks), whereas in projects touch time tends to be very high relative to project lead time, and the preponderance of wait time occurs *within* the tasks.

Some organizations offer products or services which inhabit a "gray area" between manufacturing and projects. These are situations where although "touch time" is high, project networks are very "flat," i.e. there are few feeding paths and convergence points, projects tend to be quite repetitive, and variability tends to be low. This situation seems to be best addressed by the High-Touch-Time Drum-Buffer-Rope (HTT-DBR) solution[12].

There are also distinctions within the realm of projects. In most project environments, *what needs to be done* (at least at a conceptual level) is well known. A clearly-defined project network can be built showing sequences of dependent tasks, even if the specific project has not been executed before. Individual tasks within projects have often previously been executed

[11] For the Project Management Institute (PMI) definition of a project, see: http://www.pmi.org/About-Us/About-Us-What-is-Project-Management.aspx

[12] http://www.tocico.net/CORRECTED-Scheinkopf-Kishira-Schragenheim%20Foundation%20-%20Final%202012-0521_2012-09-08.pdf

multiple times, providing experience for workers and managers and allowing "reasonable" task duration estimates.

Many project environments generally meet these criteria. This includes many engineering environments, major assembly, and construction. CCPM was originally conceived to address such an environment: the design and construction of offshore oil rigs. Therefore, the conceptual foundation of established CCPM is based around these criteria. The current practice of building critical chain plans and buffer management are an outcome of this conceptual foundation.

However, in software development, this is very rarely the case. In many projects one knows quite little about the detailed content of future tasks, and developers can often only recognize the relative *size* of tasks and their approximate order. The *what must be don*e in the project is less clear, sometimes far less so. For example, it is often the case that the customer does not have a complete picture of what they want until a working preliminary software is provided. Sometimes, unexpected (fatal) defects can be caused by a small change made during programming, occurring at a large distance from the change. Finding those in advance is often extremely difficult.[13]

Finally, in software development, an even semi-confident quotation of reliable task duration estimates is much more difficult. For many, Absolute Time Estimation (ATE) is an exercise in futility.

For many software engineers, this makes the accepted CCPM project network construction process more problematic, going so far as to allow some to challenge its validity for software development.

To gain greater acceptance of CCPM in software development, a new conceptual framework is proposed, where Relative Size Estimation (RSE) is more reliable than Absolute Time Estimation[14], and velocity-based buffer management is a superior way to measure project health and bring projects in on-time, within budget, and with better maintenance of quality and scope. These can be accomplished within the true spirit and logical boundaries of TOC and CCPM, and will be addressed in detail below.

[13] Although this can also happen in large engineering projects, it is far more common in software development
[14] For example, "new product/function X seems larger (takes longer to develop) than product/function Y".

SOG Step 5 – Identify the wrong assumption

The growing number of CCPM success stories make it easy for inertia to help us form a belief that the current techniques of CCPM implementation are the most effective techniques for all project types and all project environments. It is always tempting to believe that because we were successful in one project environment "we know" that if we implement CCPM in the same way we will be similarly successful the next time. Therefore, we run the risk of overlooking significant differences in the characteristics of different project organizations. In their book, "**The Invisible Gorilla, And Other Ways Our Intuitions Deceive Us**", research psychologists Christopher Chabris and Daniel Simons refer to this as a cognitive bias called the "Illusion of Confidence."[15] This is not a criticism of the professionals who implement CCPM. Rather, it is merely human nature.

A similar cognitive bias can cause us to believe that the *techniques* we use in implementing a solution are sacred and unalterable. Therefore, we run the risk of believing that although some minor accommodations can be made for different situations and product or service types, overall, CCPM is a fixed set of unchangeable techniques. We are prone to *not* revisit and challenge the assumptions behind our techniques. Again, this is human nature. Chabris and Simons refer to this as the "Illusion of Knowledge."[16]

Of course, we are warned in the Five Focusing Steps about using methods based on assumptions where those assumptions are not valid. For every new situation, assumptions can and should be challenged. We believe that for software development there is a benefit in challenging the following assumption in current CCPM practice:

It is necessary to estimate* a priori *the time required for every task in a project network.

Due to the conditions that often exist in software development as described in SOG Step 4 above, we claim this assumption is not always correct, especially when creating new software products or making major upgrades to existing products. Therefore, some of the current techniques used in project network construction and time-based buffer management would need to be changed if CCPM is to be perceived as superior and established as a best practice for more and more software development organizations.

---

[15] Chabris, Christopher, and Simons, Daniel, 2009, *The Invisible Gorilla: And Other Ways Our Intuitions Deceive Us,* Crown Publishing Group, New York, NY

[16] Ibid.

SOG Step 6 – Conduct the full analysis to determine the core problem, solution, etc.

Diagnosing the core problem

The pressure to perform well vis-à-vis the imperatives of project management – delivery, cost, scope, quality – exist in software development as much as they do in any other project environment, especially at the company level. However, the nature of software development, i.e. the attributes stated in Step 2 above, makes realizing these imperatives seem much harder to obtain.[17]

On the other hand, Agile project management promises great adaptability and continuous value delivery. This creates an intense conflict between the traditional waterfall project management, and the newer and rapidly expanding field of Agile project management, represented as an Evaporating Cloud[18] in Figure 1:

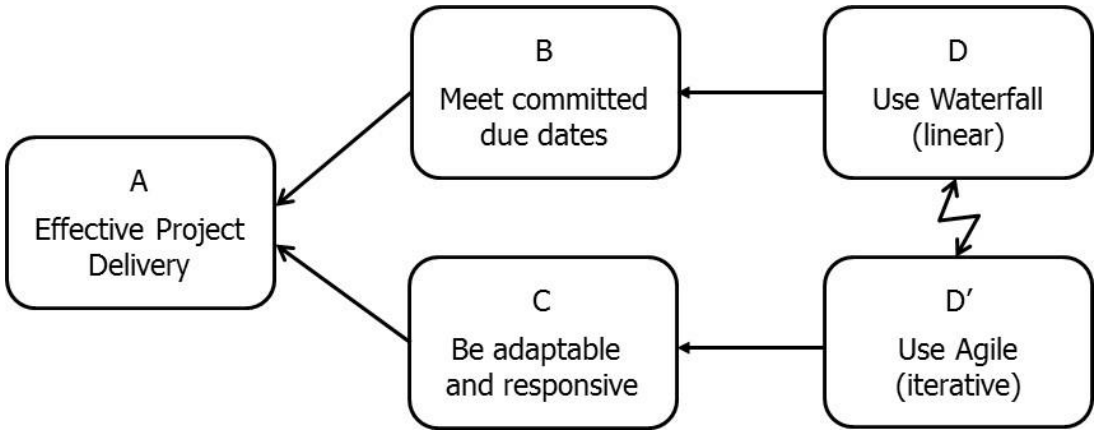


Figure 1 A cloud with CCPM ramifications often present in software development organizations

[17] This is not to say that such pressures do not exist in non-software development environments. Rather, in software development (and perhaps a few other environments) the combination and intensity of these attributes cause them to become force multipliers.

[18] Evaporating Cloud is a standard TOC Thinking Process, introduced by Goldratt (1990) *What it this thing called Theory of Constraints and how is it implemented*, North River Press. For a summary, see Scheinkopf (2010).

In the real world of software development, this cloud is increasingly 'resolved' in Agile's favor. Development teams feel the benefit of continuous value delivery but are especially drawn to Agile's adaptability, considered to be the primary weakness of waterfall. Agile also provides autonomy and control to the development team. This point cannot be over-emphasized. These things become beautiful *"mermaids" (desirable possessions)* to software developers, who in general are not willing to give them up.

Nevertheless, CCPM's claims to help bring projects in on-time, on-budget and with original scope intact attracts the attention of people in software development as much as they do in other project environments, again especially at the company level. TOC consultants often approach such organizations with deep experience, many great case studies and an impressive resume of results, insisting that CCPM has cracked the code of project management success.

But the interest of the development team turns to concern when they recognize, either from the initial training or in the early stages of trying to use CCPM, that its established techniques are reminiscent of waterfall and in fact create serious practical difficulties for them. They begin to believe that, like waterfall, the established CCPM methodology, despite its benefits, does not possess the adaptability they need, nor the autonomy they desire.

Meanwhile, the growing acceptance of Agile methods in software development makes it advisable for their parent organizations to seriously consider Agile as a solution. The adaptability offered by Agile very soon becomes apparent. This adaptability clearly solves one of the significant needs of the software development organization. Since they can see the logic in the CCPM solution and its ability to deliver on promises, they are left with a similar but very practical conflict as the one between waterfall and Agile, represented in Figure 2 as an Evaporating Cloud. By extension, developers often conclude that although CCPM has impressive merits, the established CCPM methodology appears too like waterfall, especially considering the level of effort required to meet time and budget commitments. Therefore, to them, CCPM is less desirable than Agile.

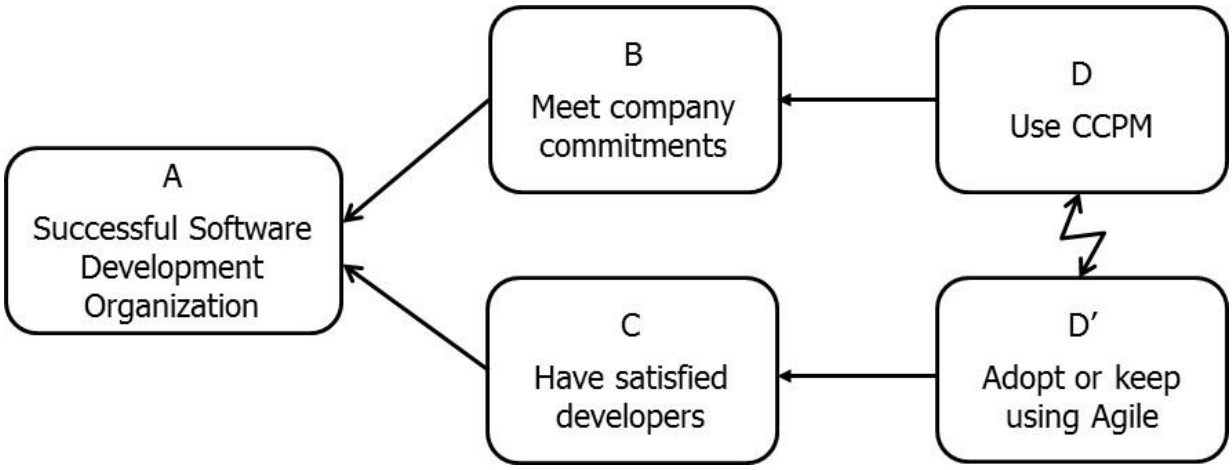


Figure 2 A cloud for software development teams that have been exposed to both Agile and CCPM.

When we begin to dive down into the established techniques of CCPM, we find out why they come to this conclusion. Based on the success of CCPM in other project environments and understanding the cognitive biases noted above, two assumptions have (generally) grown into passive acceptance in the TOC community:

1) Established CCPM techniques are superior to all other techniques in all project environments, including software development.
2) Specifically, every task must be given a numeric time duration estimate, or "Absolute Time Estimate." (ATE)

We claim that neither of these assumptions are valid and this warrants the investigation into alternative CCPM techniques which operate under different assumptions. The resulting investigation has led to a hypothesis which has been tested and the resulting method has shown excellent results in software development.

The proposed method represents an intuitive way to be more 'agile' (adaptable) with some of the techniques used in CCPM and to get greater acceptance and more demonstrable schedule and cost results in software development. It therefore delivers the best of both worlds and leaves on the table no significant need of the software development organization.

This method enhances the power of CCPM in software development by doing time-based buffer management via Relative Size Estimation (RSE) rather than the usual Absolute Time

Estimation (ATE). RSE, also popularly called "T-shirt Sizing[19]," (see Figure 3 below) is the primary injection for the solution. It was popularized from within the world of software development, but has been used in various forms since as early as the 1960s, and perhaps much longer. In the last decade, it has been adopted by advocates of Agile and has been promoted as an Agile best practice.

Relative size, put most simply, means "this thing is about the same size as that thing." In the minds of the engineers, it is determined that a new feature in a software product should require about the same *amount of effort* as a different feature previously developed, even if that feature was completely unrelated. They are of the same *relative size*.

Another way to think about RSE is as a "stable" measurement that does not change due to influence from external forces. The *weight* of two spheres might be 300 Kg and 60 Kg on the earth, but the same spheres would weigh 50 Kg and 10 Kg, respectively, on the moon. However, the relative *size* of the two spheres is stable, not influenced by the external force of gravity. "How long will it take?" in such an environment is like asking "How much does it weigh?" while comparing weight in one part of the solar system to another. The answer can be "I don't know," or, "it depends." But with relative size, the answer does not change – it is stable.

Understanding the primary injection of RSE, the following procedure should be followed to successfully execute the Agile CCPM technique:

Process Step 1. Create a feature list.
Depending upon the environment, create a list of desired features[20]/characteristics/systems or components desired to be developed.
Process Step 2. Prioritize the list by importance.
Process Step 3. Estimate the relative "size" of each feature/characteristic/system/component. This can be done utilizing the established practice of creating *story points.* A very small feature or activity might be classified as one story point. Larger features or activities will be

[19] E.g. XS, S, M, L, XL, etc. More information on T-shirt sizing can be found here: https://dzone.com/articles/agile-estimation-practice .

[20] A "feature" describes a benefit for its users in the form of "user story": "As an A (role), I want to do B (feature), because C (reason)". For example, "As a pipeline manager, I want a multi-project fever chart, because it enables us to see the health of the whole pipeline, and at a glance tells us which projects need our help". In addition, we can obtain both short-term and long-term benefits by using this method to describe features. As a short-term benefit, it helps developers maintain their objectives during the current project. As a long-term benefit, it helps train developers to think more like scientists.

represented by using multiple story points[21]. It is helpful in classification of features to use a modified version of the Fibonacci scale.[22] Estimating relative size by using these numbers allows us to reflect the inherent uncertainty and to avoid underestimation in larger features, since the distance between numbers grows progressively larger.

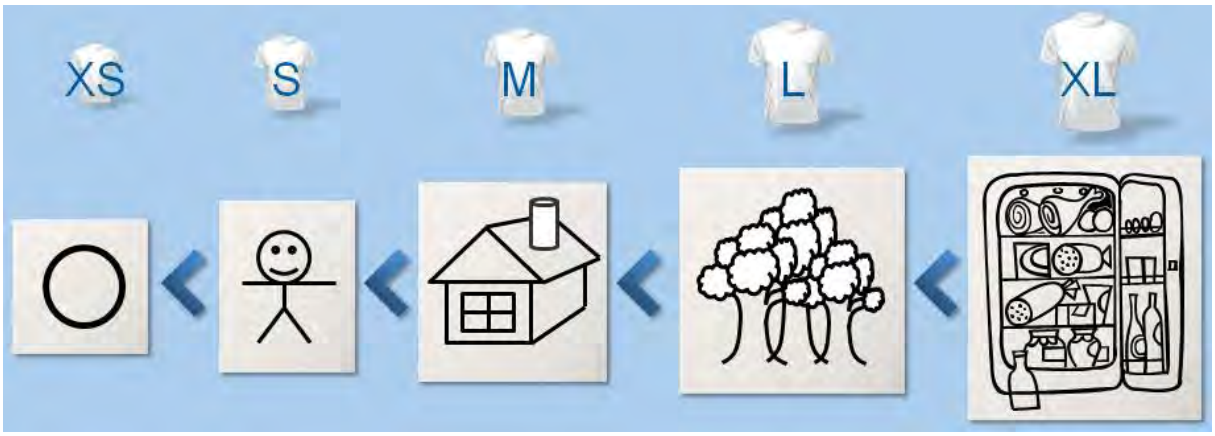


Figure 3 An example of relative size estimation. "Size" here refers not to physical dimensions, but to the level of effort required by the artist in drawing each picture.

As mentioned above, this practice is akin to how one might estimate the relative size of T-shirts (XS, S, M, L, XL, 2XL, etc.) Using the modified scale (see footnote 21), assign a value for each feature/characteristic/system/component desired for inclusion in the project.

Process Step 4. Set project parameters. Several policies need to be set as you create each project. They are illustrated below in Figure 4.

[21] In software development, Planning Poker is often used for this purpose. More information on Planning Poker is available at: http://dzone.com/articles/introduction-planning-poker. A good article on story points can be found here: https://myagilemind.wordpress.com/2011/10/18/story-points-vs-development-hours.

[22] http://www.maths.surrey.ac.uk/hosted-sites/R.Knott/Fibonacci/fib.html. The standard Fibonacci sequence is 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, etc., where each successive number in the sequence is the sum of the previous two. However, for the purposes of estimating relative size in the proposed method, the sequence may be modified by rounding to more practical values: 0, 1, 2, 3, 5, 8, 13, 20, 40, 60, 100, etc. These numbers now help us to measure relative size, or the number story points for each feature.

4a. Set the project period (duration) in days. Identify, prioritize, and group target features by relative size (in story points). Sum the number of story points.
4b. Determine and set the planned initial velocity, or number of story points to accomplish per day.
4c. Divide the number of story points by the initial velocity. The resulting number is the project size in days.
4d. Once the total duration of the project is known, select a buffer coefficient. A good starting point is generally 33% of the project period[23]. Figure 4 below shows how buffer coefficient selection would look prior to Critical Chain scheduling.



Figure 4 Setting project parameters. A selected buffer coefficient is shown, which will be applied during Critical Chain Scheduling.

[23] This produces a different result from a common practice in CCPM, where 50% of task time is removed from each task as safety, and half the removed and aggregated safety is placed at the end of the path as a buffer. In such a case, the resulting project is 75% of its non-CCPM scheduled size. But since features are not technically tasks, in Agile CCPM we want the duration of the Critical Chain plan to be the same as in the original project. Therefore, a project which is set to 90 days prior to Critical Chain Scheduling will still be 90 days after Critical Chain Scheduling. Rather than task time being 50% of its pre-CCPM value, in Agile CCPM task time is 67% of its pre-CCPM value. Arriving at this configuration may require different techniques between unique CCPM software products.

Process Step 5. Create a Critical Chain schedule.
Very simple schedules are adequate for this method – for single projects sometimes even a single path and the equivalent of one (or a very few) "tasks[24]," and a project buffer are sufficient. (See figure 5).



Figure 5 The same project as shown in Figure 4 after Critical Chain Scheduling. A very simple schedule is sufficient for single project CCPM in software development

More common in the project world are multi-project organizations, yet still the network can be very simple – a minimal number of tasks. An integration phase can be identified, and projects can be staggered based on the Virtual Drum phases of projects in the pipeline.
5a. Example: Estimate a duration for the developer test phase based on experience and the relative size of the project. This is a prime candidate for the integration phase/Virtual Drum.
5b. Determine the duration of the QA task (often a fixed duration for all projects set by policy). Sometimes this task is combined with the developer test phase in integration. (See Figure 6)



Figure 6 Critical chain with integration phase for Virtual Drum staggering

Some projects may require or benefit from one or more feeding paths, for example when different skill sets can be assigned to features and work can be done in parallel. Multiple paths may also be used when some features are being outsourced. In addition, if there are significant

[24] i.e. groups of features, or a phase of the project

differences in skill levels among resources, slower resources could be assigned to a feeding path. All paths should be managed per their own velocity. With these multiple paths, there will also be feeding buffers, as in standard CCPM. (See Figure 7)



Figure 7 Project network showing feeding chain and Virtual Drum.

5c. Designate a "Scope Buffer." Scope creep, which has a potential for existence in all types of projects, can be pervasive and extreme in software development. Not only are projects subject to customer input and change, sometimes the software development environment itself generates new ideas and improvements which add or change content.
Whereas other project environments might be categorized as in the realm of "known unknowns"[25], software development can often exist in the realm of "unknown unknowns"[26]. Standard CCPM contributes powerfully to scope preservation in most environments by optimizing project execution. However, in software development the final scope of the project is very often unknown. It is not necessarily practical or desirable to preserve the original scope. As a new feature is developed, often an important addition to the scope of the feature is discovered. In execution, and/or in the full kitting phase, stakeholders may change their minds. This can result in feature inflation or changing the priority of remaining features.

Experience shows that in software development scope inflation can be as much as 30%. This is out of the range of normal buffer management, therefore creating the need for a scope buffer. The scope buffer is a virtual buffer. If the crucial features are properly prioritized and maintained, a scope buffer allows us to defer or replace less important features – with consensus among stakeholders.

In execution, when we see a situation where the project buffer is about to be exhausted, decisions can be made on which features can safely be removed from the list. To facilitate this,

[25] A supplier might be late, a key piece of equipment may break down, a subcontractor may not be available, etc.
[26] Alternatively, in software development, the ratio of unknowns may be relatively higher.

the last 15% of the initial planned scope should be designated as the scope buffer[27]. The scope buffer is set in the planning phase, once and only once, and will be put in motion as necessary. In other words, this means also that developers promise stakeholders to defend at least 85% of the original contents "to the death".

Priority	Feature	Size (sp)	Cumulative	Pct.
1	F001	8	8	7.0%
2	F002	5	13	11.4%
3	F003	8	21	18.4%
4	F004	13	34	29.8%
5	F005	5	39	34.2%
6	F006	5	44	38.6%
7	F007	8	52	45.6%
8	F008	5	57	50.0%
9	F009	5	62	54.4%
10	F010	13	75	65.8%
11	F011	8	83	72.8%
12	F012	5	88	77.2%
13	F013	8	96	84.2%
14	F014	5	101	88.6%
15	F015	13	114	100.0%

Figure 8 Feature list showing last 15% as scope buffer. Note that the 15% mark is initially within the planned time for Feature #13

5d. Stagger projects as required.

Staggering projects should be done in the same manner as standard CCPM[28], keeping the following basic principles in mind:

1) Top management prioritization of projects (per Projects S&T 5.111.1)[29]
2) Proper CCPM network and pipeline planning (including employment of a Virtual Drum and capacity buffers)

[27] If the ratio of scope inflation is recognized as being up to 30%, and the half of the new features would have higher priority than features in the original scope, 15% of the original features can be replaced by emerging requirements.

[28] If resources are shared and Virtual Drum staggering is used consistently across all projects, it is permissible to mix Standard CCPM and Agile CCPM projects in a pipeline.

[29] Projects Strategy & Tactics Tree, Goldratt, October, 2010

3) Maintaining low WIP levels via determination of a maximum number of projects to be allowed concurrently in the Virtual Drum phase

As with standard CCPM, project completion dates are ideally committed based on where a project's completion date falls in the stagger. Therefore, lead times and completion dates are determined by collaboration between sales and the pipeline manager. Most CCPM software products allow project delivery dates to be calculated by utilizing the "what if" capabilities of the software in accordance with the above.
As with standard CCPM, if the resulting completion date is unacceptable, some top management decisions may be required regarding scope and/or prioritization position in the stagger.

5e. Start projects as per the pipeline stagger and perform velocity-based buffer management.
The start of projects should also be in accordance with basic CCPM and S&T tree principles:

1) Release of project "legs" (S&T 5.111.4).[30]
2) Release of projects is subject to the guidelines for full kitting (S&T 4.11.2[31] and below).

To perform velocity-based buffer management, or VBBM, the following procedure should be followed:

1) Initial Buffer Management Procedure – As is the case with standard CCPM, remaining task duration should be estimated in a timely manner, such as at the end of the working day. Task managers should report remaining duration in days (also as with standard CCPM). We believe this can be done relatively easily once features are in execution. However, if it seems that there are difficulties in estimating remaining duration directly (by ATE), estimation can be accomplished by dividing the number of remaining story points (remember a task can include several features) by the planned velocity.[32]

   If multiple portions of the task are incomplete at the end of a working day, the task manager should report remaining duration based on the portion of the task with the highest remaining duration. This procedure will be maintained until the duration of the

[30] Ibid.
[31] Ibid.
[32] Note however, that difficulty in absolute time estimation at this point would be a sign that the definition of the feature is too vague. Another sign that the task definition is too vague is that task level full-kitting is difficult to identify.

tasks for remaining features can be re-calculated by using actual velocity instead of initial planned velocity[33].

Initial buffer color is calculated measuring buffer consumed relative to the planned Critical Chain duration. This represents no change from the existing reporting method incorporated by Critical Chain software.

2) Secondary Buffer Management Procedure after switching to actual velocity - When the current feature and upcoming features are represented as individual tasks (i.e. [Task 1 = current feature] -> [Task 2 = upcoming features]), then 1) report remaining duration (RD) for the current feature in the same way as with standard CCPM, and 2) adjust the duration of upcoming features by dividing the remaining story points by actual velocity (only the 2nd step is different from the standard CCPM) (see Figures 9, 10).

   When both the current and upcoming features are represented by a single task bar, report the value obtained by the following equation as the remaining project duration:

   Remaining project duration = RD + ED

   where [d] = days, [sp] = story points, and

   RD [d]: (The highest) remaining duration of the current feature(s)

   ED [d]: Estimated duration of remaining features [SPr / V * (1 – Cb)]

   SPr [sp]: Story points of remaining features[34]

   V (Velocity) [sp/d] = SPc / Te

   SPc [sp]: Story points of completed features

   Te [d]: Elapsed time [d][35]

   Cb [%]: Buffer coefficient

[33] Project velocity, in the early stage of a project, can be unstable. Velocity is calculated from the accumulated value of story points and elapsed time, which means that as each data point is recorded, the ratio of fluctuation decreases gradually. When you are confident that actual velocity has stabilized (e.g. after 10 days), change the procedure for reporting your remaining duration estimates from calculating them against initial planned velocity to calculating them against the average actual velocity of completed features.

[34] Even if a portion of the current feature is completed, e.g. 4 SPs out of 8 SPs, don't count these as completed story points. Experience shows that trying to pinpoint the precise number of completed story points is out of proportion to the benefit. ("It is better to be approximately right than precisely wrong")

[35] To simplify the explanation in this paper, elapsed time is shown in days. In practice, elapsed time should be counted hourly and overtime work should be considered to obtain a more reliable buffer status.

The value is entered as the remaining duration in days for the task representing the project (single path), and this can be done in standard CCPM software (see Figure 11). An easy way to visualize the concept is to think of a project as analogous to going on a long drive:

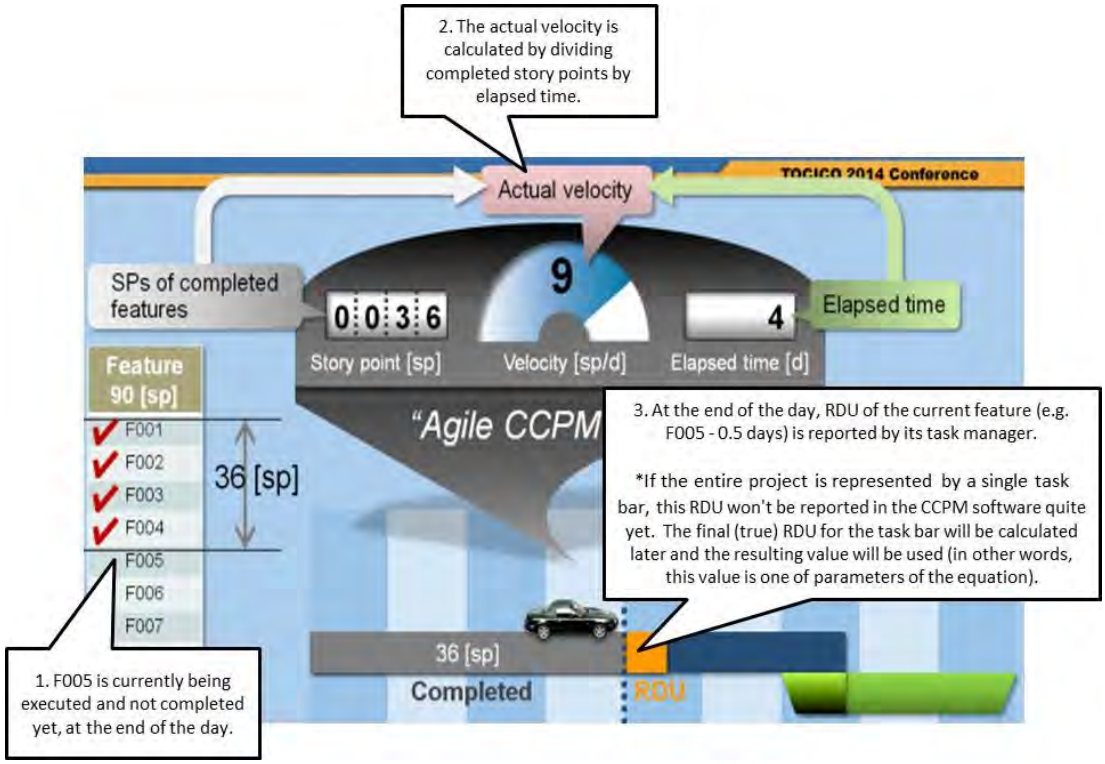


Figure 9 How to calculate actual velocity

3) As with standard CCPM, analyze the remaining chains and take actions as necessary to recover red buffers to yellow or green

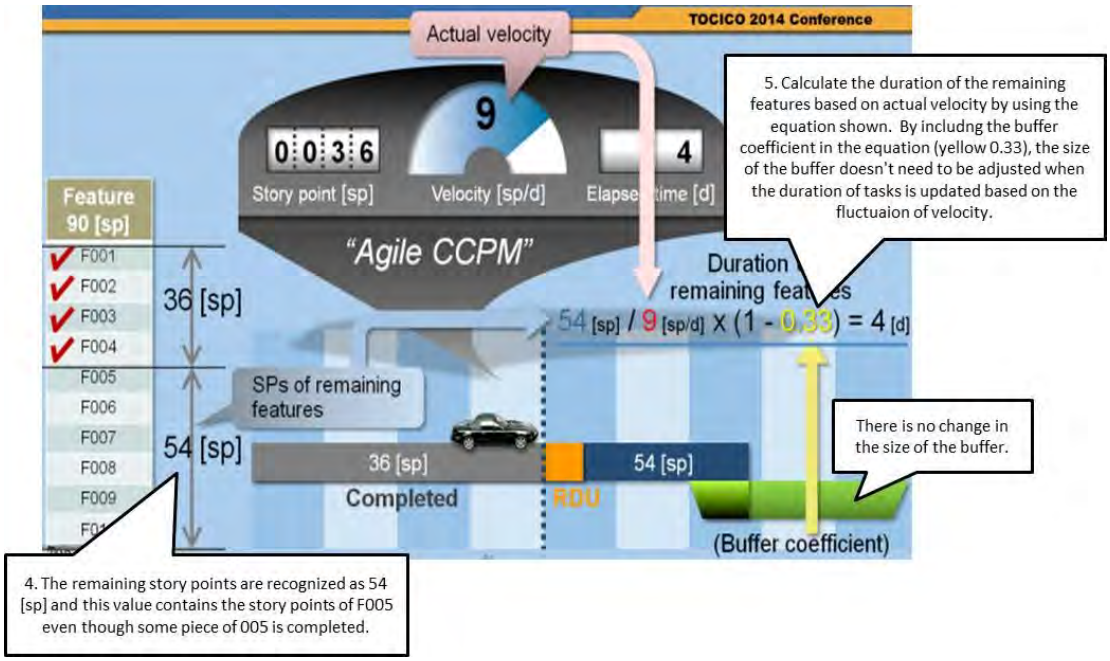


Figure 10 Calculating the duration of remaining features using actual velocity

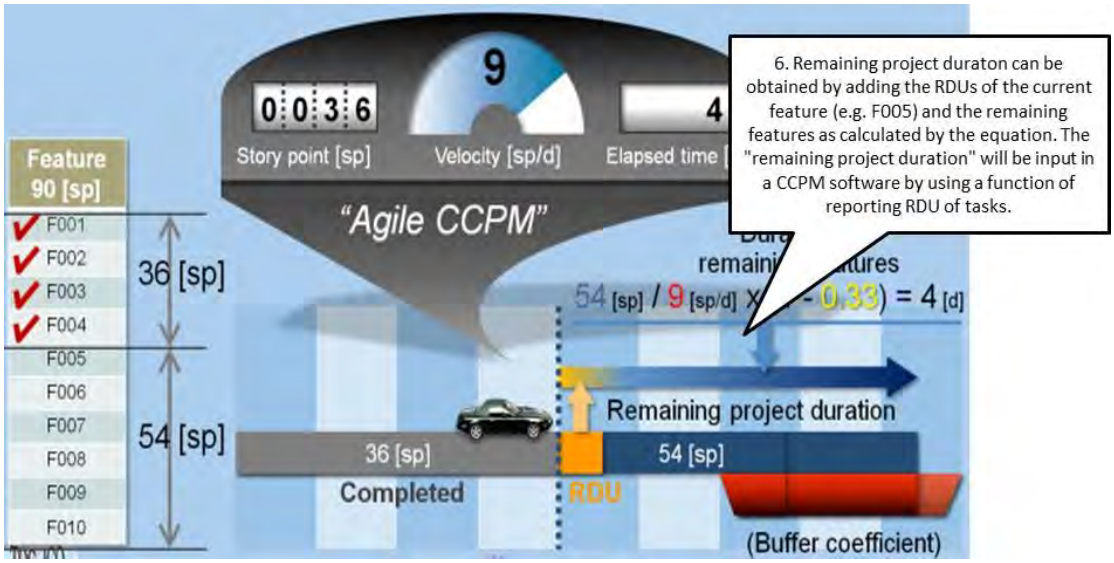


Figure 11 Calculating the remaining project duration. In this example, the buffer is shown notionally as changing to red per the new remaining duration.

Brief case study of "Agile CCPM" as applied in software development

This case study reflects the experience of Being Company Ltd. in Japan, the employer of one of the authors and main developer of Agile CCPM, Koichi Ujigawa.

Being Company Ltd. first began using CCPM for its project management in early 2005. Although some improvement was demonstrated, many difficulties remained, and the expected 95% on-time project completion rate was far from being obtained. Even though Being was using standard CCPM, DDP was less than 30%.

Amid these conditions, Being was faced with scheduling a major upgrade of their software. Because most of the source code had to be developed from scratch and historical performance data for such an upgrade was not available, the Absolute Time Estimation of tasks was extremely difficult, and thus creating a reliable CCPM schedule seemed nothing short of impossible.

Therefore, the development team had serious reservations about managing the project with CCPM, even though they still firmly believed in the power of the Theory of Constraints. The only thing they knew conclusively was that the project was much larger than anything they had attempted in the past, and the company was afraid that the project would badly miss its delivery schedule unless a solution was found and a change was made in the managing of the project.

Thus, while remaining committed to the principles of CCPM, in mid-2009 Being began to introduce ideas used in Agile methodology (e.g. Relative Size Estimation and "sprints", although it was subsequently learned that sprints are not necessary for Agile CCPM – see below), for its CCPM implementation.

Although some projects still missed their due dates in the early stages of Being's effort, DDP was improved gradually, and the resulting organic method known as Agile CCPM was fully developed and finally presented at the 2012 TOCICO International Conference.[36]

DDP had reached over 90% by the end of 2011, and with the perfecting of the Agile CCPM method, has been maintained at almost 100% in the subsequent years. A recent snapshot of Being's project performance, managed under "Agile CCPM", can be seen in Figure 11 below.

[36] Ujigawa, Koichi, Goldratt Foundation semi-finalist: "A New Buffer Management Approach for CCPM" 2012 TOCICO International Conference, http://c.ymcdn.com/sites/www.tocico.org/resource/resmgr/2012_foundation_pdfs/ujigawa,_koichi_final_a_new_.pdf

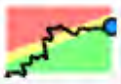
Name		% PB Consumed (PB Finish)	% CC Completed (CC Start)
Project A		39.7	100.0
Project B		12.2	100.0
Project C		39.7	100.0
Project D		99.8	100.0
Project E		63.0	100.0
Project F		90.8	100.0
Project G		85.1	100.0
Project H		69.7	100.0
Project I		69.9	100.0

Figure 12 Being Company Ltd's own completed software development projects, managed as per the process described in this paper. Certain business sensitive information has been obscured.

Conclusion

As with standard CCPM, it is important to plan for and assign optimal resources to tasks and projects as described in the Projects S&T tree (5.111.2)[37], and to ensure full kits (4.11.3 and below). Due to the optimal assignment of resources, full kitting, use of a scope buffer, and a proper stagger (Projects S&T 5.113.3), the project period is sufficient to yield on-time or early project completion.

"Agile" CCPM, a CCPM method for software development, delivers the adaptability provided by Agile, as well as the cost, delivery and scope performance afforded by CCPM. The result is greater than the sum of its parts, and much greater than the result of any existing methodology, including traditional CCPM or Agile alone. This allows a large new market sector of projects to be executed under the CCPM umbrella, further helping TOC to become the main way in business, and is therefore deserving for inclusion in the TOC Body of Knowledge.

[37] Projects Strategy & Tactics Tree, Goldratt, October, 2010

References

Critical Chain

Goldratt, Eliyahu M. 1997 *Critical Chain.* Great Barrington, MA, North River Press.

Goldratt, Eliyahu M. October, 2010 *Projects Strategy & Tactics Tree,* detailed in *The Critical Chain Implementation Handbook* by David Updegrove (below), and available from that author in Harmony software file format by request at davupde@msn.com.

Updegrove, David B. 2014 *The Critical Chain Implementation Handbook*. Createspace Publishing.

Goldratt's Change Matrix

Scheinkopf, Lisa, 2010 *Thinking Processes Including S&T Trees*, Chapter 25, *Theory of Constraints Handbook*, edited by James F. Cox III and John G. Schleier, Jr., McGraw Hill.

Fergusson, Lisa, *Applications of Strategy and Tactics Trees in Organizations*, Chapter 34, *Theory of Constraints Handbook*, edited by James F. Cox III and John G. Schleier, Jr., McGraw Hill.

Barnard, Alan, 2016 *The Change Matrix Cloud Process,* Draft White Paper, TOCICO White Paper Series, TOCICO.

"Agile" CCPM

Ujigawa, Koichi. *A new buffer management approach for CCPM.* TOCICO International Conference 2012, Chicago, Illinois, USA http://www.tocico.org

Ujigawa, Koichi. *A new buffer management approach for CCPM.* Encore presentation. TOCICO International Conference 2013, Bad Nauheim, Germany http://www.tocico.org

Ujigawa, Koichi. *Agile CCPM*. TOCICO International Conference 2014, Washington, D.C., USA http://www.tocico.org

Solving That Problem

That's Plagued You Forever

Most problems remain unsolved, not because of Ignorance but rather because of inertia (resistance to change) when we over-estimate the cost or Risk of Change or underestimate the benefits of change.

A new method – the ProConCloud – provides a possible fast track to identify and challenge those limiting assumptions that can cause avoidable decision mistakes within our lives, organizations, and society.

By Alan Barnard, PhD

Why can't you lose that extra weight? Multitasking? End a dead-end relationship? Achieve your New Year's resolutions?

Why can't organizations stop silo-thinking and local optimization? Why can't they overcome resistance to change? Stop management from fire-fighting and multitasking when it just makes things worse? These are what researchers call 'chronic problems': the undesirable behaviors and effects that plague individuals and organizations for years, won't go away by themselves, and, over time, causes stress, disharmony, lowering of expectations, and creating a perception that they are unsolvable.

Some chronic problems might be unsolvable because we simply do not (yet) understand their underlying causes and/or possible cures. However, a large percentage of chronic problems remain, despite proven knowledge about their negative consequences on all stakeholders, their reason (s), and the required changes to solve or substantially reduce their impact. Therefore, when failures are not due to a lack of relevant knowledge about the causes or cures, but rather a lack of acceptance of and/or proper application of available knowledge, it is a failure of change management rather than a failure in problem-solving.

The Chronic problem of dealing with Chronic problems

As a recognized discipline, change management has been in existence for over half a century. Yet despite the considerable investment that companies and individuals have made in change management tools, training, coaching, and self-help books (well over 100,000 on Amazon), most studies still show a 60-70% failure rate for organizational change projects — a statistic that has stayed constant from the 1970s to the present[1]. Furthermore, when we look at the failure rate of our personal change initiatives, such as our failure rate in achieving our "New Year's Resolutions," the situation is even more dire – studies show a failure rate of 80-90%.

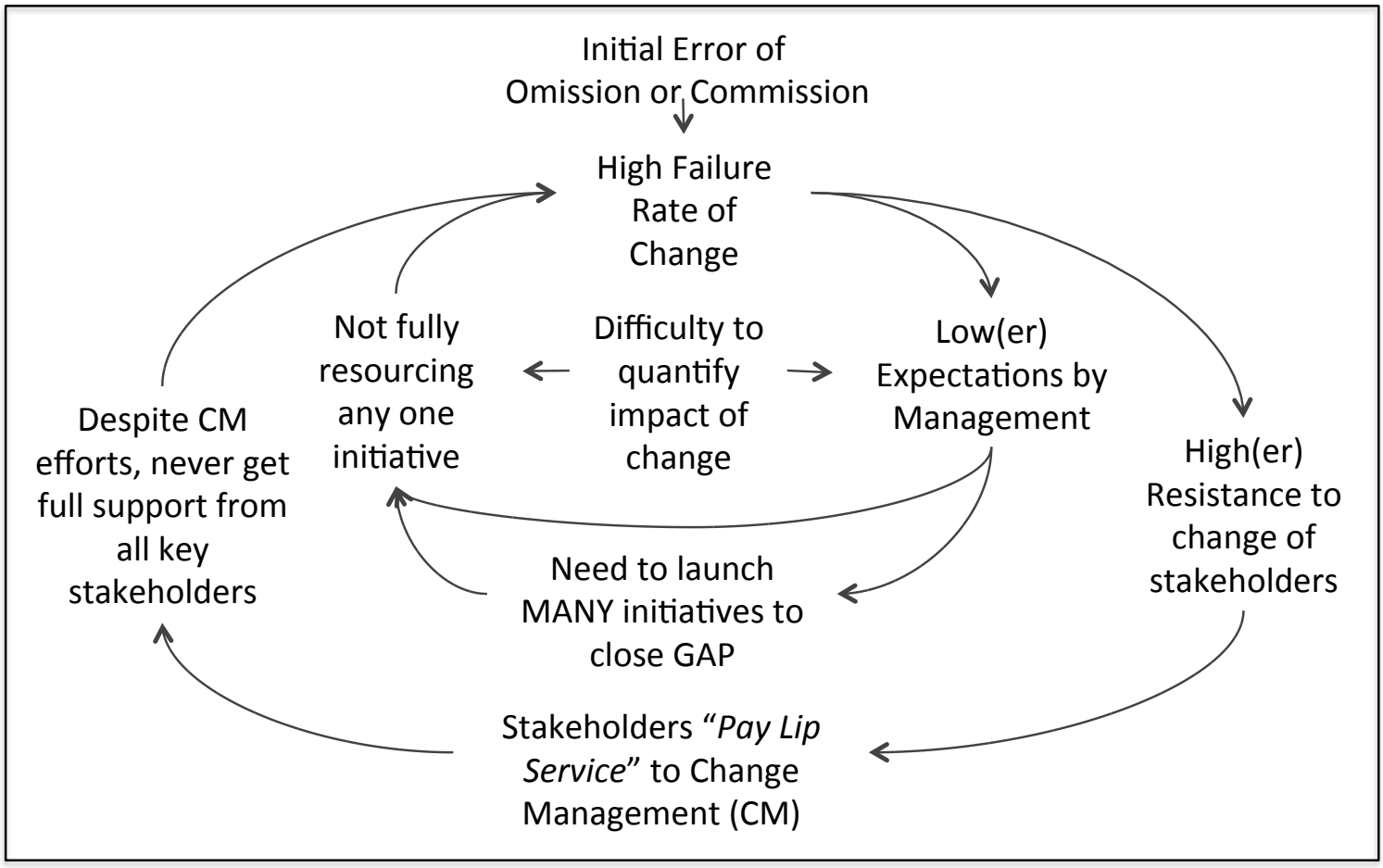
None of us expect a 100% success rate, but surely it should be at least theoretically possible to (substantially) improve on the current 30-40% success rate? Agree? If so, what is stopping a significant breakthrough in this field, and are any of these causes avoidable?

Whenever we see such significant failure rates, there is likely some vicious cycle at work where actions are taken to correct a situation that has the opposite effect. The following section provides insights into the malicious processes seen in many organizations that are not improving at the desired rate or within those that no longer exist (i.e., the ones that experienced catastrophic failures).

[1] [1] Ashkenas, Ron, Change Management needs Change, HBR Blog Network, April 16, 2013

When a specific behavior is both a consequence and a cause, it means the system is likely to be stuck in a vicious cycle (Senge 1990), such as shown in Figure 15-3 below. The higher the failure rate, the higher the resistance and the lower stakeholders' expectations. And the higher the resistance and the lower the expectations, the more likely those necessary changes will be blocked and/or that necessary changes will not receive the full support and resources needed to make them a success, which again increases the probability of failure. Over time, a vicious cycle such as this stabilizes, and soon those trapped within the cycle conclude that a response of "it will never work" is a safer response than embracing new changes or that simply, considering the complexity and uncertainties within their system, this (high failure rate) is probably the best they can do.

This fear related to the high failure rate of changes can also explain why changes that focus on local cost, waste, or process variation reduction (low-leverage changes) are more likely to be supported since they are perceived to be lower risk and more certain. In contrast, high-leverage changes that focus on "changing the rules" are less likely to be supported since they are considered to be high disk and less certain.



Unfortunately, the high reported failure rate has resulted in change management approaches evolving to become more and more complex – having more and more steps and checks to ensure all stakeholders are included – which add time to implementing changes and puts a significant burden on management attention. These are likely major contributors to why the

success rate has not improved substantially over time. What is needed is not a more complex solution, but one that is simpler, faster, and requires less of the scarcest resources of the organization – management attention – to implement and sustain.

This paper aims to offer new insights on why it's so hard to improve the success rate of organizational and personal change and introduces a new process, called the ProConCloud, which targets directly the five most common mistakes that contribute to the chronic problem of overcoming chronic problems that require behavior change.
The ProConCloud builds on the ground-breaking work of giants such as Benjamin Franklin, Dr. Daniel Kahneman, Dr. Barry Johnson, Dr. Robert Kegan, and Dr. Eli Goldratt. Through extensive field testing over the past five years, it has shown to be effective in helping people identify and challenge the limiting assumptions blocking them or others from solving chronic problems and/or making the desired behavioral changes needed within their organizations or personal lives.

Is it possible to develop a simpler, faster change management process with a potentially higher success rate that can be applied without major external guidance and/or demand on management attention?

Chronic problems and their underlying causes

Chronic problems are those types of problems within our lives, organizations, and society we're consistently unable to solve, despite our best efforts. In the 1970s, the philosophers Samuel Gorovitz and Alasdair MacIntyre published an article[2] on medical fallibility. They sought to develop a theory that could increase our understanding of why medical errors occur, to help distinguish between intentional (culpable) and unintentional (innocent) errors and recommend more rational responses to medical errors that can result in harm and claims of guilt, compensation or sanction. Anul Gawande quoted this study answering a wider question - 'Why do we fail at what they set out to do in the world?' The authors claimed that one reason why medical doctors make medical errors was "necessary fallibility" – some things we want to do are simply beyond our capacity. However, for all the many areas where we can solve problems and achieve other desired goals, Gorovitz and MacIntyre cite two reasons why we nonetheless fail. They claimed that the traditional classification of the causes of such "medical errors" are either due to the limitations of the present state of that science – i.e., due to Ignorance - or from the willfulness or negligence of the medical doctor - i.e., ineptitude. They argued that this view that Ignorance and ineptitude are the only sources of error has been transmitted from the pure to the applied sciences, and then, more specifically, from medical science to medical practice.

[2] Gorovitz S, MacIntyre A. Toward a Theory of Medical Fallibility. The Journal of Medicine and Philosophy 1976; 1:51-71

Could we apply the lessons learned from studying medical errors to management or personal decision errors?

Has this also happened in the science of change management? If a change project fails to achieve the expected outcomes, do we tend to blame either Ignorance or ineptitude? Stated differently, looking at how we try to address the low success rate, do we think more research (to develop the knowledge), more education (to transfer the knowledge), or training (to ensure knowledge is applied correctly via instructions or checklists) is almost always the cure?

The first is Ignorance or lack of knowledge; we can claim we really did not know about the existence or extent of a problem, or that there might be a way (maybe even a simple way) to solve the problem. We know the cause of an avoidable decision error was Ignorance when increased knowledge about the existence, extent of, and/or solution to the problem is sufficient to prevent or reduce such decision errors in the future.

The second type of failure is caused by what the philosophers called ineptitude, a lack of ability or skills to apply the available knowledge successfully − we did have (or could easily acquire) knowledge about the problem, its extent, and possible effective solutions, yet we ignored it or failed to apply it correctly.

When it comes to malpractice lawsuits, we can't hold doctors liable if someone dies of a disease for which there is no known cure. In the same way, we should not hold management accountable if we don't know the cure for a problem like market downturns. But what if there is a cure or way to protect yourself against the disease, but these were not implemented? Then it seems we can always hold the doctor (or manager) accountable. Ignorance – they should have kept up with new knowledge (education problem). Ineptitude – they should have learned how to properly apply the knowledge (training problem). Patient selection wrong option – the doctor should have explained it better.

Dr. Atul Gawande shared compelling research in The Checklist Manifesto[3] to show that for most of history, we've failed because of Ignorance. We had only a partial understanding of how things worked. For example, in "Taking the Medicine," Druin Burch writes, '*Doctors, for most of human history, have killed their patients far more often than they have saved them* .'We used to know very little about the real causes of why we get ill and even less about how to treat, cure or prevent these. For the most part, that's changed. Over the last few decades, our knowledge in medicine, as in most other sciences, has seen exponential growth in understanding the causes, full consequences, and effective solutions. Gawande, therefore, argued that this advance means

[3] Gawande, Atul, The Checklist Manifesto: How to Get things right, Picador Publishing, 2011.

that ineptitude now plays a much more central role in failure than ever before and has shown to what extent a simple checklist can dramatically reduce failures due to ineptitude. Gawande proposed two simple solutions to address ineptitude. A checklist and shared responsibility. E.g., A nurse not only has the right to point out errors of commission or omission to managers but has the responsibility to do so.

This leaves us with two inconsistencies. First, why, despite the growth in knowledge that should reduce failures due to valid claims of Ignorance and more education and training on simple, practical solutions like checklists to prevent failures due to ineptitude, has the success rate of change not substantially improved since the 1970s? And why do we still mostly blame Ignorance when we see others doing things they should not or not doing the things they should?

If not **Ignorance or ineptitude, then what or who should be blamed?**

It is common to blame Ignorance or ineptitude for most chronic problematic behaviors like smoking, over-eating, littering, driving under the influence, practicing unsafe sex, or not taking medication exactly as prescribed. It is also true for organizations to blame failed product launches, mergers, or downsizing on either Ignorance or ineptitude. When we assume Ignorance as the leading cause, we assume the person or group of people are not changing their behavior either because of their lack of knowledge about the existence and/or extent of the problem itself, the underlying root causes of the problem, and/or how to change their behavior to one with less undesirable effects and more desirable effects. If we know they are no longer ignorant and have received training on the "how-to," and they still do not change their behavior, we tend to blame their "lack of willpower."

We can argue that a "lack of willpower" is also a type of Ignorance or ineptitude. Specifically, Ignorance about the cost vs. benefits of the desired change or the unwillingness to incur the cost to obtain the benefit. Either they are over-estimating the costs or under-estimating the benefits. As such, the common "change management" way to change problematic behaviors related to chronic problems is to educate people about the existence and negative consequences of the problem to them and others they care about, what behavioral changes they need to and can make to solve the problem and why the benefit will outweigh the costs and effort to make the change.

But are those of us with bad habits such as smoking, over-eating, littering, practicing unsafe sex, or not taking medication precisely as prescribed ignorant or lack the willpower to stop? You'd certainly think so if you look at how experts, organizations, and governments try to solve these types of problems through more and more education, support programs, and more graphical warnings about the consequences of not changing.

It is quite concerning that it is frequently relatively easy to disprove a claim that Ignorance is the leading cause. For example, if Ignorance about the cause and/or solution for bad habits like smoking were really to blame, then surely doctors, who have the best knowledge about these would

never smoke or at least have a MUCH lower percentage of smokers than when compared to the rest of the population. Right? Would you be surprised to know that the percentage of doctors[4] who smoke is not much less than in the general population or that the percentage of doctors who smoke exceeds the percentage of medical students who smoke? The same is true for obesity rates[5] amongst doctors compared to the general population and medical students.

If Ignorance were the underlying cause, we would change our problematic behaviors once we gained the relevant knowledge to address our valid claims of "I didn't know" or "I didn't know how ."Right? But we don't. And because we don't, our "educators" and lobbyist can continue to argue, "You see, we haven't provided enough education yet. Let's invest even more resources in education, support programs, or graphical advertising campaigns. This can result in unproductive negative cycles that waste scarce resources and is difficult to escape from. This vicious cycle persists when decision-makers never question their starting assumption that Ignorance or unwillingness to change problematic behaviors are the primary cause for chronic problems

But how then do we explain why we or others will sometimes keep doing things we know we should not do or resist making the changes we know we should? Dr. Russ Ackoff, considered the father of systems thinking, called these decision errors of commission (doing what you should not) and omission (not doing what we should).

A new hypothesis – Unresolved Conflict due to Inertia, Loss or Risk aversion biases

A growing body of research in the field of Behavioural Economics has challenged the traditional "rational-based" economic theory that claims we make errors of commission or omission mostly because we simply under-or over-estimate benefits or costs related to the required changes. This new field combines[6] research from economics - the science of how and why resources are allocated by individuals and collective institutions like firms and markets, with research from psychology aimed to understand individual and group behavior. Behavioral economics seeks to use evidence-based psychology to inform economics, ensuring maintenance of an emphasis on applying the scientific method, mathematical structure, and explanation of field data that distinguish economics from other social sciences.

Two of the new Behavioural Economics findings[7] that relate to understanding why the traditional "Stop this; start that" education approach to chronic problems fails are:

[4] H.J. Waalkens et al, Smoking habits in medical students and physicians in Groningen, The Netherlands, Eur Resplr J 1992, 5, 49-52

[5] Khawla M. Al-Madani, Obesity among Medical Practitioners and Medical Students in Bahrain, Bahrain Medical Bulletin, Sept 2000

[6] Camerer, Colin, Behavioral economics: Reunifying psychology and economics, Proc. Natl. Acad. Sci. USA, Vol. 96, Sep 1999

[7] Gal, David, A psychological law of interia and the illusion of loss aversion, Judgment and Decision Making, Vol. 1, No. 1, July 2006, pp. 23–32

- *We continue to do or change things we know we shouldn't* because of our inertia biases (which can be confused as complacency or apathy) and/or neglecting to consider the total opportunity cost of continuing such actions.
- *We don't do or change things we know we should* because of our "loss" and/or 'risk aversion' biases that cause us to favor the status quo and dislike losses much more than we like gains of similar size when faced with two or more change choices.

Standing on the Shoulders of Giants

To develop a breakthrough in any field, such as finding better, faster, and simpler ways to understand better and address the underlying causes of solvable chronic problems, we should stand on the shoulders of giants, as recommended by Isaac Newton. We should look at the giants' solutions, pay respect by understanding why these worked in some areas but not in others and/or have not been adopted more widely in other areas where they could bring benefit, and then challenge their basic assumptions.

There are several giants in the field of understanding the psychology of resistance to change and what methods can help to overcome the status quo bias and/or loss or risk aversion biases when these result inChangee decision errors – not changing when we should or changing when we should not. Most notable is the work of:

- Dr. Daniel Kahneman and Dr. David Schkade collaborated to develop the notion of the focusing illusion[8] (Kahneman & Schkade, 1998 to explain in part the mistakes people make when estimating the effects of different scenarios on their future happiness (also known as affective forecasting, which has been studied extensively by Daniel Gilbert). The "illusion" occurs when people consider the impact of one specific factor on their overall happiness; they tend to greatly exaggerate the importance of that factor while overlooking the numerous other factors that would, in most cases, have a more significant impact

- Dr. Barry Johnson[9], who posed the question of *"Is this a problem we can 'solve,' or is it an ongoing polarity we must manage well?"* Dr. Johnson demonstrated that applying traditional problem-solving skills will worsen the problem rather than help resolve it in cases of a polarity. However, the Polarity Management™ model, polarity map, and set of principles he developed can, through the guidance of trained coaches, help an individual distinguish between solvable problems and polarities, and help leaders effectively manage those polarities most important to their organization's success.

[8] Schkade, D. & Kahneman, D. (1998). Does living in California make people happy? A focusing illusion in judgments of life satisfaction. Psychological Science 9, 340.

[9] Johnson, Barry, Polarity Management: Identifying and Managing Unsolvable Problems, H R D Press, June 2014.

- Dr. Robert Kegan and Dr. Lisa Lahey[10] uncovered a hidden phenomenon that can prevent us from making the changes we know we should - a dynamic they call *"the immunity to change* ."They have developed a simple process that experienced coaches may use to guide an individual through identifying and challenging key assumptions holding them back from making the changes they intend.

Another giant, more known for improving organizations than in understanding the psychology of change, was Dr. Eli Goldratt, creator of the *Theory of Constraints*. In the Introduction to his best-selling novel *The Goal*[11], Dr. Goldratt said we could make breakthroughs in any field we're passionate about (including solving chronic problems) by following just two steps:

- **Step 1:** Have the courage to face (significant or consequential) inconsistencies.
- **Step 2:** Have the wisdom to challenge basic assumptions related to these inconsistencies.

What are inconsistencies? Simply put, they're gaps between our expectations and reality.

In science, "inconsistencies" are essential as they show that our understanding or explanation of how things work or why things work needs improvement. They're important as a feedback mechanism in life because they also point to areas that require improvement – those expectation gaps that cause anxiety, stress, and disharmony between people.

And what assumptions should we challenge? Either those 'bad' assumptions on which our (unrealistic) expectations were based or the 'bad' assumptions on which our insufficient or inappropriate actions to realize these expectations were based.

An Inconsistency and Assumptions to Challenge

Considering the poor success rate and poor return on investment of most of the past attempts by individuals, organizations, and governments to reduce their most consequential chronic problems, we could challenge the assumptions that ambitious targets to reduce these were simply unrealistic. Therefore we must lower the targets or give ourselves more time. Just think about all those government targets meant to be achieved by 2000; when they were not achieved, they simply became the 2010 targets and then the 2020 targets. We do the same when we "rollover" the same New Year's resolutions each year. We think that if we just give ourselves more time, we could achieve these using the same approaches as before.

[10] Keagan, Robert and Lahey, Lisa, Immunity to Change: How to Overcome It and Unlock the Potential in Yourself and Your Organization, HBR Press, 2009

[11] Goldratt, Eliyahu M., The Goal: A Process of Ongoing Improvement, New York, North River Press, 1984.

When should we start challenging the assumptions that our past actions were insufficient or appropriate to achieve our targets? One would assume that because of the publication in popular media, more and more of the research findings from new fields such as Behavioral Economics, policymakers, self-help gurus, and personal coaches would be quick to adopt the new insights of our status quo, loss, and risk aversion biases into better decision support techniques. Unfortunately, few of these new insights have been adopted into the common methods and "how-to" methods used by policymakers and individuals to improve their decision-making. As a result, the chronic problems persist, for which many of the underlying causes and remedies are now known.

Criteria for a better way

1. Bring excellent results – outside the normal noise/variation of using existing methods.
2. Be based on better Win: win for all stakeholders – i.e., win for one and lose for another. The win does not mean getting what you want; just more of the things you want and/or less of what you don't.
3. Reduced risk when measured by considering both probabilities of failure/success AND impact of failure and success.
4. Simpler than before (else it will not be used or adopted widely).
5. Each substantial step in the process must bring benefit – either validating or invalidating an assumption about the question the step aims to answer.
6. Must not self-destruct.

Standing on the holders of giants

There are three methods the ProConCloud method, developed by the author, is directly based on—the Pros Cons List of Benjamin Franklin. And the Change Matrix and Evaporating Cloud methods of Dr. Eli Goldratt.

In 1770 Benjamin Franklin shared his Pros Cons list method with a friend asking for advice to make a good decision on whether to accept a new job or not.

In the 1980s, Dr. Eli Goldratt created the Theory of Constraints to help organizations achieve ongoing improvement by focusing their improvements on their system constraint(s). However, he was soon frustrated with the resistance to change he experienced to this new approach. He realized that to improve the success rate and speed of Theory of Constraints implementations, he had to understand better why people resist change - especially those changes they knew would be good for them and others – and provide them with the thinking processes to overcome these. As part of this quest, he developed several thinking processes, of which two are particularly relevant to the resolution of chronic problems caused by our Ignorance or ineptitude.

These are the Change Matrix and the Evaporating (or Conflict) Cloud methods.

To understand why, despite their many published successes, these methods are not more widely used in solving problematic behavior and other chronic problems, it is important to understand both the benefits of these methods and their limitations.

Goldratt's Change Matrix (CM)

The Change Matrix[12] developed by Goldratt in the late 1990s provides a practical method of understanding resistance to change and/or preparing to achieve stakeholder buy-in for a proposed change, especially if the change is a breakthrough likely to be met with significant active or passive resistance.

The Change Matrix builds on the simple Pro Con List method proposed by Benjamin Franklin[13] in a letter to a friend in 1772 by not only looking at the Pros vs. Cons of a Change. Goldratt suggested we should also list the Pros vs. Cons of Not Changing (the status quo). This additional dimension can help uncover hidden assumptions that would not have been exposed otherwise.



Figure 1: Goldratt's Change Matrix

Figure 1 shows the four aspects related to any Change within the CM.

To provide a memorable reference[14] for these, Goldratt used the analogy of a person feeling pressured to climb a mountain (the Change) for two reasons:

1. First, there is the opportunity to reach the **'Pot of Gold'** on top of the mountain - **the positive of the Change**.
2. Second, there is the pressure to escape the **'Alligator'** at the base of the mountain – i.e., to eliminate **the negative of not changing**.

So why wouldn't a person climb the mountain (make the Change) if there was a large alligator at the bottom and/or a pot of gold at the top?

Goldratt suggested that we look at the two reasons which pressure someone *not* to change:

[12] See definition for Change Matrix under "Change Analogy" in TOCICO Dictionary at www.tocico.org

[13] http://www.procon.org/view.background-resource.php?resourceID=1474

[14] https://www.youtube.com/watch?v=9T_WB--wAxU

1. First, the person does not want to give up on or leave behind a '**Mermaid**' they've fallen in love with at the base of the mountain - **the positive of not changing**.
2. Second, they risk '**Crutches**': falling and breaking their legs if they try to climb but slip and fall - **the negative of the Change**.

As an example, Goldratt's CM can be used to understand the four competing forces relating to stopping a bad habit such as smoking.

The Change Matrix and Smoking

The pot of gold and alligator are normally easy for any smoker to define. They might verbalize the positive of the Change (pot of gold) as "better health" or "lower risk of lung disease" while verbalizing the negative of not changing (alligator) as "My family continue to complain about my smoking" or "I continue to feel guilty about my smoking ."Changing will get them away from these alligators.

Interestingly, when we ask a smoker to verbalize the positive of smoking (the mermaid they don't want to give up), they frequently misunderstand the question, typically verbalizing their mermaid as a positive of *stopping*, not a positive of *smoking*. This is how they're conditioned to think and respond to a 'disruptive' question that poses an unusual, unexpected challenge. Once they realize what you are asking, they'll say, "Smoking offers me an effective way to cope with stress."

By the same token, when we ask the smoker to verbalize the negative of quitting (the crutches), they're surprised. This is not what they expected you to ask. No one who is trying to change behavior usually asks questions like this. And that's why the CM works: the simple fact of considering the limiting assumptions is often completely new and unexplored.

As mentioned, the Change Matrix was designed to help both those who initiate a change and those who resist a change to understand resistance to change or bad past compromises.

The advantage of this method is it can provide a simple checklist for understanding the likely loss or risk aversion, which can be blamed on the ineptitude and result in inertia. But it also has a limitation: what if the four assumptions all appear valid? What if the positives of changing and the negatives of not changing appear matched by the positives of not changing and the negatives of changing?

To decide what to do, we need a way to resolve such "Change vs. Not Change" conflicts. Goldratt developed his Evaporating Cloud or Conflict Cloud method to address such situations.

GGoldratt'sEvaporating Cloud (EC)

Goldratt's Evaporating Cloud was designed to provide a practical way of resolving conflicts by identifying and challenging the basic assumptions responsible for the conflict.

Figure 2 presents the structure of the Evaporating Cloud, with Box A representing the objective we are trying to achieve, Boxes B and C the requirements for achieving these objectives (system needs), and Boxes D and Not D (D') the conflicting prerequisites or actions (e.g., Change vs. Not Change) to achieve each need.

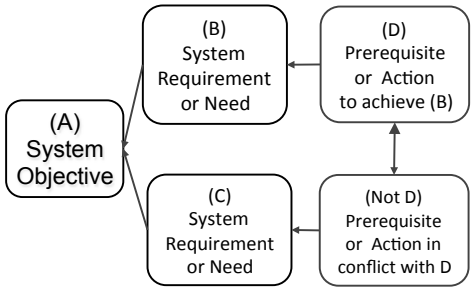


Figure 2:

Goldratt's Evaporating Cloud

The Evaporating Cloud and Smoking

An example of a typical conflict is:

To (A) be happy, I must have good health (B), which requires that I feel pressure to stop smoking (D). At the same time, too (A) be happy, I must (C) have an effective way to cope with stress, which requires that I (Not D or D') feel pressure to continue to smoke. The problem, verbalized as a conflict, is whether to stop smoking or continue smoking.

The EC was a breakthrough, not only in defining a problem as an unresolved conflict, but also in helping people find ways to resolve it, not by the "mental arithmetic" method used in Franklin's Pro-Con list, or even Goldratt's CM, but by identifying and challenging basic assumptions (between A-B, A-C, B-D, C-D, and D-D') that could enable a simple win-win resolution.

The Limitations of Both Methods

There are many documented success stories within the reference bank of TOCICO[15] to show the benefits that the CM and EC methods bring when applied to applications, as varied as allowing kids to resolve their conflicts to using it to better prepare for sales meetings. However, both unfortunately also have significant limitations that have constrained their success and adoption rates:

1. The Change Matrix helps us better understand the four competing forces at play but doesn't give a practical mechanism for deciding when the forces for and against the Change seem balanced.

2. The Evaporating Cloud helps us verbalize a problem as an unresolved conflict and offers a method of identifying and challenging assumptions that could resolve it. Yet it ignores the likely negative of changing and the negative of not changing, either of which could block us from

identifying a win-win solution. It also offers no guidance on which of the assumptions underneath each of the five logical connections can, if challenged, resolve the conflict.

So, is it possible to design a thinking process that addresses the limitations of both the Change Matrix and the Conflict Cloud while maintaining the benefits of both? Moreover, could individuals apply the new thinking process without the guidance of a facilitator or coach?

Yes. If we combine them into a simple step-by-step process that anyone can follow.

The ProConCloud (PCC) Method

The PCC represents the decision conflicts we face due to the four competing forces related to any Change vs. Not Change, or Change A vs. Change B, a decision that can result in persistence or worsening the problem, Ignorance or ineptitude.

Designed to meet the ambitious target of combining the best of the CM and EC while overcoming their limitations, it seeks to offer a complete, simple and systematic process for analyzing and solving the chronic problems caused by these avoidable mistakes.

To achieve this, the complete PCC process must overcome five common mistakes and their consequences:

1. Working on a not actual or consequential problem wastes our scarcest resources.
2. Not verbalizing the unresolved conflict(s) related to this problem and thereby facing the risk of selecting a solution that is one side of a conflict (e.g., go for centralization vs. realizing the unresolved conflict of centralizing vs. de-centralize)
3. We were ignoring one or more critical assumptions that block the conflict's resolution, thereby limiting our options within our current biases.
4. Ignoring valid reservations could result in a "half-baked solution" delivering only partial benefits and/or resistance to change that can block an implementation. These reservations are often expressed as 'Yes, buts,' relating to:
    a. insufficiency of the new solution to be a win for all stakeholders,
    b. potential negative consequences of the new solution, and/or
    c. implementation obstacles
5. Not effectively communicating the complete solution to those who need to apply it, with clear measurements of success and failure (what good and bad look like) can result in poor implementation, bad compromises, or not learning from experience

The PCC process consists of five steps to prevent or reduce the effects of these five common mistakes.

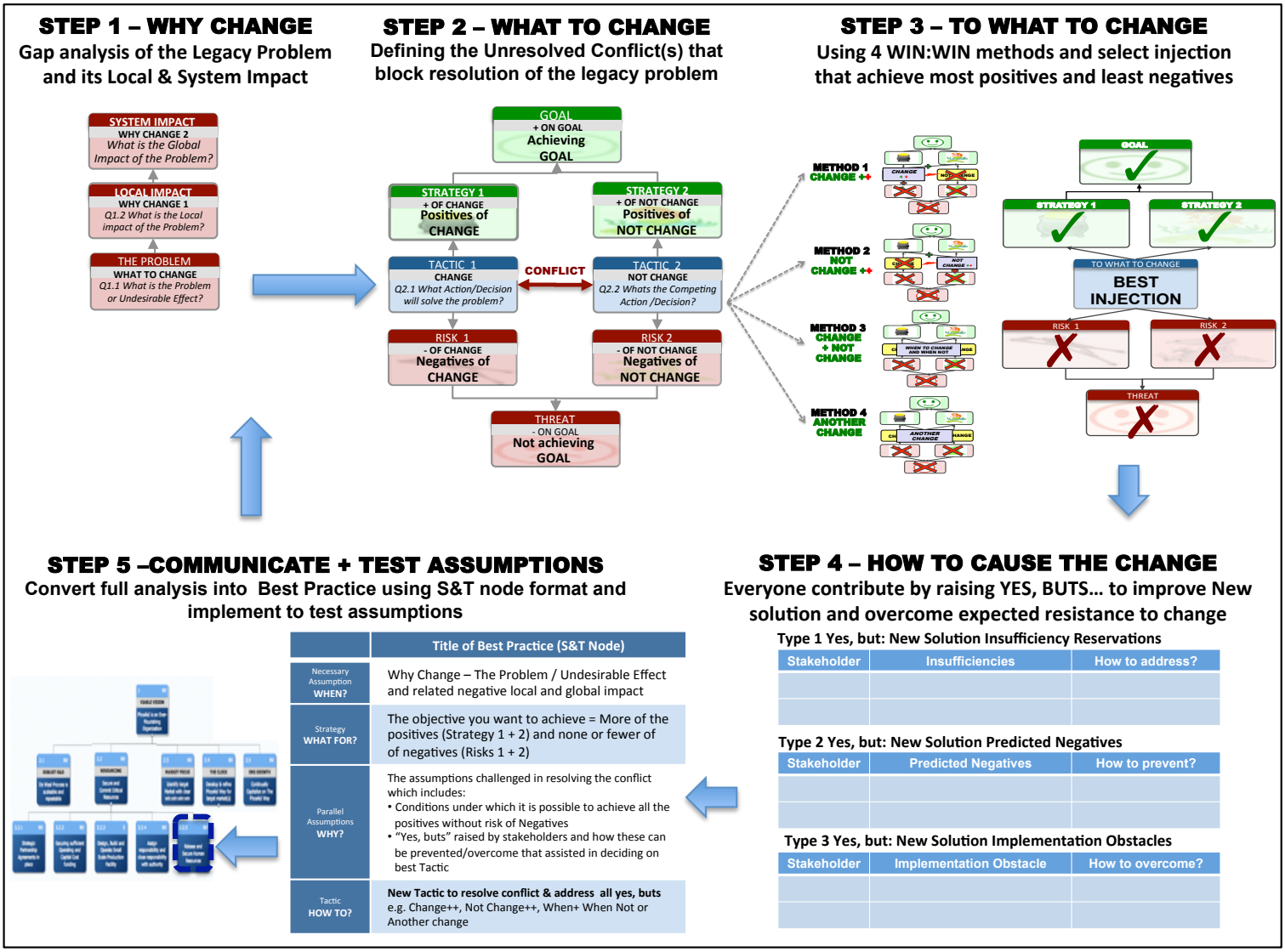


Figure 3: The 5-Step ProConCloud Method

Figure 3 above shows a schematic of the five steps of the PCC process, with the appropriate questions that guide the user through the five steps. The steps are outlined next before a complete worked solution to a typical problem is presented.

The 5 Steps of the ProConCloud Process

Step 1: Gap analysis to validate the importance of the problem

Why change? *What is the problem or undesirable effect, and why is it bad for all stakeholders"?* This is answered by defining the problem and predicting the negative impact on you or your part (the local impact) and the rest of the system (the global implications).

This step is aimed to eliminate Ignorance of the problem, its extent, and/or consequences of the problem as a cause for the problem not having been resolved before.

Step 2: Conflict analysis to define the problem as an unresolved ProConCloud

What to change? *What action do you feel pressured to take to resolve the problem (Change Box)? What is the Status Quo (Not Change Box) or the other Competing Change (Competing Change) that puts you in a conflict? What are the positives and negatives related to each?*

This is answered by verbalizing the problem as an unresolved conflict and identifying four possible sets of assumptions that will later be challenged (Positive of Change, Positive of Not Change/Competing Change, Negative of Change, and Negative of Not Change/Competing Change).

Step 3: Conflict resolution to identify and challenge limiting assumptions/beliefs, using Barnard's four methods for resolving any conflict:

To what to change? *What are the assumption(s) that block each of the four possible solutions to resolve the conflict, and which of these, if challenged, provide the best way to achieve more positives and less/fewer negatives?*

This is answered by resolving the conflict through applying each of the four methods below, and at the end, selecting the one (or a combination?) which gives the most positives (pot of gold, mermaid) and the least negatives (alligator, crutches). Each method is framed as a critical question or questions that force the decision-maker to think more creatively about a solution, breaking the preconceived assumptions that have hitherto locked them into the conflict.

- Method 1: Change Plus Plus (Change ++)
  If I decide to change, what can I ADD to ensure it does not jeopardize my valid current mermaids (1st Plus) and to ensure it does not result in any real future crutches (2nd Plus)…
- Method 2: Not Change Plus Plus (Not Change ++)
  If I decide to 'Not Change,' then what can I add to the "Not Change" or "Competing Change" to ensure it does not jeopardize my future desired pots of gold (1st Plus) and to ensure it does eliminate all the current alligators (2nd Plus),…
- Method 3: When To Change vs. When Not To Change
  Under what conditions should we decide to change, and under what conditions should we Not? This gives us a new rule of something like "As long as [current condition], do not change, but as soon as [new condition], then change."
- Method 4: Another Change
  Is there another change that does not relate to the current change that could offer more of the desired positives with fewer negatives?

Step 4:

'Yes, But' analysis to identify reservations that can compromise implementation

Say we've selected Method 1: Change ++ as providing the best solution to our chronic problem. Now: how to improve it?

Write down your and other stakeholders' possible reservations or Yes-Buts for resisting this solution, and then how to prevent or overcome these (the Yes-And), based on three classifications:

- **Insufficiency** – "Yes, I like the solution, BUT I think it's insufficient when it comes to [insufficiency reservation], so we'd need to add this [additional change] to ensure it worked."
- **Potential negatives** – "Yes, I like this solution, BUT if we implement it, it could negatively impact this stakeholder in this way [potential negative side effect or unintended consequence]. So we should also do this [additional Change] to prevent this side effect from happening, so we achieve our goal."
- **Obstacles** – "Yes, I like this solution, BUT some obstacles are blocking me/us to implement it [obstacle reservation], and this [additional change] is what is needed to overcome these obstacles…."

Step 5:

The Best Practice definition (See *Figure 4* below) summarizes the complete analysis so we and others can validate and/or contribute to improving the assumptions for current and future use.

How do we know this will work?

To allow others to check our analysis and solution, we should answer the following questions:

- Why is this Change needed (the assumptions of the necessity of the Change)?
- What is the specific objective (the strategy of this Change)?
- Why is the Change possible but difficult or risky (the assumptions we challenged in resolving a the change conflict)?
- How can we best achieve/implement this Change (the Change tactic)?

Step 5
Communicating full analysis as new Best Practice

	Title of S&T Node (Best Practice)
Necessary Assumption **WHEN?**	***The need for the change:*** What is the problem or undesirable effect that created the need for a change and why is this problem bad for the part (local impact) and bad for the system as a whole (system impact)
Strategy **WHAT ?**	***The objectives of the change you want to achieve:*** More of the positives (Strategy 1 + 2) AND none or fewer of of negatives (Risks 1 + 2)
Parallel Assumptions **WHY?**	The assumptions challenged in breaking the conflict which includes: •Conditions under which it is possible to achieve both S1 and S2 without R1 and R2 •Potential Insufficiencies, Negative Branches and/or implementation obstacles that will make implementing a solution risky or difficult that was considered to decide on the best Tactic
Tactic **HOW?**	The New Tactic to resolve the conflict with a win:win selecting the solution from using one of the four methods e.g. Change++, Not Change++, When+When Not or Another change

Figure 4: The 5th Step of the ProConCloud Method

The 5th Step of the ProConCloud method provides a summary of these communication steps. The next section shows a complete example of how the PCC process can be used to resolve a significant real-world chronic problem that plagues us all – not taking our medication as prescribed.

A complete PCC Process Example - Not Taking Medication as Prescribed

According to the World Health Organization (WHO) World Health Report 2003[16], the degree of medication non-adherence is so great. The consequences are of such concern that more people worldwide would benefit from improving medication adherence than from the development of new medical treatments. A number of studies[17] have shown that, in developed countries, patients with chronic conditions have adherence rates of 50% to 60%, despite evidence that medication improves the quality of life and prevents death.

Applying the PCC Process

Below are the five steps of the PCC process applied to incorrect medication consumption as a problem. (*Please see Appendix 1 for the graphical representation of this analysis)*

Step 1: GAP ANALYSIS

Why change? This is answered by defining the problem and why it is important for both you or your part (the local impact) and the rest of the system (the global impact).

Why is this Change important? On the individual level, if the patient does not properly take his blood pressure medication, his blood pressure will continue to be too high, and there's an increased risk the patient will die of a heart attack or a stroke. On the system level, more patients are admitted to the hospital, medications are being wasted, and bugs become antibiotic-resistant.

Step 2: CONFLICT ANALYSIS

What to change? This is answered by verbalizing the problem as an unresolved conflict with four possible assumptions to challenge.

What should I change? My unresolved conflict is that I feel pressure to take the medication on the one hand and pressure not to take it exactly as prescribed on the other. And the four impacts?

1. What is the 'pot of gold on top of the mountain (**the positive of the Change**)?

[16] http://www.who.int/whr/2003/en/

[17] World Health Organization. Adherence to long-term therapies: evidence for action. www.who.int/hiv/pub/prev_care/lttherapies/en/index.html, January 1, 2012.

If I take the medication exactly as prescribed, the positive is I will get better.

2. What is the 'alligator' at the base of the mountain (**the negative of not changing**)?

If I do not take the medication exactly as prescribed, the negative is I will face a high risk of a heart attack or stroke. Another major negative could be withdrawing medical treatment from my doctor or nagging by my family.

Note: When expressing this assumption, do not default to an alligator that is just a re-statement of your pot of gold in the negative. Instead, as we've done in the example above, add to it by focusing on emotional aspects, i.e. things you may be afraid of losing or gaining.

3. What is the 'mermaid' we've fallen in love with (**the positive of not changing**)?

Suppose I continue to take my medication incorrectly. In that case, the positive is I will avoid the hassle of having to remember to take it, the side effects involved, and spending the money required to take it exactly as ordered. And I like being fussed over by my family. I also feel entitled, by my hard work, not to worry about my health.

4. What are the 'crutches' (**the negative of the Change**)?

If I start taking my medication correctly every day, it may make me feel that I'm sick and old. So why should I change? (A recent field test using the PCC indicates that this and the feeling of entitlement mentioned above are the top two reasons patients provide for continuing their incorrect consumption of medication.)

Note: Once again, when expressing this assumption, take care not to provide a negative that is merely the inverse of your mermaid. Again, focus on the emotional, i.e., use verbs like 'feel.'

Step 3: CONFLICT RESOLUTION

What to change? This is answered by resolving the conflict by applying each of the four methods below and selecting the one that gives the most positives (pot of gold, mermaid) and the least negatives (alligator, crutches).

Note: Why do this? Because breakthroughs – if they don't come from a systematic and repeatable method – make people anxious. The best way to circumvent this and be unbiased is to explore the four options instead of just one.

Method 1: Change ++

Recall, if we are to choose the action 'Change,' then we need to make two additions to counter both the negatives identified with the Change, creating a Change ++ solution:

Ask: Why will you take the medication to jeopardize your mermaid? Because doing so every day is a hassle. State the opposite, using the injection: It's not a hassle. Then, think about how to make it true, i.e., reduce the hassle of taking medication daily with a mobile phone reminder (1st +).

Ask: Why will taking the medication result in crutches? Because taking medication will make me feel I'm sick and old. Only sick and old people take medication daily. State the opposite, using the injection: Not only sick and old people take medication; anyone who wants to live a long and healthy life does so. Then, remind yourself that even top athletes take daily supplements (2nd +).

Method 2: Not Change ++

If I continue to take my medication incorrectly, I'll have to talk to the doctor (the 1st +) and then my family (2nd +) about where I can potentially afford to deviate from the prescription; i.e., how best to make up for a skipped dose later on in the day or the week, if I forget one along the way.

Method 3: When To Change vs. When Not To Change

I'll have to create a rule for myself, like: When the doctor tells me I have to follow the script exactly, I must follow it verbatim. When he gives a guideline, I can be more relaxed.

Method 4: Another Change

I'll make an entirely different change, like using exercise and diet to manage my blood pressure – because I don't have the self-discipline to take daily medication. Or perhaps I'll ask my doctor to inject me once every few months to avoid having to take medication daily.

Step 4: YES-BUT ANALYSIS

Say we've selected Method 1: Change ++ as the best solution to our chronic problem.
To further improve our new solution and increase the probability that it will actually be implemented, we will get all stakeholders to raise as many of the likely 'Yes, buts' as possible and then, with their help, find practical ways to prevent or overcome each of these.

What if, instead of fighting our natural resistance to change, we capitalized on it, using an extra step to expose the likely 'Yes, but reservations and to use these to find what else should be added to our new win-win solution to the chronic problem.

Note: In a business environment, we use this step to allow all stakeholders to list their reservations by inviting them to help us find all the reasons why a proposed change will not work and/or be successfully implemented. This is an effective way to achieve stakeholder contribution and a sense of ownership of the Change - especially important when we expect resistance to the proposed change.

As a reminder, here's our chosen solution so far (Method 1: Change ++):

If I start taking my medication correctly, I'll have to manage the hassle of remembering to do so daily and as directed by my doctor by using a daily mobile phone reminder. To avoid feeling sick and old, I'll have to remind myself that even top athletes use medication daily.

Write down a patient's or doctor's possible reservations for resisting this solution, based on three classifications:

- Insufficiency
- Potential negatives
- Implementation obstacles

Insufficiency – "Yes, I like the solution, BUT I think it's insufficient to give more positives and less negatives. To achieve this, I need to add…."

In practice: I like the idea of using a mobile phone reminder to nudge me to take my medication daily at the right time, and I am willing to remind myself what top athletes do. Still, I also need a way to keep my medicine handy throughout the day—a possible ***answer: A numbered pillbox.***

Potential negatives – "Yes, I like this solution, BUT if I implement it, it may result in new negatives. To prevent these, I need to add…."

In practice: I like the idea of the reminder and the top athletes as role models, but my mobile phone reminders may irritate other people if they happen throughout the day. ***Possible answer: Find out from the doctor how early and how late I could take my medication so that the bulk of the reminders don't happen during work hours.***

Implementation obstacles – "Yes, I like this solution, BUT some obstacles are blocking me from implementing it. To overcome these, I need to add…."

In practice: I like the idea of using top athletes and their supplemental/medical regimes as inspiration for daily medication, but I don't know enough about the specifics. ***Possible answer: Find out exactly what my favourite sports stars take every day to maintain their top performance.***

Step 5: BEST PRACTICE DEFINITION AND TESTING

How do we know this will work?

We have two practical methods for testing whether a new idea will work.

1. The first is defining and communicating its logic in a method easy for others to understand, unpacking the critical assumptions on which our logic is based.
2. The second is designing experiments where the solution's effectiveness and sustainability can be tested in real-life scenarios.

To allow others to check our analysis and solution, we should answer these questions:

- Why is this Change needed (the assumptions of the necessity of the Change)?
- What is the specific objective (strategy of this Change)?
- Why is the Change possible but difficult or risky?
- How can we best achieve/implement this Change (the Change tactic)?
- Why is this level of detail insufficient to prevent execution mistakes or compromises (the assumption of sufficiency)?

By defining changes that answer each of the questions explicitly, we can treat changes as experiments to validate or invalidate critical assumptions by measuring whether the problem has been solved or its undesirable effects are measurably reduced.

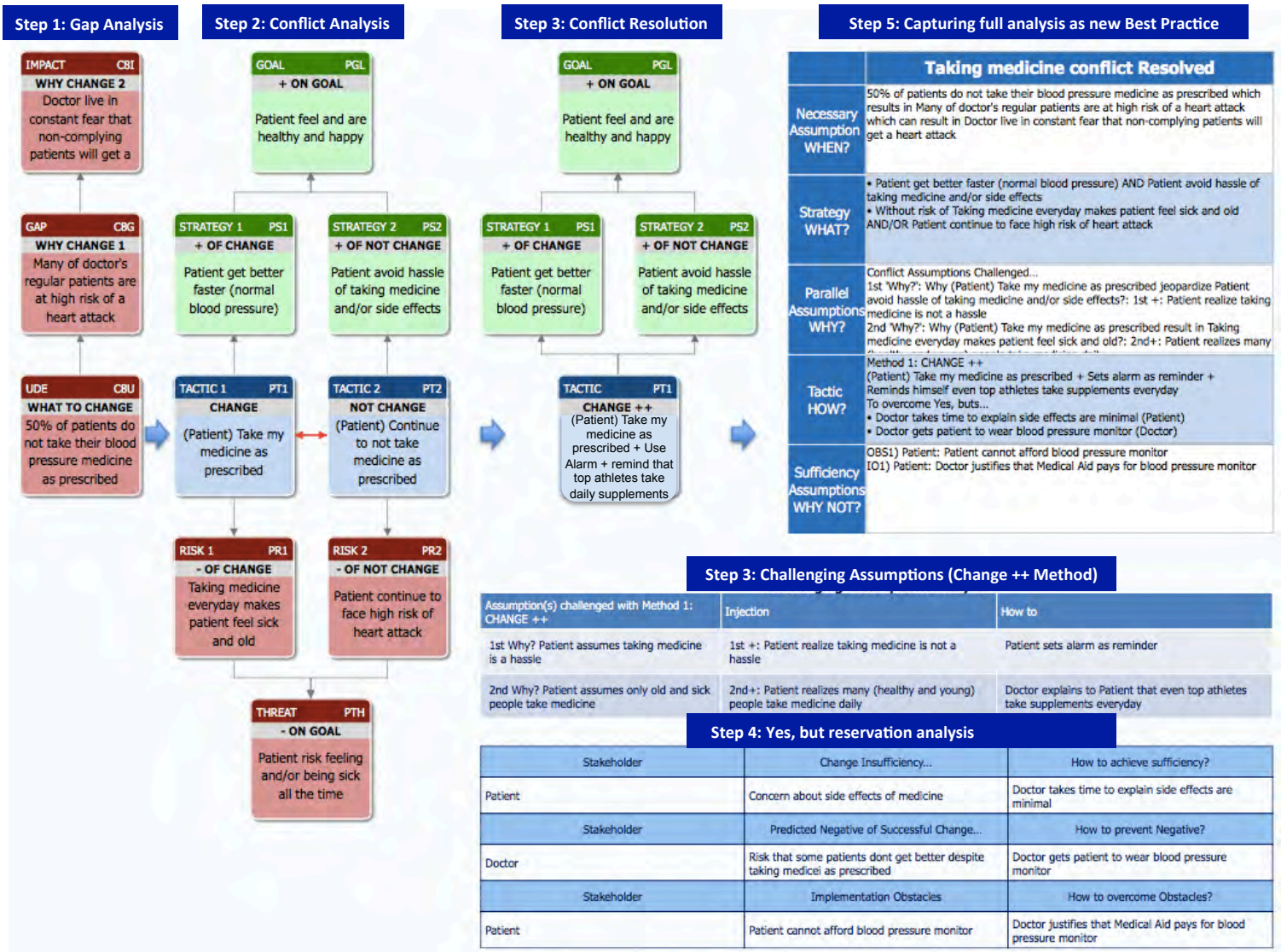


Figure 5: The 5-Step ProConCloud Method

Figure 5 above shows how to define and communicate the complete analysis of the prescription non-compliance problem as a Best Practice (captured in the HARMONY Web App available at www.harmonyapps.com)

Appendix 1 of this paper includes another complete example of a PCC analysis on why many people continue to multitask even though they know how bad it is for their productivity and the organizations they work in.

Appendix 2 of this paper includes a checklist to support the use of the four methods developed by the author to resolve any conflict.

Appendix 3 of this paper includes the author's review of the likely Limitations of the PCC Method

Appendix 4 of this paper includes interesting applications of the method found through field testing, which include SWOT analysis and testing Research Hypothesis

Conclusion

When looking at ways to analyze problematic behavior and/or to develop simple and effective solutions for chronic problems, the "Holy Grail" is a shortcut or fast track to identifying those limiting assumptions that can cause any of us to continue *doing what we should not* do and/or *not doing what we should do*. The two main causes of avoidable decision mistakes are Ignorance - lack of knowledge about the problem or how to solve it; and ineptitude – failure to apply the knowledge effectively.

For most human history, Ignorance was the main cause of all failures to do what we should and/or not do what we should not. In most fields, due to the exponential growth in knowledge over the past few decades, the situation today is that most failures are due to ineptitude. As such, we need new thinking and decision support tools that capitalize on recent breakthroughs in the relatively new science of Behavioural economics and the work by Dr. Eli Goldratt to understand how our biases influence our decisions. For example, we favor the status quo (keeping one's mermaids) and feel an aversion to loss and risk (falling and needing crutches). Such biases lie at the root of most chronic problems with known causes and solutions.

A new method, called the ProConCloud Process (PCCP), has proven to be an effective tool in helping people identify the limiting assumptions that block them or others from resolving the conflicts associated with chronic problems and/or from developing simple, robust solutions to resolve these. The ProConCloud Process follows five steps, each designed to overcome limitations of previous methods:

- First, start by picking a problem and validating its importance (so we don't waste our scarce resources like attention, time, or money to solve unimportant problems) by checking that it has a negative impact, not only on you or your area but also on the rest of the 'system';

- Second, identify the Change required to address the problem and examine the positives and negatives of changing, and the positives and negatives of not changing;

- Third, examine and enhance alternative solutions systematically, using four methods to resolve any conflict, by exposing hidden assumptions which block resolving this conflict and how to overcome these practically. Then choose the best-enhanced solution yielded by the four methods, i.e., the solution with most positives and least negatives;

- Fourth, treat the chosen solution as a 'half-baked solution,' asking stakeholders for their '*Yes, buts'* to allow them to share what could block them/others from trying it and/or implementing it successfully, and what can be done to prevent this and make the solution more 'fully-baked'; and

- Fifth, capture the full analysis into a "Best Practice" format that answers why a change is needed, what the specific objective of the Change is, why the Change is possible but difficult or risky, and consequently, what the best way to achieve the Change is.

Why could the PCC be a game-changer? Why does it have a high probability of working where other methods have not? Numerous pilot studies over the past three years have shown that:

1. The PCC provides a simple framework and language to identify which one of the possible cause(s) of chronic problems is likely the main cause. Is it really Ignorance about the problem, its impact, and/or its solution? Or is it ineptitude (or even inertia) due to a lack of ability, skill, or confidence to intervene successfully?

2. The four methods provide a practical way to explore at least four different methods for resolving conflict and identify most of the limiting assumptions which block a win-win resolution to the conflict.

3. Even the best solutions will face resistance to change. Using the 'Yes-but' process, we allow stakeholders to share these in a safe environment and improve the solution to give stakeholders a sense of ownership.

4. Converting the full analysis into a simple Best Practice framework will improve communication of any proposed change and offer the opportunity to build a library of best practices containing the full logic of where they came from. This can ensure 'ignorance' is used less as an excuse for chronic problems.

To get to this point, we've stood on the shoulders of giants, combining Goldratt's Change Matrix and Evaporating Cloud into a complete yet simple process for analyzing and increasing the probability of solving chronic problems caused by either Ignorance or ineptitude.

[Optional sidebar 1:]

When to Use the ProConCloud Process

There are certain situations in which the PCC works powerfully. Try to develop alarm bells for these so you know what to do when the time comes.

Some examples:

1. When you face a significant and consequential decision, you realize you need to invest time thinking it through. Example: Answering the question, *'What am I going to do with the rest of my life?'*

2. When you anticipate or experience resistance to change. Example: *Moving offices, treating children with autism using new technology, etc.*

3. When you want to understand the underlying causes of disharmony in your organization.

4. When you (or others) procrastinate (when you realize delaying an action causes no significant benefits, like waiting for additional information) on a decision. Example: *Implementing significant company change when there's a long sales cycle.*

5. When you seek a new way to generate a research hypothesis.

6. When you need a process for creating a Project Charter (the Best Practice outcome can be used as a Project Charter)

7. When you realize the cause of a chronic problem is inertia or ineptitude, not Ignorance. Example: *Making a country's youth more financially literate.*

8. When you want to validate understanding at the end of a training workshop. Example: *Determining whether students understand/agree with the Change and know how to resolve conflicts related to it, etc*.

[Optional sidebar 2:]

Testing the PCC Process in Real Life

Odyssey Program

The PCC Process has been used in the annual Odyssey Program to help individuals from all walks of life quickly identify the assumption(s) blocking them from making the changes they need to make in addressing stressful expectation gaps within the various aspects of their life and then to identify and overcome the "yes, buts" blocking them from creating and sustaining these.

Tata Steel (India)

Many of the technologies adopted by Tata Steel India did not realize their potential. The causes for this were categorized into 1) the technology was not adopted as it should have been or 2) the technology was adopted, but its value was not realized. The PCC process was used to understand the adopters' resistance to change.

The key lesson was that the group proposing the Change was focused on the alligator and pot of gold, and when resistance was encountered, focused ever more on these. However, the resisting group was stuck on the other side: with the mermaid and crutches. Once both proposers and resisters were encouraged to consider the four aspects, the resistance was explained. The PCC became a tool to facilitate a future focus and a checklist to get buy-in for Change.

Utah State Government (USA)

The goal of the Utah State Government is to have the best-run state in the USA. This ambitious target comes with specific objectives for each department, best summed up as doing things 25% better, faster, and cheaper. The PCC has been used to understand the conflicts and limiting assumptions blocking the Utah State Government and its agencies from achieving these objectives. The outcomes of the PCC process have been translated into best practices and are currently being tested across the various agencies and departments.

Daiwa House (Japan)

Daiwa House is the largest home construction company in Japan. They have used the Theory of Constraints (TOC) to implement their SAP project faster and improve manufacturing and sales. One of their key questions was 'Is our TOC training effective?' The PCC process was used to determine whether Daiwa employees understood/agreed with the training and knew how to resolve conflicts related to it. In addition, the PCC process? was used to determine to what extent disharmony had been caused by changes that were supposed to help but were resisted, resulting in deteriorating relationships. The key lesson to emerge was the group proposing the Change was focused on the alligator and pot of gold, and when conflict arose, focused ever more on these.

However, the resisting group was stuck on the other side: with the mermaid and crutches. Once both proposers and resisters were encouraged to consider the four aspects of the Change, the conflict could be understood, and the PCC became a tool for the future and a checklist to get buy-in for Change. This increased the effectiveness of the training.

Prominent Retail Bank (South Africa)

A top strategic thinker in retail banking decided to complete a Ph.D. in understanding why South African customers spend irresponsibly. The prevailing assumption for policymakers who have addressed this is that it must be Ignorance; i.e., financial illiteracy causes irresponsible spending. But even after millions were spent by the bank to 'educate' consumers, their behavior was unchanged. The strategic thinker used the PCC process to develop an alternative hypothesis about the real cause of irresponsible spending: primarily likely, a fear of giving up the mermaid or living with the crutches. It emerged that to help customers, banks need different strategies. Research is underway.

BHP Billiton (Singapore)

How do we know whether stakeholders involved in a change management initiative understand and agree with the proposed change? The typical way for responsible leaders and managers is to ask them simply. Do you understand? Do you agree and support this Change? For those that have heard these questions, you will probably know that by far, the overwhelming response is "Yes" and "Yes ."However, when we listen to what is said as people leave the room and consider the low success rate of Change, the real answer should probably have been "No, not really" and "No, how can I agree or support a change when I don't fully understand it or the benefits vs. costs of the change for me and others"? When facing the challenge of implementing CCPM during a major IT system implementation, we tested whether the ProConCloud, if given to attendees after the "Buy-in" session, was a more reliable way to answer whether stakeholders really understand and/or agree. This experiment validated this hypothesis as it confirmed that checking if stakeholders can answer clearly answer Why to Change, What to change, To What to change, and How to cause the Change with the PCC process is a more reliable and faster way to really check what stakeholders understand and agree with and what not, and as significantly, to get their inputs on how to create a more robust solution.

Appendix 1: Full PCC Analysis on Multi-tasking

Conflict Analysis Title: Multitasking Conflict Analysis

Step 1. Why Change? - Execution Gap Analysis

THE PROBLEM	Despite past efforts to stop Multi-tasking, most of our IT project team is multitasking
LOCAL IMPACT	We are constantly stressed, feel overwhelmed, and often argue with other stakeholders about priorities.
SYSTEM IMPACT	Projects take much longer; we get fewer projects completed, while quality defects and disharmony are common.

Step 2. What to Change? Execution Conflict Analysis

<table>
<tr><td colspan="2">+ ON GOAL
I am seen to be contributing to the productivity of the company</td></tr>
<tr><td>POT of GOLD
I will be more productive, have better relations and get more projects done</td><td>MERMAID
multitasking I look busy and important</td></tr>
<tr><td>CHANGE
To always "demand" a priority and not multitask</td><td>NOT CHANGE
Continue to work without clear priority and multitask</td></tr>
<tr><td>CRUTCHES
I will be accused of being unfair not competent...</td><td>ALLIGATOR
I will continue to feel stressed, overwhelmed, and fear to lose my job</td></tr>
<tr><td colspan="2">THREAT TO GOAL
I am blamed for contributing to the poor productivity of the company</td></tr>
</table>

Step 3. To What to Change? Execution Conflict Resolution

Selected Method 1 – Change++ : Challenging Assumptions Analysis

ASSUMPTION	INJECTION	HOW TO
Being busy is the best way to improve productivity (which require multitasking to stay busy)	Everyone agrees multitasking is the worst way to be productive	Use Multitasking game to show how bad it is.

Prioritization is always unfair to someone I have to give equal attention to being fair Only competent people can MT.	Not prioritizing is always unfair to everyone! Only incompetent people MT / Only competent people don't MT	Use the MT game to show how bad MT is and that those that MT is not competent in their jobs. Implement a new rule, "NO MT!!!!"

Step 4. How to cause the change? - Execution 'Yes, but…' Analysis

1st Yes buts - Insufficiency Reservation

Stakeholder	Change Insufficiency	How to achieve sufficiency?
Project Manager	As long as Top Management releases too much work, the pressure on MT will not go away.	We need to engage with top management to show the need not just for prioritization but also for freezing (controlling the release of new projects)

2nd Yes buts - Negative Branch Reservation

Stakeholder	Predicted Negative of Successful Change	How to prevent Negative effects?
IT Manager	It will appear initially as if our throughput goes down/ we are slowing down, especially to low priority customers	We engage low-priority customers and show that we will finish it earlier even though we are starting their project later.

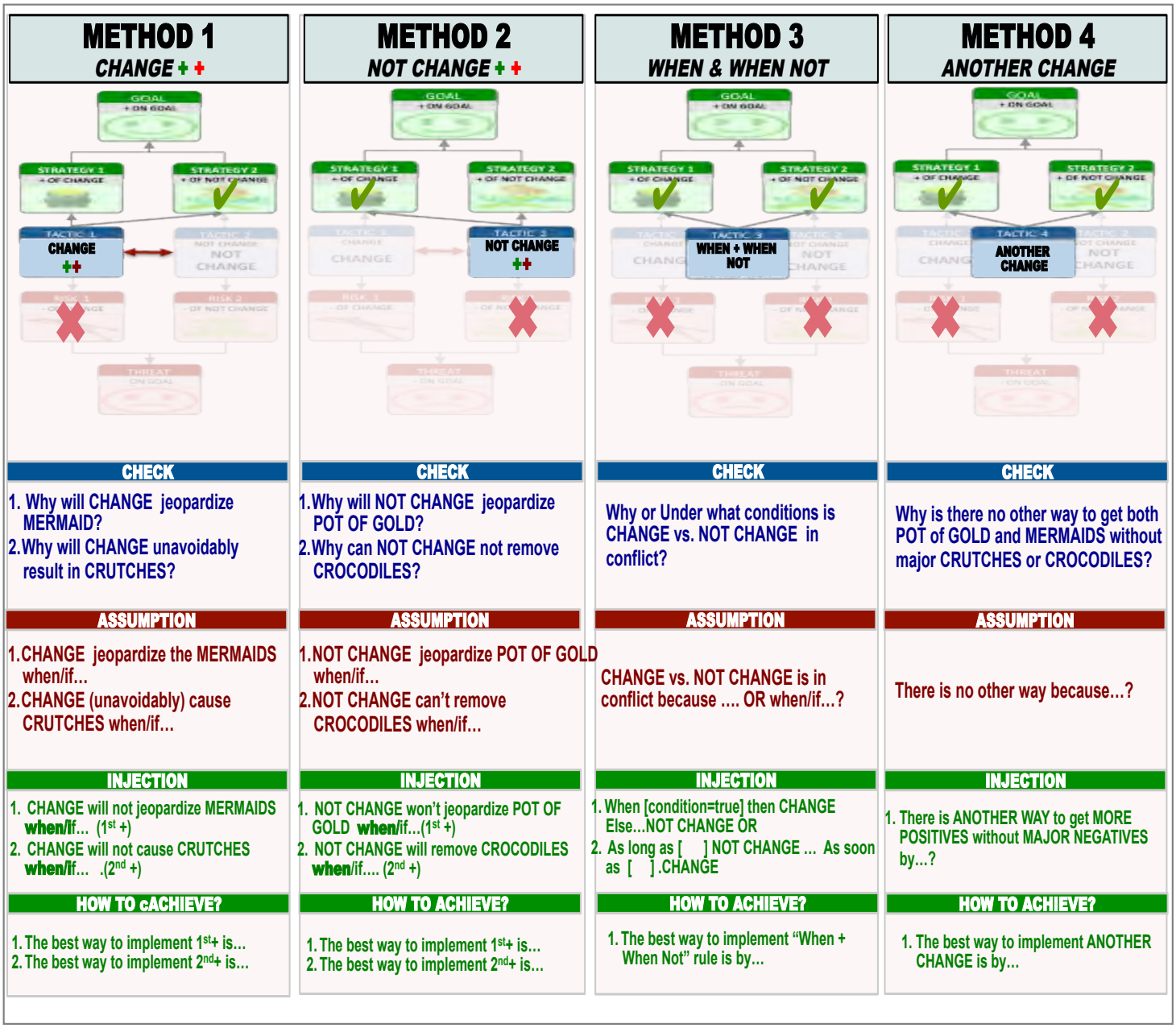
3rd Yes buts - Implementation Obstacle Reservation

Stakeholder	Implementation Obstacles	How to overcome Obstacles?
HR Manager	IT guys are already so busy they don't have time for any training	We will create a training module no longer than 2hrs and/or create online base training or YouTube video...

Step 5. New Execution Best Practice – Summary of Full Analysis

	Multitasking Conflict Analysis Resolved
Necessary Assumption WHEN?	A significant number of our IT team multitask (MT) a lot! This results in me being constantly stressed, feeling overwhelmed, and frequently arguing with other stakeholders resulting in a drop in productivity. MT also causes projects to take much longer, get fewer completed with worse quality, and have lots of disharmonies.
Strategy WHAT?	• I will be more productive, have better relations, and get more projects done, AND By multitasking, I look busy and important • Without risk that I will be accused of being unfair, not competent... AND/OR I will continue to feel stressed, overwhelmed, and fear to lose my job
Viability Assumptions WHY?	***Conflict Assumptions Challenged…*** 1st 'Why?': Why does 'To always prioritize and not multitask' jeopardize 'By multitasking, I look busy and important? • Everyone agrees that multitasking is the worst way to be productive 2nd 'Why?': Why does 'To always "demand" a priority and not to multitask' result in 'I will be accused of being unfair, not competent...'? • Not prioritizing is always unfair to everyone! and Only incompetent people MT / Only competent people don't MT ***Yes, buts raised…*** • As long as Top Management releases too much work, the pressure on MT will not go away. (Project Manager) • It will appear initially as if our throughput goes down/ we are slowing down, especially to low priority customers (IT Manager) • IT guys are already so busy they don't have time for any training (HR Manager)
Tactic HOW?	***Method 1: CHANGE ++*** To always "demand" a priority and not to multitask + Use the Multitasking game to show how bad it is. + and Use the MT game to show how bad MT is and that MT is not competent in their job. and Implement a new rule, "NO MT!!!!" ***+ To overcome Yes, buts…*** • We need to engage with top management to show the need not just for prioritization but also freezing (Project Manager) • We engage low-priority customers and show that we will finish it earlier even though we are starting their project later. (IT Manager) • We will create a training module that is no longer than 2hrs and/or create online base training or YouTube video.... (HR Manager)

Appendix 2: Checklist for the Four Methods to Resolve Conflicts



Cash Constraint-identification, corrective actions, and prevention.

Authors: Ravi Gilani & Ira Gilani

Executive Summary

Prior to early 2000's, the common understanding in the TOC community was that an organization could have a physical constraint in only one of the three areas: orders, supply or operations. In each of these areas, exploiting the constraint will increase the throughput accordingly or linearly.

In 2001, was cash was also identified to be a physical constraint. Cash constraint is a special constraint in which exploitation, and subordination of the constraint impacts throughput non-linearly. Exploitation and subordination of cash also elevates the cash constraint.

1. Constraint Identification

We can quickly identify the physical constraint through the following algorithm.

- Order constraint: An organization has a constraint in orders if its OTIF (On Time In Full) is consistently above 90-95%.
- Supply Constraint: An organization has constraint in supply if material availability is less than 95% despite paying vendors on time.
- Operations Constraint: Any organization that is unable to deliver OTIF consistently above 90-95% despite having input material availability has a constraint in operations.
- **Cash Constraint**: When an organization has OTIF less than 95% and is unable to get input materials on time due to its inability to pay suppliers on time, it faces the worst type of constraint i.e. **cash constraint**.

Cash shortage is not the same as cash constraint, though cash shortage will lead to cash constraint in due time. Despite cash shortage, it is possible that supplies do not suffer on account of vendor payments, at least for a short while. If not corrected, the cash shortage can lead to cash constraint.

In such a case, money is both the goal and the absolutely required capacity to continue the business. This is a unique situation with very critical ramifications, which should lead the management to behave differently than in any other state. When lack of cash threatens the existence of the organization all the attention of the top management is consumed in fighting one payment crisis after another.

(Taken this para from article with Eli S: https://elischragenheim.com/2017/05/11/evaporating-an-active-cash-constraint/)

An organization has a cash constraint if and only if:

1. OTIF < 95%
2. Adequate number of suppliers and yet it suffers from material shortage as suppliers are not getting payments on time
3. Additional funds cannot be arranged easily

2. Non linear impact on throughput, sales, and cash availability in a cash constrained organization

We will examine two situations of an organization having following parameters that is currently in cash constraint.

- Raw material or totally variable cost (TVC) cost assumed as % of net sales = 50%
- Throughput as % of sales = 50%
- Cash to cash time i.e. cash outflow to cash inflow time = 1 month
- Current capacity utilization is 50%

In the precariously balanced organization there is just about enough cash to survive.

Table 1: Precariously balanced system

Month	1	2	3	4	5	6
Opening Cash	100	100	100	100	100	100
Operating Expenses (All expenses excluding raw materials)	50	50	50	50	50	50
Cash available for raw materials purchase	50	50	50	50	50	50
Possible Sales	100	100	100	100	100	100
Closing Cash	100	100	100	100	100	100
Capacity Utilization	50%	50%	50%	50%	50%	50%

Table 2: Slight decrease in cash at the beginning of month 2

In this case a very small decrease in cash availabity is sufficent to make the organization bankrupt.

Month	1	2	3	4	5	6
Opening Cash	100	90	80	60	40	0
Operating Expenses (All expenses excluding raw materials)	50	50	50	50	50	50
Cash available for raw materials purchase	50	40	30	10	0	0
Possible Sales	100	80	60	20	0	0
Closing Cash	100	80	60	40	0	0
Capacity Utilization	50%	40%	30%	10%	0%	0%

The downward spiral caused by a small decrease is the unique property of cash impacting throughput (contribution), sales, and cash flow non-linearly. Similarly a very small increase in cash will increase throughput, sales, and cash exponentially.

3. Why do companies get into cash constraint?

The prime reason for getting into this situation is the wrong overall global organizational measurement. Most organizations measure their growth either in terms of sales turnover or volume of product sold. Some organizations do focus on increasing Profits after tax (PAT). *However very few organizations measure their performance in growth of Free Cash Flow (FCF).* In fact it is quite common that an organization declares healthy PAT but has negative FCF.

Let me share in very simple terms the relationship between PAT and FCF.

PAT is the net profit after deduction all expenses from the net sales.

FCF is the net increase in cash availability in the bank before taking or repaying loans.

FCF = PAT + Depreciation (Non cash expense) – Increase in working capital – all capital investment

As shared earlier most organizations focus on increasing sales though a few also try to increase profits. But if the increase in working capital is more than PAT + Depreciation / non-cash expenses then it results in negative FCF.

4. Application of five focusing steps to cash constraint

Step 0: Decide the correct overall organization measurement. Measurements drive behaviour!

In a cash constrained organization, the key parameter to focus on is not sales, not profit / loss or even throughput. It is ***Free Cash Score (FCS)***.

FCS = Throughput (T) – Operating Expenses (OE) – Income tax + reduction in Investment (I) + reduction in vendor overdue payables.

Most cash constrained organizations also make losses; hence income tax may not be there. Similarly it may not also be investing in acquiring additional plant, and machinery etc. Accordingly the reduction in I will only be from depreciation included in OE and decrease / (increase) in working capital (accounts receivables, + inventories – vendor payanles). Since it may be possible to increase the FCF by delaying the vendor payments, we recommend FCS as it will reduce when vendor overdue payables go up or increase when vendor overdue payables are reduced.

Once cash has been identified as the organizational constraint (strictly based on the conditions described above), the next step is **exploitation** of the constraint.

We can use the standard PQ case study here too for exploiting the constraint resource. In the standard PQ case, operations is the constraint-more specifically it is the capacity of resource B. The prime metric for giving priority for selling product P or Q is the throughput per unit time of constraint resource B. In cash constraint situation cash is the constraint. Here also we use a metric cash velocity for decision making for prioiritizing selling P or Q. Cash velocity is defined as increase in cash per unit of cash per unit of time. Since cash increase or decrease impacts all the relevant parameters non linearly, cash velocity is calculated by the formula

(**S/TVC**)^(1/ **N**)-1, where **S** is the unit selling price, **TVC** is the unit totally variable cost, and **N** is the cash to cash cycle time.

In our precariously cash balanced organization example, the truly variable cost (TVC) is 50% of sales and the cash-to-cash cycle time is one month. In other words, an incremental cash induction of $50 will become $100 in one month's time. Here, the cash velocity will be 100% per month.

Cash-to-cash cycle time is the total time from cash outflow to cash inflow in the system. In other words the time from the actual payment to a supplier until the client pays. We can measure the time by days or weeks or months.

If the company has inventory of 2 months, receivables of 1 month, and payables of 1.5 months, the cash-to-cash cycle time will be calculated as follows:

Cash-to-cash cycle time = Inventory (in months) + Receivables (in months) – Payables (in months)
= 2.0 + 1.0 – 1.5 = 1.5 months

Table 3: Cash Velocity for two different products P & Q.

Parameter	**P**	**Q**
Selling price per unit (S) in $	100	80
Truly Variable Cost per unit (TVC) in $	50	50
Manufacturing lead-time in weeks	2	2
Credit period in weeks	4	1
Cash to cash cycle time (n) in weeks	6	3
CV/ Week ={(S/TVC)^(1/n)}-1	12%	17%

In the above table, selling Q is preferable because it would generate cash faster. In cash constraint situation, the focus is on generating as much cash and as fast as is possible **through effective utilization of existing cash**. A small increase or reduction in cash can make or break the organization. This unique property of cash impacting throughput non-linearly could help organizations to overcome cash constraint in a very short period of time. In most cases it may be possible to come out of cash constraint in less than three months by **reducing cash to cash time,** and by that accelerating the cash velocity. *Often just shrinking cash to cash cycle time is good enough to come out of the cash constraint situation provided the right measurements are in place.*

Reduction in customer payment time

More often than not, customer payment time is the single largest component of the cash-to-cash cycle time. Most managers think that when we reduce payment time by one week, we save interest cost only for one week. It is extremely important to note that even this small decrease in cash-to-cash cycle time increases cash velocity significantly, and thereby impacts throughput non-linearly. As we can get huge benefits from shrinking customer payment time, we must explore all possibilities including significant discounts for immediate payment.

Giving the customer price reduction in exchange of significant faster payment is of paramount importance for achieving faster CV. It can be shown that even after **providing 20% price discount to shrink customer payment time from 4 weeks to one week** could exploit better the cash constraint, and thereby increase cash in the system.

Shrinking manufacturing lead-time

Drum-Buffer-Rope (DBR), the production solution of TOC, shrinks the manufacturing lead-time by a factor of 2-10. This is particularly effective where manufacturing lead-time is a significant part of the cash-to-cash cycle time. For organizations that make capital goods, these tools help immensely in reducing manufacturing lead-time. In several cases, this paves the way for increased selling prices by offering reduced lead-time. Companies that make to stock also benefit by reduced Work In Progress (WIP), and finished goods inventory, thereby releasing cash.

Buying small quantities more frequently

This aspect is often overlooked and companies pay heavily by not examining supplier policies in a cash constraint situation. Reduction in supplier MOQ (minmum order quantity) is one of the important means of crashing the cash-to-cash cycle time as the raw material inventory holding requirement comes down with more frequent purchases of small quantities. In some cases, it may also be worthwhile to switch to a supplier who has a higher price per unit but is willing to supply in small lots

reliably. This may impact the gross contribution or throughput (though not significant) but it can shrink raw material holding time. These decisions should be taken after evaluating the impact on affected parameters such as input price increase, reduction in cash-to-cash cycle time, reduction in raw material inventory requirement, and most important, improvement in cash velocity.

While the above may seem like common sense, often this is not common practice. Local measurements or departmental KRAs (Key Result Areas) often prevent companies from adopting these practices that can prevent bankruptcy.

All functions, departments, decisions should be aligned to get the most out of the constraint. In our experience, **subordination** is often the most difficult to implement as it requires changes in existing practices and policies of local optimization.

Many organizations waste their most precious asset cash for purchasing more than immediate requirement just because the purchase team can get a **volume discount** by buying additional quantity. In turn, this additional cash outflow starves the organization of other required materials, thereby jeopardizing full material availability. It has often observed that dispatches are held up because non-availability of one of the insignificant inputs. This increases cash-to-cash cycle time and hastens bankruptcy. It is recommended to buy just the minimum quantity required for making 'Full Kit' for immediate production.

Similarly, chasing local optima in manufacturing invariably leads to more production than immediate requirement to achieve better **capacity utilization**. Plant managers produce more quantity of some products to save on set-up times. The additional production not only blocks cash and increases cash-to-cash cycle time but also delays other important products and disrupts the flow.

There is one common behavior that has been observed in almost all cash stressed units. Organizations are extremely reluctant to change current business practices be it in buying materials, manufacturing, or in selling. An actual case study is shared below.

This client organization was in the business of making electrical switches. It declared a loss for the first time after making profits for continuous 42 years. Situation became extremely critical as suppliers stopped supplying input material unless paid upfront. As a consequence, its capacity utilization dropped to less than 20%. Its TVC as percentage of net sales was 40%, manufacturing lead-time was 3 days, and realization time was 60 days as it was selling primarily to retailers.

Every additional inflow of Rs. 40 would generate additional sale of Rs. 100, resulting in cash inflow of Rs. 100 after 63 days. *This means every additional Re. 1 will get converted to Rs. 2.5 after 63 days.*

A suggestion was made to shrink collection time even by offering up to 50% discount for immediate payment. The instatneous response was that it will increase the loss even more.

Here are the calculations.

For every addition of Rs. 40, the sales would only be of Rs. 50 (50% of 100). However, the cash to cash cycle time now gets reduced to 6 days (3 days for manufacturing and 3 days for getting the credit in the bank).

Or for every additional Re. 1 will now generate cash of Rs. 1.25 only but after 6 days. After another 6 days, the Rs. 1.25 realized would generate Rs. 1.56 (1.25 X 1.25). Continuing this for 60 days, the initial Re. 1 would get converted to Rs. 9.31 - a little less than four times of Rs. 2.5 being generated in the conventional way! Of course it is assumed that we have adequate orders and sufficient operational capacity.

This organization offered this proposal in a segmented market and turned around in less than 3 months! Segmented markets are those where any volume sold in one segment does not impact volumes and prices in other segments.

There is no magic in this. All we need to work out the rate at which cash is being generated in one period of time. In this example, the existing cash velocity was about 55% per month and in the suggested proposal it was 205%. *Ten years later this company was sold to a multinational organization for about Rs. 650 crores (US $ 150 million)!*

In most situations, recognizing that cash is the real constraint, exploiting and subordinating all organizational measures and policies to the cash constraint will shift the constraint either to orders or operations within 13 weeks. However, in extreme situations it may be necessary to **elevate** cash i.e. induct additional cash. For cash stressed organizations, cash may be available only at significantly higher rate of interest. Here we must understand that for most organizations the cash velocity varies from 10% to 30% per month. Hence, it makes sense to borrow even at very high rate of interest so long it is significantly less than cash velocity. Another caveat is also in order. **Partial induction of cash will not work.** *Either induct the total minimum required cash at one go or none at all!*

Table 3: Partial induction of cash

Month	1	2	3	4	5	6
Opening Cash	90	90	90	90	90	80
Operating Expenses (All expenses excluding raw materials)	50	50	50	50	50	50
Cash available for raw materials purchase	40	40	40	40	40	30
Possible Sales	80	80	80	80	80	60
Adequate survival cash required	100	100	100	100	100	100
Additional cash induction	10	10	10	10	-	-
Closing Cash	90	90	90	90	80	60
Capacity Utilization	40%	40%	40%	40%	40%	30%

Total cash inducted in 4 stages = $40

Table 4: One-time induction of sufficient cash

Month	1	2	3	4	5	6
Opening Cash	90	110	120	140	180	230
Operating Expenses (All expenses excluding raw materials)	50	50	50	50	50	50
Cash available for raw materials purchase	40	60	70	90	130	180
Possible Sales	80	120	140	180	200	200
Adequate survival cash required	100	100	100	100	100	100
Additional cash induction	30	-	-	-	-	-
Closing Cash	110	120	140	180	230	280
Capacity Utilization	40%	60%	70%	90%	100%	100%

Total cash inducted in one go = $30

The main obstacles in overcoming cash constraint are the local measurements (sales, market share, tonnage, freight cost control, interest cost control etc.) that organizations continue to improve when in cash constraint. Continuing to use the same measurements lead to further deterioration of the situation and must be done away at all costs.

Companies do not fold up when they make losses. Rather they close down when they run out of cash. Survival time is the period of time in which the existing cash in hand can cover fixed expenses. Any action that has beneficial impact after the survival time is irrelevant. All actions should be taken to increase survival time by shrinking cash-to-cash cycle time.

Preventing cash constraint through Cash Buffer

Step 5 of the POOGI is "Go Back to First step". In fact it is to *choose the constraint.* Constraint could be in operations or orders. However cash must never be the constraint.

It is possible to shift cash constraints in a few months, and in due course constraint will be in operations / orders.

As the Goal of the company is to make more and more money, throughput increase is almost a must. In most cases it will demand an increase in sales. This in turn will require increase in investment in the form of higher accounts receivables, and inventories.

In order that cash does not become constraint again while the sales is increasing, the organisation must have protective capacity in cash as cash buffer. The amount of cash that should be kept as buffer depends upon the uncertainty in managing working capital with planned growth rate of sales.

The cash buffer can be worked out keeping in mind the following parameters.

- Cash buffer should be adequate for a certain number of months for OE so that the organisation has no problem in making payment for fixed expenses, should there be no inflow of money
- in addition, it should cover the amount of account payables that must be paid while inflows may not happen
- Cash buffer should also be able to cover additional demands of working capital when the sales is growing

It is helpful to project cash inflows and outflows statements for next 13 weeks.

Unique Features of Government and How Governance Could be Assisted by the Theory of Constraints

Written by Alfredo Mycue and Eli Schragenheim

TOC strives to improve the performance of any organization, in other words to achieve more of the goal. As a first move the idea is to draw more from the current resources of the organization.

For-profit organizations have a clear goal of making more money now and in the future. Non-profit organizations, most obviously governments, face a challenge of clearly expressing their goal.

The expansion of TOC to new environments requires special attention to the unique features of the new environment and the resulting impact of them on achieving more of the goal. The penetration of TOC into government agencies have highlighted both the unique difficulties and also the opportunities for TOC to achieve considerable additional public-value.

The purpose of this essay is to describe the features of government, so that we can better appreciate how the arts and sciences of the Theory of Constraints (TOC) might be applied to the endeavor of governance. The TOC champions that have successfully implemented a variety of TOC concepts and tools have created the basis for a methodology of applying TOC to governments. It seems it is the right time to clearly verbalize the special features of governments, all over the world, in order to clarify both the obstacles and the opportunities for achieving more public value with the wisdom of TOC.

The authors of this document envision the TOC community interrogating these observations and having a productive dialog regarding these statements in order to advance our understanding of how government might benefit from established TOC concepts, Thinking Processes, and TOC solution implementations. We recognize that at least 37 cents of every GDP dollar spent across the globe is spent by public sector organizations and we acknowledge that the critical charges of government (security, justice, stewardship of both the commons and the economy, etc.) are fundamental components of the future advancement of the globe and the human condition.[1] Government is an organizational environment in which TOC applications can potentially improve operational effectiveness and efficiency. Pervading this essay is an optimistic sense that the body of TOC knowledge and wherewithal can benefit the planning, policies, and execution of governance at every level on every continent. That said, **the focus of this essay is not on the top government, federal or local, which is heavily impacted by politics and politicians wishing to be elected again, but mainly on departments and agencies that have to accomplish well defined services for the citizens.**

<u>The need for characterization of new environments for TOC</u>

[1] These facts can be accessed at https://www.usgovernmentspending.com/ and https://tradingeconomics.com/european-union/government-spending-to-gdp#. US federal, state, and local spending totals over 37 cents per dollar of spending that constitutes the GDP. By the mid-2010s, federal spending was over 20 percent of GDP, state spending amounted to about 9 percent of GDP and local spending was declining towards 9.5 percent of GDP. Globally, the amount of spending and data reliability varies significantly, but the governments of EU countries spend a larger percentage of their GDP than the US, over 44 percent.

TOC consistently challenges basic assumptions and by that achieves superior overall performance of variety of organizations. TOC was born on the Production Shop-Floor, challenging the common desire to gain high efficiency from every work-center. It also challenges the concept of cost-per-unit, which actually is the core cause of the refusal to acknowledge that only very few, usually just one, resources clearly limit the Production. That critical challenge developed into the Drum-Buffer-Rope (DBR) methodology, and that was just the beginning.

From that starting environment TOC has expanded to other environments. For each additional environment new knowledge, and a somewhat different use of the tools, like the Five Focusing Steps (5fs), has been developed. For instance, moving to distribution organizations raised the need to define a different type of buffers: stock buffers. Later, stock buffers demonstrated their benefit and usage for production as well.

Going into multi-project environments raised the need for new solutions, still mainly based on the key original thoughts of TOC. When TOC entered healthcare, for example, it forced changes to the original TOC thinking, recognizing there is no practical way in healthcare to choke the release. The use of Buffer Management to identify what to change in order to improve the flow pushed the TOC philosophy further.

In addition to manufacturing, project management, and healthcare, TOC has also provided considerable value to supply chain, educational, retail, information technology, and service industry operating environments. There are more organizational environments, such as government, that TOC can potentially provide huge contributions toward their performance improvement. But, in order to achieve this, there is a real need to understand what the key differences are between the new environment and the current TOC BOK, which might require changes or development of new knowledge to be efficacious in the new environment.

Let us evaluate the key characteristics of government, focusing on those aspects that fundamentally relate to the TOC BOK in order to learn what aspects of TOC readily apply to government and what will likely require modification or adaptive integration to be effective in that environment. Using a structured approach to achieve this objective, we will first identify a key characteristic of government that differentiates it from other environments that TOC has traditionally provided considerable benefit. Then our approach is to pair this unique aspect of government with a TOC key assumption or principle that pertains to a particular aspect of the government environment. On this basis we will provide early speculation on the promise a TOC implementation might hold for government adaptations and we will consider what adaptations might be required in the TOC BOK to facilitate successful integration of TOC concepts into the practice of governance. Through the lens of TOC, we will take a close look at the opportunities and the difficulties of achieving significantly better performance in government agencies. Thus, in a nutshell, this paper aims to identify a differentiating characteristic of government, pair it with a TOC concept, and consider the benefits, or difficulties, of deploying the TOC approach in government.

Such an unprecedented and vigorous pairing of TOC and government attributes might benefit from a running example that provides tangible description and detail. As we consider these concepts, those of

us both in and out of a government environment will likely benefit from a recognizable and frequent task of government. The investigative work of a team dedicated to identifying fraud or abuse in a government program might provide this analysis a good, straightforward running example. Investigators and the work they do to gather evidence as it relates to criteria establishing a breach of expectations or a crime is a ubiquitous function of government around the world.

The first key characteristic distinguishing the government environment**:**

A clear and agreed upon organizational goal is elusive in democratic government because of shifting political priorities and values.

The Theory of Constraints (TOC) has the following key assumption: The organization has a clear and agreed-upon goal. But we doubt whether the overall government of a democratic country has a clear and agreed-upon goal. Theoretically the goal of every government is to generate public value for the citizens. In practice, defining the public value is open to different perspectives, depending on certain values that mark the beliefs of political parties. Not only is it difficult to express the goal, and the vision, of any political party, but the possibility of a change from one party to another brings considerable shift of values that has a considerable impact on many government activities and their related objectives. The conflict cloud, a major TOC tool, is effective when both sides of the conflict agree on the ultimate goal. When values clash it is not certain that using the cloud would assist in resolving the conflict. When a clash of values exists, a compromise might be the best practical result that can be achieved.

This vacillation between varying values and differing goals is not a new phenomenon to senior government administrators. They often find themselves in a balancing act between two sets of political values and goals. Consequently, they strive to create rules and systems that thread a viable path through political differences. Administrators defer to existing laws and help to formulate rules and goals with as much equity, fairness and balance as the statutes allow. For example, the words “effectiveness and efficiency” are often used together in government goal statements in order to accomplish objectives that appeal to multiple parties and varying political affiliations. Organizational performance measurement efforts often target both effectiveness, the ability to accomplish program objectives, and efficiency, the ability to do so in a cost-effective manner.

The TOC BOK may be able to provide insight, problem-solving, and methodological approaches which may be able to assist government administrators striving to balance competing values and their associated demands. For example, this assistance might include providing agencies with a clear goal with associated metrics to track improvement promises to enable government agencies to generate considerable value from TOC solutions.

So, a key element for TOC to improve the performance is to have an agreement on the goal and the ability to measure progress toward that goal. Harvard Professor, Mark Moore, in his 2008 lecture entitled, “Recognizing Public Value: The Challenge of Measuring Performance in Government,” put the challenge thus: “while standard financial accounting systems can capture financial flows through and organization together with the costs expended by an organization in producing particular products and services, it should be clear that if we want to measure the public value an organization produces, we will

have to construct some other technical system that can allow us to record when public value is being produced."

The measurement system Moore envisions would need to clearly identify what is produced by government and be able to reflect the value of that good or service. But the value in government cannot be reflected by the price the market is ready to pay for the government's goods or services. Governments create value for the generic good of all the citizens and commercial considerations of value-based pricing should not play any role in these decisions. Instead, while the value to the customer will likely remain an intangible, we can determine the total operating expenses (or the budget) to produce the total amount of items in a year. Still, the question is whether this may assist us in recognizing public value. TOC's throughput economics mindset and its associated body of knowledge can help government delineate public value goals and measurements, while associating them with the total cost of generating that value.

It may be possible to link the cost of providing the service with the public value of the service to help the government and stakeholders evaluate whether the public value is worthy of the cost. The first step in doing so is to define the 'goal units', or quality-throughput (QT), in a manner that allows measuring it. This is necessary for determining whether the public value created by the agency last period was better, equal, or worse than previous periods, and also for setting the expectations for the future. Throughput can be defined as either money, or service-units. A QT goal unit thus defines the basic service.

The reason of adding Q, quality, as an integral part of the throughput definition is that for a commercial organization the market decides upon the value of the product or service while including quality considerations. When the quality is not good enough the market would punish the organization by shying away from its offerings. But the market for government services is usually captive. Thus, the value assessment of the government services has to include an objective assessment (as possible) of the quality of the service. Certainly, response time, completeness of the service rendered, and possibly also number of complaints and rework, should be part of the definition of the Q part of QT.

This TOC approach acknowledges that the agency produces other services and provides a way to define them by assigning a proportional QT value to other services based on their functional relationship with the basic service. In other words, it is possible to define a QT unit as a delivery of a basic service on time and quality standards, and then define other services is relationship with that basic service. For instance, issuing an extension to a driving license is defined as one unit of QT, while issuing a new driving test is three units of QT.

Of course, when government produces QT, there is an operational expense (OE) associated with the production. Dividing QT by OE creates a practical measure, which allows a simple comparison of the overall agency performance between last year and previous years, and could also point to wishful targets for next years. Building on the work of Theory of Constraints luminaries, Eli Goldratt and Robert Fox, Dr. Alan Barnard developed a ratio for measuring productivity while consulting with Cisco Systems, Inc in 2003. He proposed a primary metric that pulled key performance data into one equation. These key elements included productivity, quality, and all costs associated with the production of services or

goods (Barnard, 2009, 186).[2] Utah Governor Gary Herbert and Kristen Cox, who collaborated with Dr. Barnard, used QT/OE to considerable effect as they strove to measure government improvement to demonstrate a statewide government improvement of 25% in four years. Clearly, cost (OE) and quality are important components of government goal setting and are also integral to TOC-based improvement concepts. But we also acknowledge some distortions and unintended consequences that might be introduced if OE is used for the QT definition.

Therefore, because introducing OE into the QT definition likely has both beneficial and pejorative aspects, we want to answer two questions. Firstly, we want to examine why putting a cost price on government QT might be harmful to our noble objective of enriching the practice of government with TOC wisdom and tools. Secondly, in somewhat of a rejoinder, we want to layout the benefits we see to using the formula QT/OE to determine the (inverse of) cost per quality unit government produces. This dual analysis will also shed a bit more light on the purpose of this essay: to identify distinguishing characteristics of government so that we can better appreciate how the arts and sciences of TOC might be applied in a governmental environment. Let us examine our first question:
Will putting a price on government QT be harmful to our objective of enriching the practice of government with TOC wisdom and tools?

Should QT for a government agency be based on money? The advantage of money is that it allows objective comparison of the value created by different products or services, which could be necessary when the overall available budget doesn't allow providing all the wishful products and services. In other words, when the budget is clearly the constraint. However, when the product or service is not actually sold to the consumers, or even when the consumers do pay for it, like buying a ticket to a museum, the overall revenues are usually far less than the intuitive estimation of the public value created. Moreover, when a certain government service costs $10, while another costs $20, can we assume the value of the second service is double the value of the first service? Even for a commercial organization this conclusion is many times wrong. While a specific investigation is focused on a specific case, which might involve financial aspects, a more generic public value is generated by the message that the government does not tolerate fraud and is going to inquire into every case where a suspicion of fraud is detected. So, how can the government associate money as a measure of the overall public value of investigations into suspicions of fraud?

There are two general ways to handle the estimation of QT. One is refraining from the use of money, and instead define for every agency a basic service, for which its delivery in 100% quality generates one unit of QT. Other services would be given QT units based on estimation of their value relative to the basic value. For instance, fraud investigations could be roughly divided into three categories. Class C investigation is for a simple, one-time, attempt of fraud. Class B is for cases where a series of frauds over time are investigated. Class A deals with a wide case for major corruption where several different people, possibly even several functions, have been involved with. Say that Class B investigation has a

[2] Alan Barnard, *How to Identify and Unlock Inherent Potential Within Organizations and Individuals Using a Systems Approach*, 2009. Dissertation at DaVinci Institute.

value of 3 units of QT, while Class A generates 10 units of value. The other way is to use the current OE, actually the budget of the agency, to help determining the QT, which is not defined in money.

Before we move to the benefits of putting a price on quality throughput, there are a few more cautionary tales we should consider. Putting a price tag on government services may be interpreted by the public and stakeholders as defining the value of the QT produced. The danger is seeing cost=value, which, in government is distortion of the true value society gains from the QT. We can know that an investigation into a civil rights discrimination charge costs an average of $4,500 dollars, but the real value of that investigation is much greater. It safeguards the fabric of our societal values and the case outcome brings some element of justice to the claimant, if warranted by the gathered evidence. The clear concern in this example is that society will begin to see the work accomplished by the Civil Rights investigation team valued at only $4,500 per case.

Clearly there are challenges associated with putting a price tag on government QT, but there are also potential benefits which are addressed in our second question:

What are the benefits of including OE in the TOC goal analysis, which can be accomplished using the formula QT/OE to determine the cost per government QT?

The measure, quality throughput over operational expenses (QT/OE) holds the promise of "telling the truth" about government performance. In this measure, Q (quality) is defined by what quality level of service the program manager would like to provide as compared to the organization's actual quality level. Quality, often represented as a percentage, can be delineated by cycle time, "first-time go" success rates, error-rate (rate of rework), customer satisfaction, funding source expectations, etc. T (throughput) is simply the good or service that the government produces. Throughput is a term for the widget or service provided. Put simply, throughput in government is public value. Throughput production is the raison d'être of a government agency; the purpose of the agency is to produce throughput for the community it serves. OE (operational expenses) are ALL of the expenses incurred by the organization producing the throughput in a defined time period. OE is always measured in money.

Here is an example: If an investigations team produces 100 case determinations (the throughput) this month at a 95% quality and an OE cost of $9,800 then the QT/OE calculation, (.95)(100)/9800 would yield 0.0097. The yield of the calculation is a fraction that shows what percentage of the throughput that one dollar will buy. Governmental teams often choose to represent this fraction as a percent change for simplicity and clarity. The inverse of the QT/OE yield (1÷QT/OE) is the cost per throughput (cost per service), adjusted for quality; in our eligibility example it would be $103 dollars per one unit of QT, which in this example is a quality determination. Thus, if we overcome the obstacle of defining QT, we can provide government a feasible way to measure and significantly improve the performance of any public-sector organization.

No matter whether one uses QT and OE as two separate performance measurements, or QT/OE, any improvement can be compared to the reference measurements. Suppose the result of improvements is an increase of 25% in the QT, while OE remains the same. This means a clear increase in the public value generated. If, in order to achieve the additional 25% of QT, there was a need to increase OE by

10%, then d the QT/OE has been improved by 13.5%. Still, from a wider perspective of the budget this improvement should be compared to other improvement suggestions, which might produce higher increase of the QT/OE measurement.

One adaptation to the TOC BOK that should be considered in regard to government applications of QT/OE and clear goal setting revolve around a concept of *Value Realized*. *Value Realized* is the amount of increased value achieved by the agency as a result of improvements that usually do not incur additional cost or offer significant return on any investment costs. In the investigation team example above, if the team improves production by 25% with existing resources, then the team has created an ability to produce 25 more investigations every month, moving the monthly total to 125. If each investigation has a baseline cost of $103 dollars, then the hard-won improvements the team built created $2,575 ($103 x 25/month) in value realized every month by accomplishing 25 more investigations with existing resources. The application of QT/OE and value realized enables government organizations to compare improvement initiatives and total up their ROI "yield." Government improvement and its benefits can now become quantifiable in terms that everyone understands: dollars.

In essence, QT/OE and the ratio it renders enables managers from any agency, managing any type of throughput to calculate their improvement or lack thereof. The cost-per-quality-unit enables you to see and measure progress with an easily understandable metric. Improvement and innovation can become incentivized in government—something that has been elusive despite waves of effort by different names: Total Quality Management, New Public Management, Lean, and Six Sigma. QT/OE can enable the public administrator to make difficult cost-benefit analysis when allocating resources and setting performance goals.

Clearly, budgets, and the expenses that consume those budgets, are part of the structure and rhythm of government. It is how government translates tax dollars into public value required by society. Cost matters relative to the benefit we obtain from those expenditures. QT/OE helps tell us "What bang we get for the buck we spend." It is an important component variable, along with quality, productivity, and outcomes. Legislators, for better or worse, allocate money to programs to obtain a societal outcome. Including OE with QT analysis helps inform that decision-making by providing information on what can be done to achieve more with the same budget, or much more with some additional budget.

Perhaps, if we identify the undesirable effects of OE inclusion into TOC goal analysis, we can mitigate the pejorative effects while optimizing the benefits of knowing how much it costs to provide units of quality public value.

A point that should be raised in this discussion is whether an agency's budget should be viewed as a strategic constraint or if key, high-level constraints can be found only in value-producing resource constraints. It is tempting to see the budget as the ultimate constraint in government. Public servants use their allocated operational funds to accomplish public value. When those funds are expended the production of public value ceases. The cause and effect are clear: budgets enable public value production, so it is logical to assume that budgets necessarily limit production.

They do. However, there is a large assumption at work in such causal logic and needs to be exposed and evaluated. Budgets limit public value production when other key resources have already been fully exploited. Viewing the budget as the ultimate constraint presupposes that we have accomplished the public value in the most optimal way possible. This assumes we have already improved key processes iteratively over time until the gap between potential capacity and actual capacity has attenuated to nearly zero. The large assumption is that the organization has fully exploited the key resource constraint in government and we are doing the most we can with the budget the entrusted to the organization.

When this assumption is truly met, then the budget is indeed the ultimate strategic constraint in government. However, most organizations will have a significant delta between *current* operational capacity and the outfit's *potential* capacity to produce quality units of public value. In such cases, the logical and likely constraint will be the resource or asset producing the value. In government this is often the professional decision-maker, such as a clinician deciding eligibility on a Medicaid waiver, or the team producing the service desired by the public, such as investigations or permits. Until these resource constraints begin to produce quality throughput optimally, they will remain the constraint and should continue to be the focus of improvement efforts.

Second key characteristic of the government environment

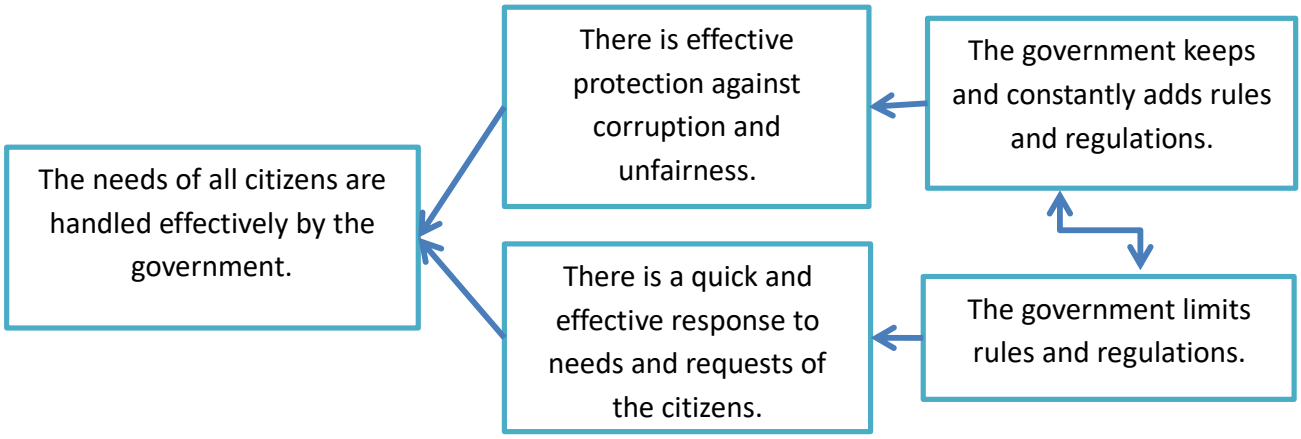
A unique government agency characteristic is being subject to many restrictions due to variety of regulations, which cannot be challenged, at least not on the level of the agency itself.

There are several sources causing this thick labyrinth of restrictive rules, regulations, and policies. These sources include a desire to achieve the intent of legislation with specific procedures, in pursuit of fairness and equal access to services, and to reduce the risk of fraud or abuse, to eliminate the possibility of something going wrong and, as a consequence, being excoriated in the public eye. Consequently, this rules-based environment often creates a risk adverse and officious climate that may not be conducive to the introduction of change and experimentation required of continuous improvement efforts.

While any other organization has set of rules, policies, norms and performance measurements, which impact the behavior of its employees, managers at nearly all levels retain the flexibility to take actions that seem beneficial for the organization. Government agencies are truly bound and restricted in terms of their ability to act upon their own understanding of what contributes to the goal. This is true unless the government takes steps to change the regulations, which takes time and a lot of effort.

A special side-effect of any government agency is the concern for corruption and unfairness. In many ways the bureaucracy yields a certain protection against the corrupt use of the government power. Any challenge on any law, rule, or regulation has to face checking to ensure that it does not open the door to corruption, as a generic potential negative branch. On the other hand, the bureaucracy slows down the response of the government, and any government agency. This means there is a generic conflict between the huge value of being able to respond very fast to the needs of the citizens, and the need to

control the system from corruption and procedural unfairness.



Still, within the boundaries set by the stiff rules there is enough flexibility to improve the flow of services to the citizens.

Third key characteristic of the government environment:

Continued funding and authorization of government functions offers a generally stable environment.

Government agencies are usually stable environments, even though a change after elections, or a national disaster might introduce considerable changes, but then they are usually stabilized again. Their funding year-to-year is very stable and generally rises in attempts to meet the demands of growing populations. Continuity in funding, generally consistent missions, and pension systems that encourage employee longevity help to create a stable environment for government.

In his "Standing on the Shoulders of Giants" article, Eli Goldratt speaks about three aspects of stability.

I. The processes and the products do not change significantly for a considerable length of time.
II. Stability in demand over time per product.
III. Stability in total load placed by the orders on the various types of resources.

Being stable in all three aspects makes government agencies suitable for Lean, Six Sigma, and certainly the TOC tools in combination with Lean and Six Sigma. The immediate objective of the combination is to accelerate the time response to the citizens' requests, without harming the quality of the response.

A certain aspect of instability in governments is created by the nature of service – having to directly interact with the citizens asking for the service or product. This interaction can cause two different elements of potential instability. One, is the request for the service and the required information from the citizen applying for the service. This interaction usually doesn't cause considerable instability. The other element of dealing with complaints might cause certain instability, especially when the media, many times invoked by a specific complaint, gets involved. However, the forces of stability are strong in government and, as the issue is addressed, equilibrium is often reestablished fairly quickly.

The question is how this relatively stability can provide opportunities to deploy TOC solutions and methods. Consider the following theory for government and public sector agencies: That public sector organizations who use continuous improvement methods attain operational excellence more often and more profoundly than agencies who do not use continuous improvement approaches. According to this theory, a process of ongoing improvement is the path toward not only better and more public value, but also a viable way to achieve and maintain operational excellence. Perhaps the relative stability of government can facilitate ongoing improvement efforts by providing a consistent environment that is less subject to disruption than the comparatively more turbulent environments found in the private sector.

TOC strives to achieve very significant improvements, leading organizations to become ever-flourishing. It seems that with government agencies achieving a high level of operational excellence, producing consistently more public value, is a huge achievement. TOC appears to offer a way to provide government with ever-flourishing and ever-renewing processes of ongoing improvement.

Fourth key characteristic of the government environment

Government cannot control demand.

In government the mandate is to serve the community based on a set of rigorously established criteria. If demand for services exceeds capacity, like having an internal bottleneck, and government continues to accept new requests for services, causing more and more delays in the delivery of services, then this will generate widespread dissatisfaction and even resentment towards the government. Such undesired effects of high demand generally result in an appeal for more funding, which always takes long time to be effective in reducing the queue for the government service. Increased demand rarely results in definitive efforts to improve capacity within existing resources. We have seen this happen in healthcare due to Covid-19, a situation the citizens would not like to see ever again.

The use of TOC, which is especially tuned to reveal hidden capacity, could be of considerable value to prevent the problem from occurring and actually improve the response time to the citizens requests. The strategic gatekeeping inherent in Simplified Drum, Buffer, Rope (SDBR) may also serve to steady demand on governmental systems. Critical Chain Project Management (CCPM) has the potential to enable organizations to take on less projects in one snapshot period with the considerable reward of achieving many more projects on an annual basis.

Buffer Management, a unique feedback tool, is used to create one clear priority system for any government agency, that points what should be done next. It also serves as a warning mechanism when the demand grows too fast relative to the existing capacity. Buffer management can be used to prioritize improvement initiatives, pointing to the areas where an improvement would truly improve the performance of the whole agency.

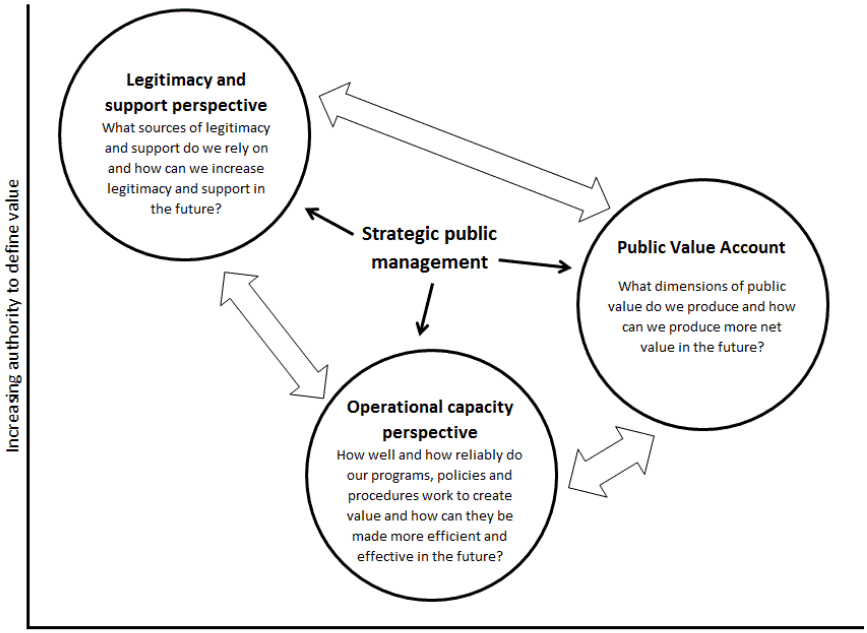
Anti-fragile organizations that are resilient to the ebb and flow of demand can build in contingencies and trigger points, which can be created with cross-training and subordinating less-critical functions to the constraining critical activities. Public managers can be educated on ways to manage the work, control

work-in-process, and predict bottlenecks, which can in turn reduce the high stress, high effort periods currently caused by unpredictable demand and the tendency to always begin all work immediately.

Fifth key characteristic of the government environment

Governments uniquely operate in a Strategic Triangle as they strive to find balance between expectations that they maintain legitimacy and support, produce public value, and maintain operational capacity.

Governments have to develop strategy as they navigate competing demands, allocate limited resources, and produce public value. The Government Strategic Triangle, which was developed by Dr. Mark Moore, reveals how government functions and reacts differently to stimulus from stakeholders than other types of organizations. The Strategic Triangle creates a distinctly different operating environment which is very sensitive to criticism and puts the legitimacy of government in a precarious situation. Government strives to maintain legitimacy and is loath to lose or risk any legitimacy, thus creating a predominately risk adverse environment. Change invites a degree of uncertainty which is unsettling to government employees and steering commissioners. Even efforts to improve hold a degree of risk and improvement projects are often viewed with suspicion or avoided altogether.



From: Recognising Public Value, Mark Moore, 2013

Government agencies have to strive to manage and balance the three elements of the Strategic Triangle and this push-and-pull makes determining an agency strategic path very difficult. Political pressures, mission, legal mandates, regulation, and stakeholder demand causes government organizations to tend to shy away from true strategic planning and efforts to achieve strategic change despite a rising need for transformation.

The TOC Evaporating Conflict Cloud has the potential of removing some of the core conflicts troubling agencies operating in the Strategic Triangle. For example, in many cases, agency leadership assumes that solutions are not viable because "that group of stakeholders would never go for it" when, in reality, agreement is only clouded by untested assumptions and unnecessary pre-requisite "wants."

The strategic thinking tools of TOC promise to provide government the wherewithal to meet the challenges of the Strategic Triangle and still be able to chart out a course of vision and transformation. Strategic planning tools like Current Reality Trees and Pre-requisite Trees can help government obtain strategic goals despite complex stakeholder entanglements. Future Reality Trees and Goal Trees can bolster strategic operations by offering government a way to connect high-minded goals with tangible tasks, projects, and improvements that will target constraints and result in decisive change.

Sixth key characteristic of the government environment

Government must pair money with authority to achieve legitimate expenditure.

In government available money and authorized authority are two different concepts. This dynamic must always be understood and managed in the public sector to a degree not found in other operating environments. Just because you have money in government does not mean you can spend it; you must have authority to do so. Even federal funds must be appropriated by State legislatures. State funded county programs are meticulously audited to ensure every dollar is spent on the program in accordance with elaborate expenditure rules. In government there are many colors and buckets of money which often expire within two years of assignment to programs. Projects hurriedly spend money from this fiscal year to prevent cost overruns next fiscal year. These factors introduce a mind-boggling complexity that often results in fiscal shortfalls or in mismanaged money that goes unspent despite critical public need.

Adaptive integration of buffers and throughput economics may enable flexible and logical expenditure on public priorities with less back and forth and at a lower cognitive load for staff. Authorized buffers could potentially provide emergency funding for unanticipated challenges. Perhaps shared buffers would free government agencies from the requirement that they spend every dime in this year's budget or face punitive budget reductions during the next fiscal year. Throughput economics also has the potential to identify programs with the highest system ROI and thus enable better fiscal decision making and budget allocation.

Seventh key characteristic of the government environment

Government has a unique responsibility to safeguard and care for its citizens, especially during disasters.

A government's legitimacy can be threated if it does not move swiftly and effectively to assist its citizens after natural or man-made disasters. This is because government is charged with the responsibility to safeguard and care for its citizens, especially during emergency situations and major change. Government can sometimes contract out the tasks of assistance and recovery to non-profit and for-profit companies, but it can never delegate away its accountability and responsibility to help its people in emergencies. It is in such moments of emergency that constraints management has significant potential to enable and elevate relief and recovery efforts. Two examples illustrate this potential and provide a glimpse of what wherewithal TOC might hold for post-disaster governmental operations.

Major Jack Snow was in eye of hurricane aftermath when he was put in charge of the Houston shipping and receiving docks dedicated to relief efforts by the mayor in the hours after hurricane Harvey hit the City in 2016. The situation was a mess. 18-wheelers with bulk relief supplies had converged on the City docks from every direction resulting in a snarling traffic jam. No one was arriving or departing the docks. The area was locked in a truck-strewn Gordian knot. An Army Reserve logistician, Jack had recently learned about TOC and constraints management in his civilian job where he investigated potentially fraudulent applications in a subsidized childcare program. He deployed his TOC knowledge energetically on the dire situation before him.

When Jack arrived a day after Harvey struck, City officials were distressed at the failure to distribute water, food, medical supplies, and other essentials to the flooded and devastated regions of Houston. The officials knew the relief supplies had arrived, but nothing was making it into the neighborhoods. They estimated it could take over a week to work out the traffic jam and get the docks functioning. But they did not anticipate that the TOC-trained Major Snow would apply the Five Focusing Steps and get the docks fully functional in less than 30 hours.

When Major Snow took command of the emergency supply operation at the Houston docks, he first identified the receiving docks as the primary bottleneck in the operation. Second, leveraging his logistical experience, he determined the optimal capacity the docks were capable of and worked to feed that constraint with uninterrupted supplies. Third, he ensured that all other activities of the trucks and the docks were subordinated to the function of receiving supplies at the dock. Then, fourth, he elevated the constraint by repurposing idle City workers to unload trucks, assess bulk supplies, and build "retail" packages that city trucks delivered to the neighborhoods.

At this point, Major Snow reassessed the situation and applied the fifth focusing step. He realized he had broken through the receiving dock constraint and shifted his focus to the shipping docks which he recognized as the new and enduring constraint of the operation. Major Snow's successful application of the Five Focusing Steps during the emergency situation is illustrative of a larger potential TOC has to assist government in disaster recovery missions. Government staff does not habitually work in distressed, emergency conditions, but TOC teachings can help them achieve their recovery goals by providing them proven TOC methods and techniques.

Similarly, Milan Gupta in India, combined his supply chain experience with TOC constraints analysis to solve a medical oxygen distribution problem that was contributing significantly to COVID casualties across the country.[3] Applying Little's Law to the known production rates, Milan was able to determine that the true constraint in the process was not oxygen production, as the government believed, but rather the transport time that was the defining constraint. Milan's analysis concluded that for the entire national distribution process "reducing the container travel time by just 1.7 hours will improve the daily supply rate to Delhi by the same amount as is achieved by importing/adding one more cryogenic container." This constraints analysis flipped all the government's current logic and assumptions because

[3] Linked in article, Oxygen Crisis: An Immediate Solution, by Milan Gupta, with discussions on the topic by contributing professionals, 27 April 2021, at https://www.linkedin.com/feed/update/urn:li:activity:6792791599370780672/.

he revealed the government's focus should be on improving transport times and not on improving oxygen productivity/imports, which was sufficient. Clearly, it was a transport problem, not a production/import problem. Many lives could be saved if we could focus on the right part of the process.

These two examples illustrate some of the "ASAP wherewithal" that TOC thinking and solutions could provide government leaders and staff who are handling a crisis. TOC knowledge has the potential to more profoundly enable government to safeguard and care for its citizens, especially during emergency conditions. Putting TOC thinking and solutions into the "kit bag" of government has the potential of decisively assisting those government leaders handling emergency situations caused by major change or disaster.

What can be achieved with TOC in government agencies?

From the TOC perspective the first mission is to define the public value, the products and services, generated by the agency. This is the key input for defining the goal-units, which TOC refers as the throughput (QT) of the agency.

Defining the goal-units for different products and services, notifying some requests as having higher value than others, might require careful judgment. For example, considering the response time to the requests as part of the value definition is an important component of quality in government, but not the only aspect of quality throughput (QT). Determining a definition for quality throughput will prove itself critical for achieving higher public value.

The use of conflict clouds has potential for overcoming certain obstacles, generated by the strict regulations. Finding solutions that do not compromise the regulations, but allow the generation of more value, is of considerable importance.

In many ways, the TOC applications of SDBR and CCPM, can be implemented in government agencies in a straight-forward way, with one obstacle: the key resources are human, so measuring their capacity is tricky. Also, the phrase "exploit the system constraint" has negative connotations. However, the promise of TOC's "breakthrough results" in the service of government, and the potential to address wicked constraints in our global community, makes overcoming the challenges a worthwhile effort.

Implications of the Theory of Constraints for Sales

A BOK Paper

Justin Roff-Marsh (Author of The Machine. Founder of Ballistix.)

Introduction

Traditionally, the Theory of Constraints (TOC) has been applied in Production and Project environments. In these environments, it has been adopted as an alternative to the traditional (cost-based) approach to decision making.

TOC's critical insight is that in modern work environments Throughput is constrained by a single resource at any one point in time. This is a function of specialization (division of labor) and the impact of natural variation on flow within those environments where operations are dependent upon one another (which, of course, is a consequence of the division of labor).

The implication of this single constraint is that a manager can choose to anchor the constrained resource in a single location (by deliberately maintaining protective capacity at all designated *non-constraint* resources) and that the constraint, once stable, can then be used as both a source of management intelligence and a means of exerting control over the performance of the environment as a whole. This means that short-range decisions can be made by considering their impact at a single resource, rather than attempting to estimate their impact across a complex network of resources.

This insight has been used to create scheduling frameworks (*applications*) for production, project, and distribution environments. And in many organizations, these frameworks have resulted in rapid, significant, and sustainable improvements in operational performance.

For this reason, TOC has been well recognized and well regarded by operations professionals all over the world for the last 20 years or so.

> It's worth noting that TOC is not really an approach to managing complexity (as is often stated). When faced with a complex system a TOC practitioner will initially use brute force ("choke the release") to simplify the behavior of the system (i.e. eliminate complexity) and then apply the appropriate TOC scheduling framework.

Until recently, the sales function has rarely featured in discussions of TOC.

There are two reasons for that. The first is that, for most organizations, there is significantly more upside in operations than there is in sales. As Say's Law counsels us, *supply creates its own demand*.

The other reason is that Sales is the one remaining organizational function to which division of labor has not been applied. In most organizations, the sales function consists of a number of autonomous individuals who are compensated on a piece rate and who assume almost total ownership of customer relationships.

Without the division of labor, you do not find the same network of dependencies that you find in production environments and, absent dependent operations, TOC's critical insight is not relevant.

It's also worth noting that the traditional approach of the TOC practitioner has been to make decisions as if the sales function doesn't exist. It's common to hear practitioners state that *the constraint has shifted to the market* when a production resource is no longer constrained.

When this statement is made, the implication is not that production has more capacity than the market (in aggregate) has demand, rather the implication is that the fraction of market demand that arrives in the form of purchase orders is less than the current production capacity.

Obviously, the implicit assumption here is that sales (and marketing) is not responsible for (or lacks the ability to increase) that fraction of market demand! If that were true, it would presumably make sense for the organization in question to liquidate its sales function and pass the reduction in operating expenses to customers in the form of lower prices.

This paper argues that, while the critical insight of TOC does not apply to the traditional sales function in its current form, there is good reason to apply division of labor to Sales. It then argues that the sales function, once transformed, will benefit from a TOC-based scheduling framework (or application).

Redefining the responsibility of Sales

It's obvious to all who look that the traditional design of the sales function is flawed.

In most industrial organizations, today, production is not fully activated even though the organization will produce the optimal return on shareholder capital when it is.

The reason why production is not fully activated is that the organization has already scaled its sales function past the point of diminishing returns. Practically, this means that the cost of additional salespeople is greater than the value that these additional salespeople will generate.

This inability to scale is the telltale symptom of a fundamental flaw in the design of Sales. No further evidence is required!

The flawed assumption that underpins the design of the traditional sales function is that *Sales should be responsible for revenue*.

While it feels correct, this assumption is wrong (and obviously wrong)!

In almost all organizations, in any reporting period, the greater proportion of revenue is not a direct consequence of salespeople's activities, it's a consequence of customer inertia (contented customers keep purchasing).

Now, salespeople will claim that they are responsible for the contentment of customers but this claim doesn't stand up to even the most casual scrutiny. If we look at the reasons why customers defect, in most organizations the primary reasons are all related to operational performance (on-time delivery performance, pricing, product quality, and product range). It's almost unheard

of for a customer to abandon a vendor with excellent operational performance, simply because they are unhappy with their relationship with a salesperson!

When we allow the sales function to assume responsibility for revenue, the inevitable consequence is that salespeople establish themselves as owners of customer relationships. This means that, as salespeople win customers, they spend an increasing amount of time servicing those customers and a decreasing amount of time pursuing new business. Paying salespeople on a piece rate amplifies this tendency.

In due course, management will come to realize that, even though the organization has plenty of salespeople, the entire sales team has evolved into highly-paid customer service representatives—who are too busy to sell!

Not surprisingly, this is not a scalable model. (Nor does it result in optimal customer care.)

If we recognize that contented customers keep purchasing, then we should also recognize that a customer is (at least, in economic terms) an annuity: a stream of future income.

And, if we recognize that customer contentment is primarily a function of operational performance then we should also recognize that operations must be made responsible for managing customer relationships, and not salespeople.

This forces us to redefine the responsibility of sales. Sales, in this new order, should be responsible for winning new annuities and handing them to operations to manage. New annuities, means winning new customer accounts and selling new categories of business to existing customers.

Importantly, the performance of the sales function should not be calculated by summing revenues over a standard reporting period. Rather, the contribution should be calculated by summing the *net present value* of new business won over that period.

The logic here is obvious, even though the conclusions are counterintuitive. This means that if you expose senior executives to this line of reasoning, almost all will admit that it is correct, without hesitation!

Division of labor

Our redefinition of the responsibility of Sales is not a trivial one.

It's so radical that we have no choice but to reimagine the design of the sales function from scratch.

A good starting point is to define, at the most fundamental level, the procedure for winning new business. Conceptually, the procedure is simple. We start with a compelling proposition. We then build a list of organizations—and ultimately individuals—whose business we wish to win. We then present this proposition to those individuals and pursue them until they resolve to either transact or to say *no*.

If we have a compelling proposition and if we perform these steps at a sufficient rate, then we will win new customers and sell new categories of business to existing ones.

The raw material we're working with here is what's called a *sales opportunity*. It springs into existence when we have paired a compelling proposition with a target individual, and it ultimately resolves to either won or lost (or abandoned) as a result of sales activities.

The primary sales activity is what's called a *selling conversation*. But there are other activities too. In major sales environments, the three notable additional activities are *requirement discovery, solution design,* and *proposal generation*.

The most interesting question now is, *for what, exactly should salespeople be responsible?*

The easy, and conventional, answer is, *everything*. However, this conclusion ignores two critical factors:

1. Salespeople are the only people in most organizations with the ability and willingness to perform selling conversations. But, if we allow salespeople to perform activities other than selling conversations, they will do so; and they will do so to the detriment of selling conversations (there is no better example of *student syndrome* in the modern organization than salespeople's general reluctance to pick up the telephone!)
2. There are other people in the modern organization who are more capable of performing all activities other than selling conversations. Executive teams do a better job of generating compelling propositions than salespeople do. Marketing teams do a better job of compiling lists of target individuals than salespeople do. And engineering teams do a better job of requirement discovery and solution design (or, at least, they do if they are resourced properly).

Accordingly, a smart executive will structure the environment in which salespeople operate so that it is not possible for them to perform any activity other than selling conversations. They will then manage this environment to ensure that salespeople perform a consistently high volume of selling conversations.

The generation of sales opportunities should be the responsibility of marketing (in conjunction with the executive team), and all other non-selling activities should be the responsibility of operations (engineering and customer service).

The design and management of the sales function

As mentioned earlier, without division of labor, TOC has nothing to offer the sales function.

However, with the structure proposed above, we now have a scheduling (or programming) problem. How do we coordinate work among all these specialists so as to ensure appropriate throughput?

For simplicity, this discussion will ensure that the sales function is the organizational constraint. This means that customer service, engineering, production, and marketing (as well as all other functions) have surplus capacity.

If Sales is the organizational constraint the implication is that the sales function should be fully activated at all times. And, if we peer inside the sales function, it's pretty obvious that the internal resource that should consistently be fully activated is salespeople (in almost all circumstances).

From this observation, we can conclude that:

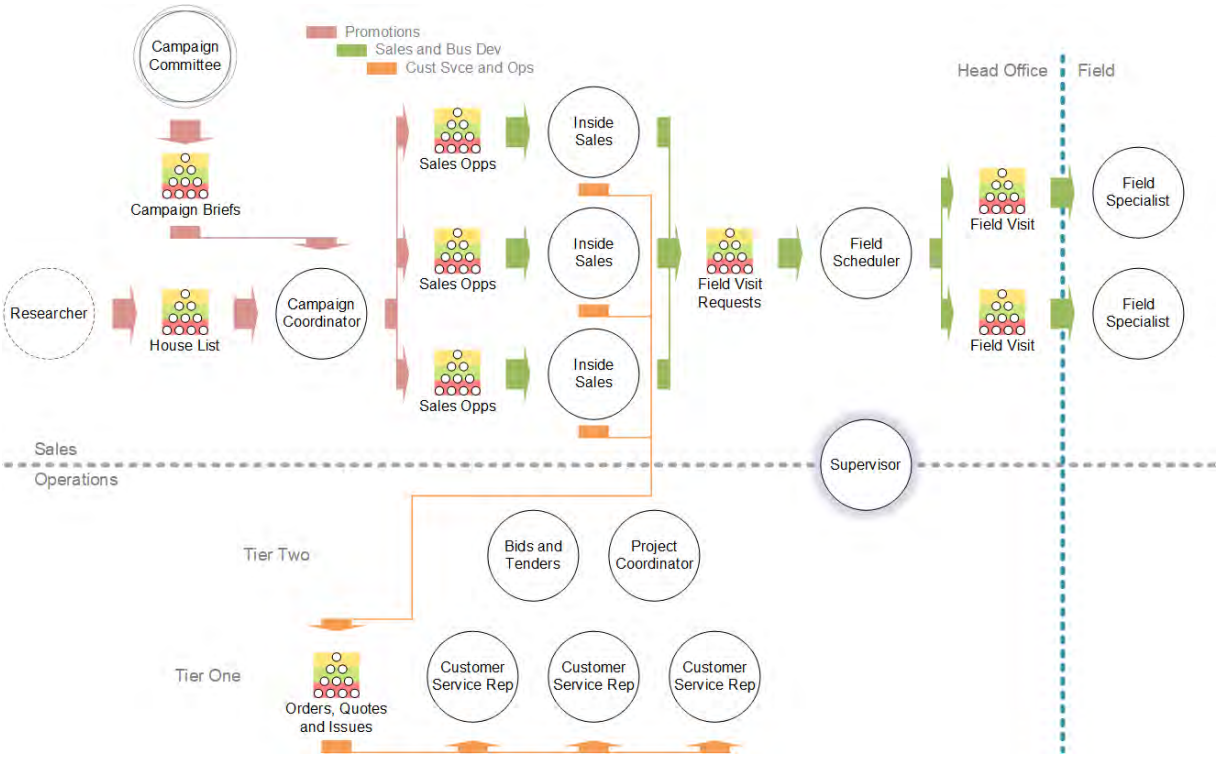
1. Marketing must ensure that salespeople never run out of opportunities to work on
2. Operations must ensure that activities for which they are responsible are turned around well within customers' reasonable expectations

Given that even the most complex sales process is relatively simple by production standards, it should not be surprising that *Drum, Buffer, Rope,* the TOC production scheduling application can be pressed into service here.

To ensure that salespeople are fully activated, marketing should maintain a queue of sales opportunities upstream from each salesperson (the *buffer*). The signal for marketing to replenish each salesperson's queue is the closure of an opportunity by each salesperson (the *drum*). It's important to note that an opportunity is closed when it's either won or lost. Technically, to ensure the existence of the salesperson's queue, the replenishment signal must preempt the salesperson's closure of their opportunity. This means that marketing releases sales opportunities to salespeople at a time equal to the time at which an opportunity is closed, minus a period, sufficient in duration to result in a buffer of appropriate size (this early-signaling mechanism is the *rope*).

Where other parties who contribute activities to the sales environment are concerned, the only necessary rule is that they consistently complete activities within a lead-time that is well within customers' reasonable expectations.

A typical sales function



The image above represents a typical end-state after an organization has transitioned to the structure described above. Please note the following:

- Customer Service is now considered part of Operations. The customer service team consists of generalist Tier One operators, supported by a smaller group of Tier Two specialists.
- Customer Service is responsible for all continuity business (existing customers, repurchasing). This means that they generate quotes, process orders and resolve issues (including questions and the like).
- The Sales function has been moved inside. A small team of professional internal salespeople, each have 10-15 selling conversations a day and do *nothing* else.
- While the Sales function may have moved inside, legacy salespeople probably have not. It's more likely that they have been transitioned into field-based Field Specialists. Their role is now to support both Sales and Customer Service with any and all face-to-face customer visits.
- The job of the Campaign Coordinator is to replenish salespeople's opportunity queues daily. Typically, a fully-activated internal salesperson will need about 100 opportunities in order for them to consistently perform 10-15 selling conversations daily. And, typically, they will process opportunities at the rate of about 10 each a day.
- If we assume that Sales is the constraint (Production is not fully activated), then salespeople's Opportunity queues are the constraint buffer. (Salespeople are the constraint).

- If the constraint moves to Production (which is often desirable) then salespeople can switch to selling offers that represent *free Throughput* whenever the Production constraint is fully loaded.

Transitioning to the ideal end state

While the ideas represented here are radical, it's important that the transition to the ideal end state is incremental and free of major risk.

The trick is to start with production and work backward, rather than starting with marketing (as executives are most likely to do!).

Practically, this means rebuilding Customer Service first to ensure that:

1. Customer service is performing all of the transactional tasks that were previously (at least in part) performed by salespeople
2. Customer service is performing these tasks at a significantly higher velocity and quality than salespeople previously were

The result of this new Customer Service team is that customer relationships will transition quickly (and naturally) from individual salespeople to the Tier One Customer Service team. The team as a whole, not specific operators.

Once it's clear that the organization's continuity business is safe, the next step is to build an internal sales team. In most cases, it makes more sense to staff this team with new operators and allow the legacy sales operators to stay in the field (where they are more comfortable).

As the internal sales team generates an increasing demand for field activities (demonstrations and detailed-requirement discovery), legacy salespeople can be transitioned into Field Specialist roles.

Common Questions (and answers)

Do salespeople like this approach?

The small number of salespeople in each organization's sales function who actually enjoy pursuing new business will probably like this approach. The greater majority who enjoy being overpaid customer service representatives probably will not.

A smart executive will recognize that this latter group should not continue to be salespeople in this new model. Our standard approach is to turn them into floating, field-based technical specialists.

The folks in an organization who will be most uncomfortable with this approach are not salespeople. They are sales managers! Rank and file salespeople and senior sales executives are well aware of the problems with sales (and of the distance between the traditional sales orthodoxy and reality). Middle managers, however, tend still to be believers in the orthodoxy.

If we get rid of piece-rate pay, how do we compensate salespeople?

The solution is to simply pay salespeople their market value (as is the approach with everyone else in the organization). Given the massive increase in productivity that this model will generate, management should be prepared to pay salespeople more than their current total earnings if this is necessary in order to retain them (it's probably not).

Do salespeople need to be in the field?

In almost every environment (particularly major sales environments) salespeople do not need to operate in the field. In current times, it is no longer practical to start conversations with potential customers in the field. Whether folks like it or not, every conversation starts on the phone. And if you look at the activities that are performed, once the conversation has been started, the typical ones that require face-to-face visits are *requirement discovery* and *product demonstrations*. Even though these activities are performed during the opportunity management process, they are not selling activities, they are technical in nature. Accordingly, these activities should be performed by technical people—either engineers or the floating, field-based technical specialists mentioned earlier.

How do I learn more?

You can purchase a copy of the author's book, *The Machine* on Amazon.com.

Goldratt's Six Questions for Assessing the Value of a New Technology

By Eli Schragenheim

Introduction: the importance of assessing the value of new technologies

The objective of the six questions is to lead organizations to reveal the potential value of developing a new technology. It is certainly critical for the organizations, many times startups, developing breakthrough technological advances to comprehend the actual value to the users. Better understanding of the value will help justify the investment, but also focus the development on the truly needed features and the marketing. Dr. Goldratt created the six questions as a leading tool for such organizations.

Actually the value assessment of new technologies is becoming more and more critical to all organizations! The flood of new technologies makes it necessary to come up with a quick objective analysis of the potential value to the organization. Too many organizations are exposed to slogans about Big Data, Blockchain, Artificial Intelligence (AI), Internet-of-Things (IoT), RFID, and so on. Every such technology gives the impression of a new wagon taking you to a new world. Only a cold objective analysis reveals the true potential practical value the organization can gain from the new technology as well as understand better the supporting conditions, such as the need to change some key policies.

In describing the six questions we'll use two imaginary new technologies as leading examples:

1. A non-rechargeable battery that lasts 200 times longer than a regular battery.
2. A word processor with two unique capabilities:
    a. Offering superior grammar check and more effective verbalization adjusted to the targeted audience.
    b. Perfect translation to several languages, which includes automatic adjustment to the target audience.

Question no. 1: What is the Power of the Technology?

The first question is the only one from the perspective of the technology itself. We definitely need a brief description of what the technology can do. We also need to understand the boundaries of the technology, making it clear also **what it cannot do!**

Applied to the battery, we need to know that it can replace the current common batteries, including size and voltage. Also we need to know whether there are exceptions that the current technology cannot, at this stage, replace. We need also to be aware that the cost of producing such a battery is about 25 times more expensive than a regular battery.

We probably need more information regarding the word processor's new capabilities. While the current common grammar and translation technological capabilities look on every sentence, the new technology, using artificial intelligence (AI), is capable of reading the whole document and deduces the nature of the writing, such as academic, journalistic, or popular. It also identifies whether it targets

young people, and whether the style could embrace slang or sophisticated language. The grammar and the effectiveness of every sentence are also checked. The use of AI means the quality of the document is going to be enhanced when more and more documents are being checked and re-written by the software in the future, as well as corrections the human author introduces after the software version.

The translation capability exhibits the same capability across other languages. Thus, a good document in one language is effectively converted to another.

Question no. 2: What current limitation or barrier does the new technology (or product) eliminate or vastly reduce?

The second question defines the meaning of 'value' for the users of such a new technology. While some people love new technologies as something that stirs the mind, like 'it is amazing what mankind is now able to achieve', this in itself doesn't yield practical value. In order to be practically worthy the new technology has to reduce a limitation, maybe even to eliminate it.

The user is the one that suffers from the existing limitation, thus eliminating it is the core of the value.

In order to assess the value it is absolutely necessary to identify the existing limitation, or barrier, that the user is facing.

While it is not clearly mentioned in the question itself, it could well be that a new technology eliminates more than one limitation, and the value could be different for different market segments.

In the example of the battery the immediate limitation is that devices stop, from time to time, without early warning, when we need them the most. The actual value depends on how critical it is to us at the time.

When we consider the word processor **the specific market segment** is of major importance. For most people, who mainly write emails, WhatsApp, and possibly routine posts on Facebook there is no real limitation that the new technology eliminates.

The new word processor reduces, even eliminates, two different limitations that are significant for specific market segments.

Limitation no 1: **The ability to quickly produce documents that conform to good standards of written text**, especially regarding using perfect grammar and good sentence structure. Such well-written documents are frequently used to impress the readers and/or deliver a clear message and the inability to quickly produce such documents that conform to the standards is damaging.

The relevant segments are:

- Organizations that frequently require standard documentations (technical documents etc.)
- Newspapers and magazines.
- Various publishers of professional text books.
- Professionals, like marketing people, where part of their job is writing documents.

Limitation no. 2: **Being unable to read and understand documents written in a foreign language**.

Optional market segments:

- Organizations with international activity.
- Academics, news agencies and other professionals with international activity.
- Book publishers including eBooks.

Question no. 3: **What usage rules, patterns and behaviors exist today that consider the limitation?**

While overcoming the limitation is the core value for the user, the current state is also critical to determine the difference in value between having to cope with the existing limitation and the removal of the limitation.

People do their best to bypass the limitations reality imposes on us. Detailing the current habits in dealing with these limitations is critical to gaining the value when the limitation is no longer active.

The current ways to deal with the batteries losing their power are:

- Using rechargeable batteries. However, this way still imposes stopping the work of the device until the recharge is complete.
- Carrying replacement batteries, even when the batteries are rechargeable. Some damage persists in the need for the batteries to be replaced.

So, the key damage is due to the limitation associated with **the time where the device cannot be used**.

Applying the 3rd question to the work processor also leads to several options to deal with the limitations.

There are three behaviors that currently handle the first limitation:

a. Ignore the quality of the writing – assuming it is good enough.
b. Spend a lot of time in writing the document, read and correct.
c. Using professional editors to polish the original documents.

The second limitation is currently handled by current translation software and using it with the warning that the translation cannot be relied on, or letting a professional translator to do the job. In many cases documents in foreign language, for which their value is not clear upfront, are totally discarded.

Question no 4: **What rules, patterns and behaviors need to be changed to get the benefits of the new technology?**

This question leads to recognize all the required changes the user has to do in order to draw the full value of the new technology. The insight is that we shouldn't assume the user is fully aware of the potential value and what changes are necessary to achieve the full value. While it makes sense that

users will eventually understand the requirements to draw the full value, it might take considerable time, which is bad for the developers of the new technology.

Part of the added-value of truly long-life batteries is giving up buying, storing and carrying regular batteries, which is currently the common practice. The other part is preventing the devices from stopping too often, or even at all.

If the new technology would also fit electrical cars, then overcoming the need to frequently recharge the batteries is of immense value. Likewise, such new batteries for smartphones eliminate the need for re-charging – again gaining considerable value. These two major potential segments might hint at another approach to the net value, which will be analyzed later.

For the batteries the behaviors prior to the new technology are easy to give up. In other cases it might be more difficult.

The new work processor, with its unique capabilities to improve the writing and being capable of translating with the same impact , does require changes in how people write documents and articles.

First, people without the skills and knowledge of writing good text, have now a valid option to communicate their ideas very effectively. Is it that easy to overcome the fear of writing?

People who are good writers still struggle to come up with good documents that express effectively their thoughts. Much time can be saved providing new writing opportunities. More, organizations with international activity are able to easily maintain the same level of articles and documents across all the countries they have business with.

However, working with a new word processor requires getting used to it.

Question no 5 (later version): **What is the application of the new technology that will enable the above change without causing resistance?**

This is mainly a call to actively look for negative consequences from implementing the required changes.

The question also urges the need to look for obstacles, which are practical difficulties in the implementation itself, like users resisting the need to be trained, or even read a detailed manual, just to be capable of using the new technology.

Once good answers to the former questions are received then it is a time to assess not just the added-value, but also **what it takes for the user to eventually draw the full value**, and also **what the user might see as loss of value**. The answer could be several additions and changes to the technology to make it more “friendly” while eliminating the negatives.

This is an important step that too many technology developers and enthusiasts too often miss. Hilarious as the new technology may be, dealing with the changes invoked by the new technology causes trouble as well. Realizing the negatives and balancing the added-value against the lost-value is not enough. Negatives can be resolved! It is the duty of management to make sure that the breakthrough doesn’t

blind them from seeing what the user might object to, and come up with improved overall usage of the new technology.

When we check the idea of batteries that last 200 times the current ones we might realize that for the user the cost of 25 times the price for regular batteries is a serious drawback. While there are cases where the added-value is worth the significant extra cost, in many cases this is definitely not the case.

Analyzing the impact of this cost could raise the idea of **relieving the user from the task of replacing batteries at all**. This could involve selling the new batteries to the electric devices manufacturers to be installed within the device. This fits especially devices that such a battery can be used through the whole device lifetime, like simple cameras, very simple smartphones (for 6 months of active life) and electric shavers. Other devices would still need to be replaced, possibly at a laboratory.

The analysis for the new word processor would raise the following reservations:

a. Having to learn a new word processor is hard for many who are used to Microsoft Word.
b. Some potential users might feel they are being dictated by the software to follow a certain style they don't like.
c. If such a tool would become popular it might harm the desire to learn foreign languages.

Analyzing the first reservation raises the question: As the value lies in the two unique capabilities, that are effective when the draft of the document is completed, then **what is the added value of the normal features of a word processor?** A feature that can be called independently, or even within, Microsoft Word, PowerPoint, or within internet browsers, can achieve most of the value without generating strong reservations.

The second reservation simply means giving up relatively small number of users who are too sensitive. After all nothing could prevent the user from subsequently changing the perfect text to reflect their style.

The cause and effect behind the third one should be scrutinized. On the one hand there would be less need to speak more languages as translation aids would be available, but on the other hand learning more languages would be significantly easier.

The conclusion is: the product application should be a program to be called from Word and other programs to translate/edit a document. Much more analysis is required to focus on specific market segments possible reservations.

Question no 6: **How to build, capitalize and sustain the business?**

While the previous question could easily lead to changes in the strategy for the new technology, this question leads us to integrate it within the overall strategy of the company.

The organization that develops the particular new technology, but maybe also other new technologies, has to see the full picture how the specific new technology is integrated with the marketing aspects as well as with all the other offerings of the organization.

Strategy in the TOC Way includes the specific requirements for 'Build', 'Capitalize' and 'Sustain'. 'Build' is focused on acquiring the required capabilities to generate the added-value to the customers. 'Capitalize' focuses on making it clear to the customers how to draw the full value, and 'Sustain' is how the organization ensures it has enough capacity to meet the expected significant growth of the demand.

Applying the sixth question to the two examples is difficult unless we know what else each company is doing, and many other aspects that are beyond value assessment of the new technology. The answers to the previous questions, especially the fifth question, yield direct impact on the global strategy of the companies.

The management of the company developing the long-life battery has to decide whether to focus on approaching producers of relatively short-life devices, which will include the battery as an integral part of the device, or sell the batteries directly to consumers. It might be possible to do both, but then sustaining the commitments to both markets has to be carefully planned with capacity buffers to ensure high delivery performance.

The developing company of the software that is able to improve the writing and translate to other languages has a key strategic issue: having an agreement with Microsoft to allow Word to access the special features from Word. It could well be that having a complete word processor at hand is used to pressure Microsoft to reach a win-win, where the company wouldn't come out with its own full word processor, in exchange for being able to make money based on the use of the special features. There is no doubt that the strategic issues of building the business case, capitalizing on it, and being able to sustain the success are absolutely critical to plan carefully.

Systematic Learning from Significant Surprising Events

Drawing the right lessons for improving the future

A BOK paper for TOCICO

by Eli Schragenheim

Abstract

It is easy to suggest to others to constantly check their assumptions. However, it is very difficult for us to even express many of our hidden assumptions and paradigms. Yet, it looks valid to assume that at any given time our achievements are limited by several flawed assumptions.

How should we effectively identify flawed assumptions and be able to update them?

The objective of this paper is instituting a systematic process of learning to reveal **the root flawed assumptions behind unexpected events, both good and bad, and draw the effective conclusions** for superior achievements in the future. In other words, the flawed assumptions reveal themselves by causing us to be surprised by an outcome we haven't expected due to a flawed assumption.

Just to illustrate the need, consider the blockage at the Suez Canal that began on March 28, 2021. The relevant question for the future is: **What was learned from that event?**

This paper defines the area where the regular Thinking Processes (TP) have to be used in a somewhat different way in order to explain surprising events that should be viewed both as emerging threats and also as the opportunity to overcome flawed paradigms.

Among other insights, the paper suggests using a team to inquire into a surprising event as a vehicle for gaining new understanding.

The proposed methodology for organizations to learn from such surprises consists of eight steps:

Step 1: Choose the right event to learn from.

Step 2: Create a team for the chosen case.

Step 3: Verbalize clearly the gap between prior expectations and the actual outcome.

Step 4: Raise a list of all possible explanations/hypotheses one can think of.

Step 5: Create detailed explanations and invalidate those that clearly didn't cause the gap.

Step 6: Identify the flawed paradigm/assumption.

Step 7: Develop the necessary changes in the policies and norms.

Step 8: Share the new understanding.

The first two steps are preliminary to any learning. The key to the process of identifying the flawed assumptions is described in steps 3 to 6. Step 7 is focused on drawing the value from the new understanding and step 8 is spreading the knowledge.

This proposed methodology could be viewed as part of the 'The Learning Organization' – an interesting and challenging objective. Some of the insights of this paper could push the current knowledge to more effectively achieving the higher objective.

Introduction

Are there clear signals whenever we make mistakes due to flawed basic assumptions?

It is logical to assume that there are. TOC succeeded to discover several common flawed paradigms in managing organizations causing severe negative impacts. This was shown through logic, simulations, and case studies, suggesting every organization is still trapped by flawed paradigms to some extent.

TOC suggests we start with the question: what most limits us from achieving more? It pushes management to build the cause-and-effect behind the current state, identify the limiting factors, and then ask what needs to be changed to get more. The TOC Thinking Processes (TP) is focused on the ongoing undesirable effects (UDEs) that are known to most members of the organization.

What the TOC Thinking Processes don't effectively cover is the area of being surprised by events, which could point to flawed assumptions that might cause huge damage in the future. The trigger for the unexpected outcome, which caused a surprise, could have been a recent change that wasn't fully noticed or understood. When that surprise doesn't initiate proper cause-and-effect analysis, then it could easily cause a serious threat that is too late to deal with successfully.

In almost every area of life, unexpected or unexplained events occur. The first reaction is to quickly handle the immediate situation, which is often referred to as fire-fighting. But this doesn't help much in preventing similar occurrences in the future.

This paper is focused on learning the **right lessons from surprising events**, in order to draw all the value from revealing a flawed hidden assumption, and realize new opportunities based on the updated assumptions. The surprise should be viewed as an opportunity to identify and update hidden invalid assumptions.

The most vicious obstacle to effective learning is the tendency to blame others. This paper claims that although negligence and bad intentions might be part of the explanation, it is not the common case. Most organizations operate under a flawed paradigm that every undesired outcome is because of a "mistake" made by a person who should be blamed for it and pay the price. Without understanding the flaw and how to correct it, the result of blaming is forcing people to hide information and refrain from any move that is somewhat risky. There is no positive value to blaming.

I'm aware that Kepner and Tregoe (1976) have dealt with the topic of using rational thinking for decision making. As this paper is focused on the TOC BOK, it doesn't go into comparing the two approaches.

The TOC current knowledge regarding learning

Dr. Goldratt pointed out the need to look for **inconsistencies** as signals to what we don't know. He used the term 'mysteries' as a trigger for learning since it is obvious that any mystery means that we are operating under at least one flawed paradigm.

The main 'bread-and-butter' of TOC regarding analysis of reality has been expressed in the TP tools.

The TP starting point is a list of several UDEs. The term 'undesirable effect' identifies a consistent **effect that is known and widely recognized as 'undesired.'** It raises the question about why the organization has not yet solved the UDE. The answer is that solving the UDE would create another problem. In other words, the UDE is the result of a conflict. Thus, the Current Reality Tree (CRT) starts with several UDEs and converges on a root cause. The root cause expresses a policy, measurement or behavior that causes damage. Presenting the root cause as a conflict (cloud) triggers efforts to reveal a flawed hidden assumption, thus leading to the development of superior policies, measurements, and behaviors.

However, **this kind of analysis does not deal with a new unexpected UDE**. A new and unexpected UDE cannot be translated into a conflict, because the causes behind it are not recognized. Thus, the damage associated with preventing the UDE is not known. We also don't know, at this initial stage, how the new UDE and its causes are connected to the current reality state of the organization. Additionally, we are unable to predict the full impact of the new UDE and its cause(s) in the future.

The norm of the TOC TP methodology is to verbalize the cause-and-effect logic in the present tense. This makes sense under three key assumptions:

1. People within the relevant environment are aware of the UDEs and recognize the conflicts causing them.
2. Whenever we claim that "If (A), then (B)" we actually claim that in the majority of the cases an incident of (A) causes (B). However, it could sometimes happen that (A) doesn't cause (B) due to an insufficiency that has not been included due to its relative rarity.[1]
3. The time of impact between the cause and its effect is relatively short.

Mapping the cause-and-effect logic of a specific past event has to be expressed in the past tense. We shouldn't assume the people involved were aware of the full relevant logic. We also have to consider the remote possibly of a mere statistical fluke.

[1] For example, "If a known politician is accused of committing a crime", then "The reputation of the politician with his potential voters is dropping." Sometimes, voters believe so much in their leader that they will deny the accusations.

The proposed methodology was developed in the mid-90s by Eli Schragenheim and Dr. Avner Passal, a behavioral consultant in Israel (Schragenheim and Passal, 2005). The process was implemented in several security-oriented units in Israel.

The fear of learning

Human beings fear to admit, or even realize, that while operating under a flawed assumption they have made mistakes in the past. Generally speaking, we need to deal with two different causes of fears preventing learning:

a. The blow to our ego.
b. Being blamed by others for making a major mistake.

The first is a conflict between correcting a flawed assumption for doing better in the future and protecting our self-confidence that we know what we're doing.

The fear of being blamed is tricky to handle because it is caused by the organizational culture encouraging internal competition. That paradigm means someone has to be punished for incompetence for any damage that occurs.

Goldratt's insight of *"Tell me how you measure me and I'll tell you how I'll behave"* points to the negative impact of blaming. Acting against the measurements causes blaming and punishment. "Mistakes" are interpreted according to the results that follow the actions. When people are negatively measured due to their "mistake", it is obvious that whenever an undesired result happens, people try to conceal their involvement, and by that destroy any possibility of inquiring about the cause.

A process targeted at identifying and fixing paradigms and assumptions without blaming, unless clear negligence and bad intentions were revealed, should be formally launched by top management. To do so, the process has to be based on sound logic, applied by a team, and aimed at revealing common assumptions that require updating. This is a necessary condition for reducing the fear of learning and promoting a culture of striving for excellence.

The systematic process of learning from a surprising event

Two leading examples for the process:

1. ***The company has just lost its largest client, who announced moving to the company's main competitor. The chief sales officer says that no formal complaints were ever received.***
2. ***A company producing food has launched a new soup expecting enough sales just to cover the development costs. Those expectations were based on mediocre results of the tasting team that checks all new products. The soup became the top fast mover of the company products.***

Step 1: Choose the right event to learn from.

The first step is to identify a worthy event to learn from. Focusing on the few variables that truly impact the performance is a key TOC insight. Thus, effective learning has to define when NOT to invest effort.

The first condition for dedicating the effort to learn from an event is being **significantly surprised**. Only then is the event worthy of being investigated.

Any surprise is caused by a significant gap between **the prior expectations and the actual outcome.**

Considering the first example: if the loss of the client didn't surprise anyone, then there is a bigger problem, and that event is just part of it. The right TP technique to deal with that case is the Current-Reality-Tree (CRT).

However, if the act of the client caused a real surprise, then there is a flaw in one or more assumptions concerning the relationships between the organization and its client. It is possible that the flawed assumptions might impact the relationships with other clients as well. Once this assumption is identified, new answers to the three key TOC questions are required.[2]

The second example poses a situation where the surprise is "good" – meaning the result is welcomed. However, the fact that the success of the new soup was a surprise signals that something important was not clearly seen a priori. Why were the expectations were so low when the market had eventually reacted enthusiastically? If better understanding of the critical elements for outstanding success is achieved, then it will lead to more successes and probably less mediocre ones.

There are two different categories of surprising events:

The first category consists of events where the clear a priori expectations didn't materialize.

The second category consists of surprises without any a priori well-defined expectation. One example is when an embezzlement is discovered by coincidence.

The main parameters for deciding to invest efforts to learn from a specific case are:

a. The gap between prior expectations and outcomes is significant.

b. The ramifications preventing the surprise to repeat in the future are relevant to the goal of the organization. For example, being greatly disappointed by the food at a supposedly good restaurant might have little future ramifications for the management of a paper manufacturing company.

Step 2: Create a team for the chosen case.

The fear of learning, certainly within an organization, is a tough obstacle. How can a person realize an old basic assumption is flawed without self-defense mechanisms coming to the rescue? Relatively few people have the ability to change their basic paradigms even when they face hard evidence that they are flawed.

A team has a better chance to deal with updating common assumptions, especially when it includes people with different life experiences and relationships that are not too close. It is critical to include

[2] What to change? What to change to? How to cause the change?

within the team **people who were involved in the specific event** and other people who were **external to the event.** This combination provides the full team with the closest current intuition on the cause-and-effect logic concerning the event, together with the ability to challenge well-rooted assumptions coming from the external people.

The inclusion of people who were directly involved sends a clear message that the objective is not to blame anyone, but to find better ways.

A team of 3 to 5 members seems right.

Step 3: Verbalize clearly the gap between prior expectations and the actual outcome

The **focus of the learning** is to understand the cause(s) of being surprised: the gap between prior expectations and outcome.

Thus, clear verbalization of the gap should ignite the cause-and-effect analysis that leads to a focused search for the flawed assumption(s) causing the gap.

When the prior expectations were clearly verbalized, like in detailed planning, then the gap is easy to verbalize. Some caution is required as **the planning objectives usually represent the optimistic assessment**, while the real expectations might have been lower.

Many cases of big surprises, good or bad, happen without any record of prior expectations. The feeling of surprise means the expectations weren't met. So, the first need is to verbalize the gap and get full consensus on it.

When analyzing the first example, the team should realize the gap is not losing the client, but not knowing ahead of time that the client is considering moving his business elsewhere! The gap should be described like this:

Prior Expectations: ***We have a good idea how the client views his business with us.***

Actual event: ***The client stopped his business with us without us getting an early signal.***

The second example leads us to the following gap:

Prior Expectations: ***We have a good idea of the prospect of success of every new product based on the testing of the taste team.***

Actual event: ***A specific soup had huge success that was not predicted by the test.***

My own experience in leading inquiry teams shows that verbalizing the gap is a significant step which takes considerable time to get consensus of all the team members. The following steps went much more smoothly due to the agreement on the focus of the learning.

Step 4: Raise a list of all possible explanations/hypotheses one can think of

The Categories of Legitimate Reservations (CLR), a key part of the TP, include the "Another cause" reservation. Even when we have a cause and a valid logical cause-and-effect branch starting with Cause 'A' leading all the way to Effect' Z', it is still possible that 'Z' is being caused (as well) by another cause 'B'.

The TP deals with chronic cause-and-effect where frequent actions are causing the same effects. It is still possible that Effect Z is caused by several causes, some more frequently than others.

Here we have a somewhat different situation. We have an UDE that happened, so far, just once. It seems obvious that there might be several different possible causes, so it is easy to get stuck by one possible explanation and ignore all others. In order to reach the right conclusions, the team has to evaluate the validity of **every potential explanation** that looks somewhat possible.

There is a need to raise many possible explanations, hopefully covering the whole scope of possible explanations, to gain confidence that the analysis would point to the true cause(s).

Coming up with a possible explanation is NOT the equivalent to a detailed cause-and-effect branch. It is just the first step aiming at expressing the gross possibilities. The next step is where a cause-and-effect branch would be constructed and tested!

For instance, when we view the second example, such a high-level potential explanation could be: "There was a mistake in the recording of the data of the tasters."

This is an initial statement of a direction for a full explanation. At this stage, such a statement of a possible explanation is enough, provided all the team members understand it might explain the gap.

Generally speaking, we can distinguish between two types of explanations:

1. Claiming the expectations were not realistic to start with.
2. While the prior expectations were justified, something else went wrong.

The focus in this step is **to cover all the possibilities of explanations** before determining which one is right.

Step 5: Create detailed explanations and invalidate those that clearly didn't cause the gap

The objective of the fifth step is to identify and validate the **operational cause**. Two missions are interwoven in achieving this objective:

1. The first is to turn every explanation/hypothesis into a full cause-and-effect branch. We need to ensure that every explanation/hypothesis looks complete.
2. The second mission is to answer the following question:

Did it really happen like this in reality?

As the explanation could involve several causes, the question is whether it is possible to validate that all the assumed causes truly happened leading to the gap between the prior expectations and the actual outcome.

There are four broad ways to validate or invalidate whether an assumed cause has occurred.

a. ***Direct validation that the effect did or didn't exist at the time.***

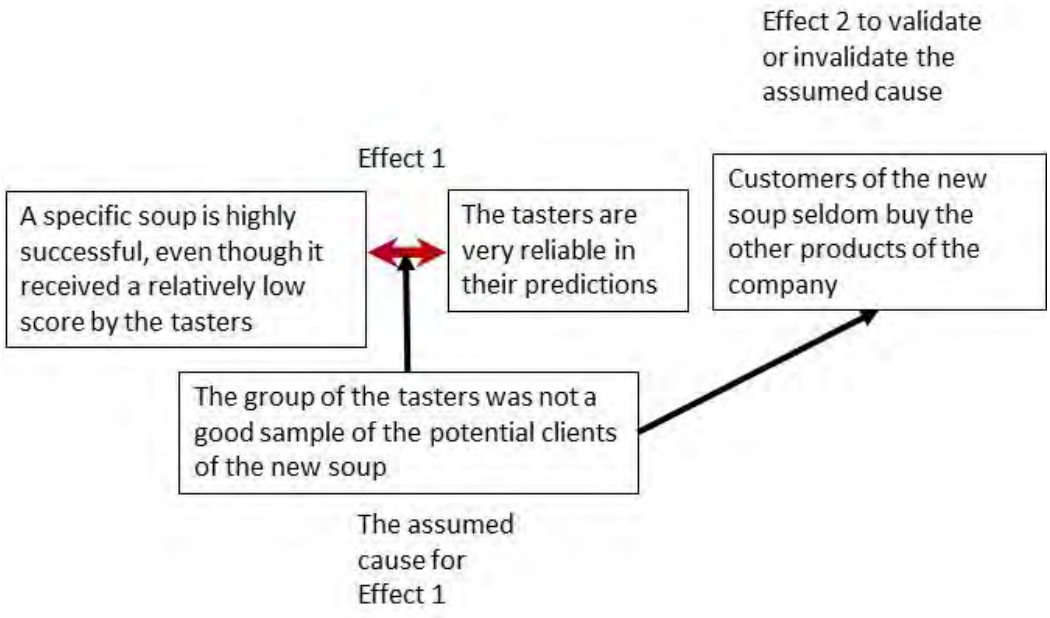
For instance, the effect of "There was a mistake in the recording of the data of the tasters" could be easily validated or invalidated by checking the recorded answers on the original forms filled in by the tasters.

However, it is not always possible to directly validate a proposed cause. One example is the following hypothesis: "The group of tasters was not a good sample of the potential clients of the new soup".

b. **Using the effect-cause-effect basic structure**.

The term effect-cause-effect was used by Goldratt to validate proposed causes. The idea is to show logically that if that cause existed at the time, then it had to cause another effect, which we might be able to use to prove its existence.

For instance, if the assumed cause "The group of the tasters was not a good sample of the potential clients of the new soup" truly existed, then if we inquire about the sales data from the supermarkets and see that customers who bought the new soup did not usually buy other products of the company, we can conclude that the assumed cause seems to be valid. Note that even though effect-cause-effect is widely used in science to validate hypotheses, it can never fully prove any hypothesis; however, it could prove the hypothesis is invalid.



The effect-cause-effect method is especially strong for invalidating certain hypotheses as validation is probable rather than proven. In the above example, if the correlation is high, there is still a chance that the assumed cause is still valid.

c. **Identifying a cause for an effect**.

Suppose that in inquiring into the crash of an airplane one of the explanations is that "the pilot made a human error". It is difficult to validate whether this was true. What might be used to validate this hypothesis is to identify a cause for such an error. If we find that the pilot did not sleep well or had a very pressing personal situation, then the hypothesis has some support.

A partial, but practical, validation:

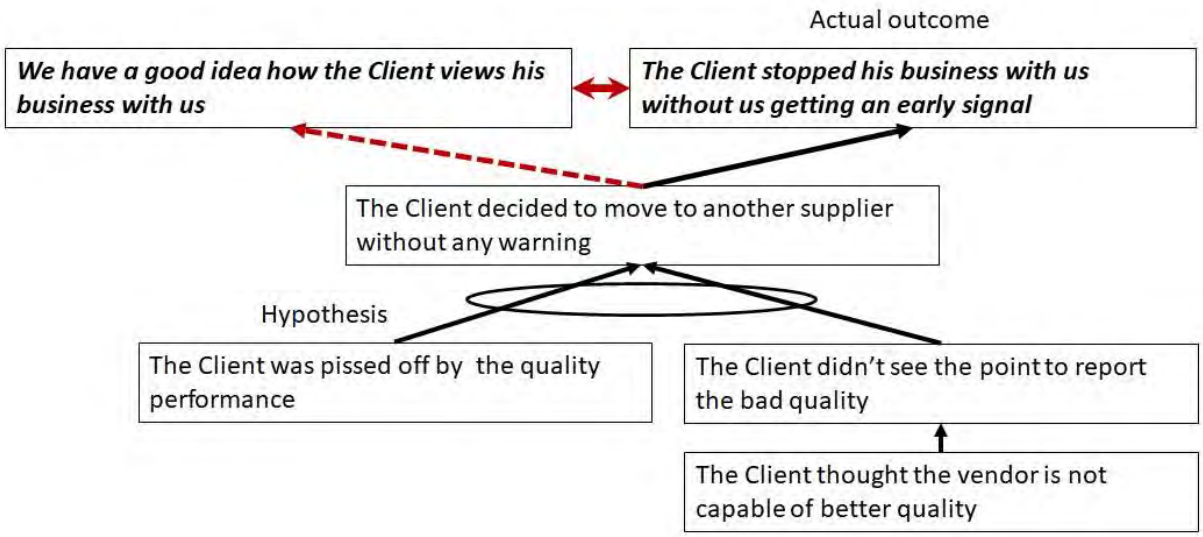
d. **All other possible explanations have been invalidated. This is "proof by elimination".**

Step 6: Identify the flawed paradigm/assumption

This step is clearly divided into three sub-steps. First, the team needs to fully verbalize the logical connections for each hypothesis explaining how it **might** explain the gap. Then sub-step 2 requires the team members to actively look for the '**core operational cause**', which the group of sufficient facts that have caused the gap. The third sub-step would force the team members to dive down from the operational cause to identify the flawed assumption or paradigm that caused the operational cause.

Sub-step 1

Each hypothesis is checked for its logical connection leading to the gap. In the first example, let's begin by checking one possible explanation for the client moving to another supplier, which assumes the client was pissed off because of bad quality. The simple initial logical claim is:



This is a logical possible explanation of the gap. The specific hypothesis explains the surprise of not having the signal: the Client thought the vendor is not capable of better quality.

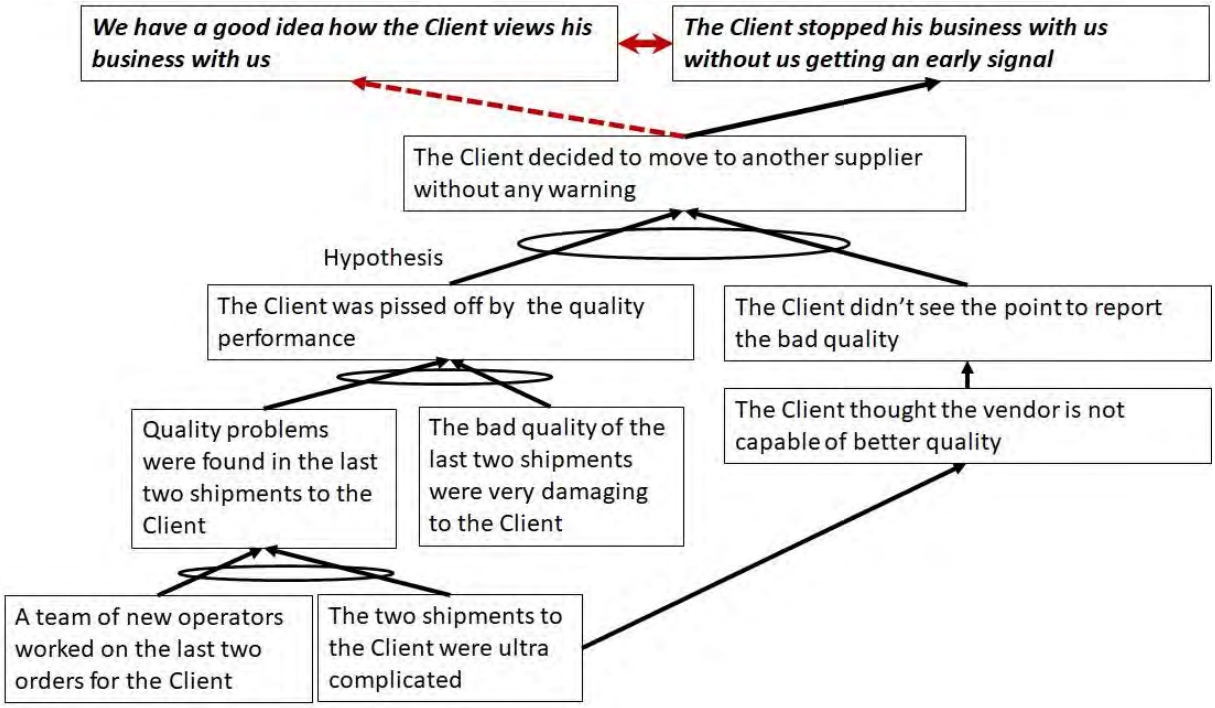
Note, this is still a hypothesis, not necessarily what truly happened. All the entities at the bottom need to be validated in reality!

All the hypotheses should be built to this level before going to sub-step 2.

Sub-step 2

The main body of this sub-step is to check facts that would either **invalidate or validate** the hypotheses. The emphasis on invalidation is to rule out the definitely wrong hypotheses. Note that it could well be that more than one hypothesis is validated – so, the event was the result of a combination of effects. It is less likely that there will be more than one flawed paradigm without one causing the other. In such a case, it is important to assess which one has the stronger and wider effects.

The objective is to **uncover the core operational cause**. The resulting new cause-and-effect structure is:



The effect of "A team of new operators worked on the last two orders for the Client" appears to be the core cause that led to the gap. We should now proceed to the third sub-step.

Sub-step 3

The mission now is to ask the question: Why did **the core operational cause happen?** The regular TP would call for constructing a cloud. However, in such a case which never happened before, **there is no obvious conflict.**

So, why did the company let a team of new operators, supposedly well trained (this has to be checked in reality), deal with complicated orders without special quality checks and attention of a more experienced supervisor? Diving down the logic has to confirm that special supervision did not take place. Let's suppose that this has been validated.

The existing paradigm, which worked fine so far, has to be carefully verbalized. In this particular case, we could verbalize it as:

Our operators have been properly trained and thus are equal to the more experienced ones.

When people discover a flaw in a basic assumption then the automatic response might be to reverse the assumption. This is a very erratic behavior. One has to realize that the paradigm had been a good match to reality in many previous cases. Thus, the team needs to record the cases where the paradigm worked well ***and identify the difference between this case and the previous ones*** that made the paradigm to be wrong.

Every paradigm is actually a small branch of cause and effect. Let's verbalize the original paradigm:



When we notice that in this particular case the operator's job was not routine then we could update the original with the following paradigm:



The team should be challenged to generalize the new assumption to a wider area. Possibly the original assumption is thought to be valid **not just for operators**, but for other roles within the organization! For instance, could be that the original assumption would fit also salespersons.

The team should do their best to verbalize the most generic new assumption, actually an updated paradigm, to fit the reality of the organization and its environment.

For instance, the more generic updated paradigm could be:

Our employees and managers are well prepared for their routine jobs; however, when an ultra-complicated mission appears, expert support should be given.

Step 7: Develop the necessary changes in the policies and norms

We have reached the stage to develop the Future Reality Tree (FRT), deriving all the changes that are required due to the update of the flawed paradigm. In most ways, this is quite a regular FRT.

What makes this process a little different is that the desirable effects (DEs) are usually prevention of threats in the future.

As the whole learning was initiated based on one UDE – a gap between prior expectation and an actual event, **the ramifications of the FRT could and should look much wider than the original objective**. This sort of FRT requires more care and attention from the team because the ramifications of a flawed basic assumption could touch upon issues that were not mentioned at all in the previous analysis.

In the first example, we could assume that examining again the quality of work from new employees might lead to different policies in Operations and Sales, in addition to probably analyzing the performance of newly promoted managers.

Let's assume that the analysis of the second example has revealed the following paradigm:

The average score of the taste team predicts well the expected sales.

However, there is a clear difference when half of the group loves the new soup, while the other half hates it. Those who love the soup would probably buy the soup regularly, while the others won't buy at all. From the sales perspective, a 50% market share is GREAT. The full analysis should check the new assumption by running the statistics on the old tasting tests and validate whether the correlation with the actual sales is higher. If that hypothesis is validated, then changes to the general strategy for new products should be introduced.

TOC has not dealt, so far, with **the identification and prevention of threats to the organization**, with the exception of the concept of negative branch reservations (NBRs), which is focused on the threat of implementing new ideas that cause problems. The whole process described in this paper is designed to look for flawed paradigms, which mostly mean potential threats, but also learning to look for potential opportunities that are hidden below "good surprises", which this process also handles.

This paper does not detail the process of building an FRT, including raising the negative branches and the trimming of those, as these are all covered in the TOC regular knowledge. The implementation procedures are also skipped, with the exception of spreading the new learning within the organization, which is the last step in the proposed process.

Step 8: Share the new understanding

Implementing the new policies that stem from the updated paradigm is not the same as **sharing the experience** of identifying a common flawed assumption and updating the paradigm.

Making **a story** of the discovery has the potential of delivering the idea of the search for new understanding through keen interest of those who have not been involved. The bare facts of the event that initiated the learning are key in generating interest of other people. Presenting a very concise version of the final cause-and-effect tree as a story is a powerful way to communicate the logic, including the policies that have been changed, and the negative branches and their trimming ideas.

The shorter we can express the logic and its impact, the higher the chance that people who were not involved in the event would learn the lesson.

Addressing the fear of learning

For the whole process to be implemented in an organization, overcoming the obstacle of fear is a must. Implementing such a process requires a clear effort of top management to change the culture. Instead of the norm "do not make mistakes" as an appreciated value, management should lead based on the very different norm of "**making mistakes the first time is inevitable, repeating them is bad!**"

A key paradigm in programming software is: **it is not possible to prevent bugs in software**. The mission is to be able to identify the bugs and fix them as fast as possible. This is the common culture in developing software. If we can somehow implement this kind of culture in the organization in a generic way, then the proposed process would be easier to implement.

The TOC culture certainty backs up the need for learning from mistakes through its "challenge your own hidden assumptions" insight. This process makes this insight clearer and stronger and should be, in the author's view, an integral part of any TOC implementation.

Experiencing the process

The main ingredients of this process were developed by the author and Dr. Avner Passal. It was implemented in several security-oriented organizations in Israel. The implementations were not TOC-oriented and the TP was not utilized. Instead, the need for logical verbal explanation was emphasized, including the need to check sufficiency, which seems to be the most common mistake people make when raising logical arguments.

The author has led several teams to inquire about events that were identified not just as surprising, but also as painful to the organization. While details of the specific inquiries cannot be revealed, two effects seemed to be common to all:

1. Verbalizing the gap took a relatively long time, but then the rest of the inquiry was fast.

2. The teams were amazed by the scope of general ramifications from fixing the flawed paradigm.

References

Barnard, A., and Morgenstern, B. (2012) “Learning from experience: Why we should, why we don’t and how to do it”, 10th TOCICO international conference.

Schragenheim, E. (2003) “Learning from Experience” 1st TOCICO international conference, Cambridge.

Schragenheim, E. and Passal, A (2005) “Learning from Experience – A Structured Methodology Based on TOC”, Human Systems Management No. 24, pp. 95-104

Kepner, C.H. and Tregoe,B.B (1976) The Rationale Manager: A systematic approach to problem solving and decision making. Kepner-Trego Inc (2nd Ed.)

The TOC Pillars – a Whitepaper

Humberto R. Baptista

Feb/2021

Introduction

Eli Goldratt wrote in the introduction to the first edition of The Goal[i]:

> *"Finally, and most importantly, I wanted to show that we can all be outstanding scientists. The secret of being a good scientist lies not in our brain power. We have enough. We simply have to look at reality and think logically and precisely about what we see. The key ingredient is to have the courage to face inconsistencies between what we see and deduce and the way things are done."*

And in the third edition[ii]

> *"The Goal is about science and education […] science is simply the method we use to try and postulate a minimum set of assumptions that can explain, through a straightforward logical derivation, the existence of many phenomena of nature. […] This book is an attempt to show that we can postulate a very small number of assumptions and utilize them to explain a very large spectrum of industrial phenomena."*

With these and the name *Theory of Constraints,* it is clear that TOC was created to be a Science aimed at explaining and consequently managing human organizations.

It is then more than reasonable to ask: what are the basic assumptions of TOC? Nicknamed "The Pillars," these are the basic building blocks that enable understanding how organizations function and how to improve their performance in a practical and logical way.

The Pillars are not etched in stone, were not developed all at once, and not worded as they are now. This dynamic nature is a characteristic of any living science, the ongoing process of expanding knowledge either by introducing new assumptions or replacing old ones with more general and far-reaching ones.

This whitepaper will present the five Pillars of TOC in the form that Eli Goldratt explained them. Other authors have explored these concepts. Some of the most relevant are listed at the end of this paper.

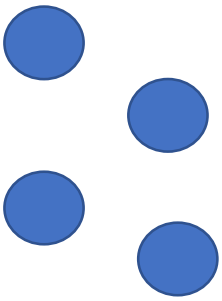
Inherent Simplicity

In the series of videos *Necessary and Sufficient*[iii] - Section 2, "The Basic Assumptions of TOC," Eli Goldratt states that "TOC is nothing but the extension of Physics, or for that matter all the hard

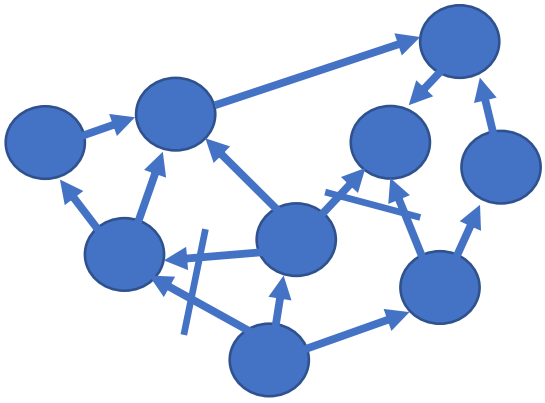
sciences." And he proceeds to highlight that the approach of the hard sciences is based on few beliefs, which are usually associated with specific (and sometimes unusual) definitions of common terms. The first one is "complexity." The usual (or social sciences) definition of "complexity" is very different from the hard sciences (and the TOC) meaning. This difference creates many important consequences.

To understand the differences, and their effects, let's consider two systems:

System A



System B



Here the different definitions of complexity are opposed: in the social sciences definition, System B is more complex than A, while in the hard sciences System A is more complex than B.

Let's compare the different definitions of "Complexity":

- Social Sciences
  "The more data needed to fully describe a system, the more complex it is."
- Hard Sciences
  "The more degrees of freedom a system has, the more complex it is."

Degrees of freedom refers to how many points must be affected to impact the whole system.

System A is more complex with the hard sciences definition because all points (circles) must be affected to impact the whole system, while in System B, affecting only the bottom point generates ramifications and impacts the entire system (through the cause-and-effect relationships illustrated as arrows).

The hard science's definition leads to the fundamental belief: "There are no complex systems in reality."

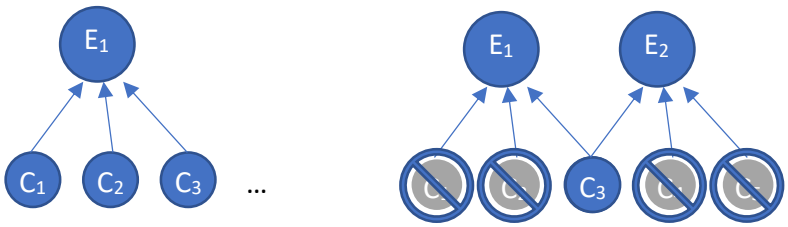
As we increase our understanding of real systems, we discover more cause-and-effects relationships among their parts. And the more connections a system has, the fewer points we need to affect to impact the whole system. In other words, real systems are highly interconnected and have few degrees of freedom.

The Social Sciences view leads people to think that to improve an organization, one must improve every part of it. Still, the fact that all parts are interconnected with cause-and-effect relationships means that if you try to improve one aspect without addressing its cause, the results will be minimal.

So, the first Pillar of TOC is:

> ***Inherent Simplicity**: systems (for instance, organizations) are inherently simple, despite their apparent complexity. In other words: a few or even one point (Constraint) controls the performance of the whole system, and a few or even one cause (Core Problem) generates the vast majority of the problems.*

In the book "The Choice," Goldratt highlights the fact that one effect can have many causes, but as we consider more and more effects in one system, the number of causes drops dramatically:



Only common causes to <u>all effects</u> remain. Causes of one effect that aren't causes to others are eliminated in this process. And this also indicates that the more effects we consider in one system, the fewer causes will explain all of them. In other words, there is *Inherent Simplicity* in deriving the causes of multiple effects.

Inherent Consistency

Also, in Necessary and Sufficient, Section 2, Goldratt defines a "Problem" as a conflict that prevents a system from achieving its objectives. And presents the second fundamental belief: "There are no conflicts in reality." Here the word conflict is a synonym with inconsistency (or contradiction). Goldratt also states that "no physicist will compromise" when presented with a conflict/inconsistency.

The conclusion of the hard sciences (and therefore TOC), when confronted with an inconsistency, is that there must be a mistake somewhere. Since "there are no conflicts in reality," we must conclude that we, humans, made a mistake.

An example is two methods of weighing an object. If the two produce very different results, scientists will conclude immediately that one or even both are wrong. Or it may be even that

our concept (or understanding) of weight is wrong. Never a scientist would say "let's compromise" and average the two results, for instance.

We come to a paradox: if there are no conflicts in reality and conflicts prevent systems from achieving their objectives, how come we see tremendous struggles in human organizations trying to achieve their objectives? This comes from the fact that the only place where conflicts can exist is our minds, a place outside the physical reality. And if we try to use these thoughts of conflicts to describe reality, we will unavoidably miss essential aspects. Why do we think there are conflicts if there is no evidence of it? Because we hold invalid assumptions, preconceived ideas that create inconsistencies in our interpretation of reality.

The natural conclusion is that each perceived conflict must come from an invalid assumption(s). So, we come to the second pillar:

***Inherent Consistency (Harmony)**: There are no conflicts (or inconsistencies) in reality. All conflicts (on inconsistencies) exist only in our minds. One or more invalid assumptions produce any perceived conflict (or inconsistency).*

Inherent Goodness

We can see in many places Eli Goldratt stating that even though someone may present an obstacle to a significant improvement, this is not because "they are stupid." He lays out the logic behind people's actions and behaviors that lead to the resistance to change. In the Satellite Program (later renamed to the Self Learning Program or SLP), section 7[iv] deals with People Management. And here, he introduces one of the most misunderstood Pillars of TOC.

Right at the beginning of this section, he proposes one word to summarize what people know about managing people: Respect. And from there, he proceeds to uncover the conflicts that make it so hard to give and receive respect. It is clear that to give respect requires work. It is implied that we need to understand people's assumptions and motivations to respect, which is the basis for the third pillar.

During the years that followed, Eli Goldratt and many colleagues revisited this concept, and the synthesis came in the book The Choice[v]: he states that the third pillar comes from a bad habit: when something goes wrong, there is a strong tendency to blame people. And when we do so, our capacity to understand plummets and relationships deteriorate.

In chapter 16, Efrat Goldratt goes: "How can I seriously entertain the opinion that people are good?[…] On the other hand, Father's approach is pragmatic, and it does work. […] If I want to improve my chances of living a full life, I'd better learn how to think clearly. And to do that, I must overcome the obstacle of my tendency to seek refuge in blaming others; raising derogatory explanations."

This pillar's crucial point is to recognize that Goldratt is not talking about people's nature when he states: "People are good." The affirmation is a working assumption, in other words, a mental stance that steers our thinking away from blaming and towards assumptions and circumstances.

So, the third pillar is:

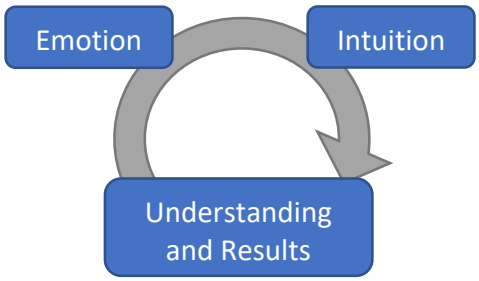
***Inherent Goodness**: People are good. The reasons for anything that goes wrong do not come from people's nature (good or bad) but from their assumptions and circumstances.*

Change/Improvement

Also, very present in Goldratt's thinking is that there is no practical limit for improvements. That any situation can be substantially improved. In "The Choice," he comes back to this notion, and in the Keynote address he prepared for the 2011 Conference[vi], he clearly states the fourth pillar: "Never Say I Know." And the associated process is called "Standing on The Shoulders of Giants."

What is meant by this statement? There are two fundamental lines of thought behind it: the first is the interplay between emotion intuition and logic, the second is behind the structure of cause and effect.

Goldratt explains to Efrat in Chapter 18 of "The Choice" that his logical view of the world is not cold, and this is not just a vain attempt of sugar-coating how logic applies to rational and irrational behavior. He points out that when people care about a subject area, they have strong feelings about it. With the energy from this feeling, there is the possibility to develop more and more intuition about the area. And eventually, the intuition coalesces into new understanding and new results, which is a powerful emotional moment. So, the loop goes:



And he points out that thinking clearly is an excellent accelerator of the connection between "Intuition" and "Understanding and Results." Looking at this loop, we can see that it is like a helix propelling people and results upwards. That is why we should "Never say I know": if we

for one moment believe we know something entirely, the cycle is broken, and we'll be prey to a self-fulfilling prophecy.

The second part comes from the subtitle Goldratt chose for this pillar: "The more solid the base, the higher the jump." It comes from the structure of cause and effect: as we face inconsistencies and expose invalid assumptions (Inherent Harmony pillar), we reveal deeper causes. And deeper causes cover many more effects than the shallower ones. This means we gain more knowledge and influence over a broader field. And with that, we conclude that by seeking deeper causes, we'll have enormous jumps in the knowledge. When we read the subtitle, we notice Goldratt mentioning, "The more solid the base," which is a clear indication of the cause and effect thinking and how we can rely on it (via Inherent Harmony) to grow and cover more and more.

***Inherent Potential**: Never say "I Know." The more solid the base, the higher the jump. Any situation can be substantially improved. Thinking otherwise will almost guarantee it won't.*

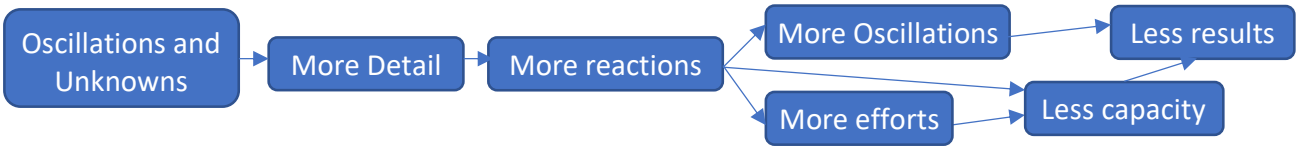
Variability & Uncertainty

The book "The Choice" covers what is needed for an individual to live a full life. It is not covering what is necessary for an organization to be successful in the long run. Goldratt was writing another book that was supposed to be his last when he passed away in 2011. This book was titled "The Science of Management," and Goldratt published its introduction in a video[vii] where he reads the introduction and includes more explanations on the principles (pillars) of TOC.

In this work, he revisits the Complexity (countered by Inherent Simplicity), Conflicts (countered by Inherent Harmony), and he verbalizes another crucial problem: The fear of Unknown. And with it outlines another TOC pillar.

The problem is that people, especially in organizations, when faced with unknowns and variability, usually respond by diving down into more details and increasing the resolution of the control mechanisms. For instance: problems in managing the budget can lead to a more detailed account structure and more control points in tracking movements, unknowns in delivering projects in time, scope, quality, and cost can lead to more detailed plans, and so forth.

The detailing makes people more likely to react to small oscillations that are in the vast majority innocuous and intrinsic to the organization's everyday life. The energy, time, and effort dedicated to pursuing small fluctuations drain essential resources from managing and improving more significant areas and movements in the organization, leading to diminished performance and people working harder.



As we can see in the logic above, the effects are quite devastating. And the efforts spent are often confused with productive work.

The pillar outlined by Goldratt here is the basis for TOC buffers and their respective buffer management.

Since Goldratt did not coin a specific term for this pillar, we must read between the lines and pick one. The desired effect of the pillar is to allow people to know when they should act upon fluctuations (act on the "signal") and when to do nothing (tolerate the "noise"). Another effect is to allow for plans to be followed under the majority of normal oscillations present in the system (using buffers to protect the commitments). As we can notice, the usual response is to act, and the pillar is to remind and guide us when not to do so. Therefore:

***Inherent Tolerance**: Don't optimize within the noise. All human-based organizations have fluctuations. Reacting to all regular fluctuations ends up amplifying variability. Planning and execution must explicitly account for them with simple mechanisms to withstand regular fluctuations (without any further actions) and react to extraordinary ones.*

Other Sources

Other sources illustrate important concepts related (or included) in the five pillars above:

- **Pareto Principle**: coined by Vilfredo Pareto[viii], also known as the 20:80 principle. States that few causes (the "20%") are producing the majority (the "80%") of the effects. Works in a wide range of fields and phenomena. Requires the studied phenomena to be independent.
- **Isaac Newton**: specifically, the quote[ix] "Natura valde simpex est et sibi consona" (Nature is very simple and harmonious with itself). This quote introduces the first two pillars of TOC and the hard sciences: Inherent Simplicity = Nature is very simple, and Inherent Harmony = harmonious with itself.
- **Funnel Experiment**: devised by W. E. Deming the experiment illustrates what happens when we react to "noise." The name given by Deming to such reactions is "Tampering" or, even better: "worsening" the system.
- **Scientific Claim**: Goldratt explicitly adopts Karl Popper's definition of science[x]: any claim that can be proven false (falsifiable) is a scientific claim. And he is prudent when

checking abstract causes (checking if they and their effects are testable and falsifiable). See more in The Choice, p 126.

- **Herbert Alexander Simon**: Nobel prize in Economics for his model of the human mind: Bounded Rationality. According to Simon, human mental faculties are limited (sensory, memory, and cognitive wise), and this implies that our decision making is not well described by "picking the optimum alternative after examining all possibilities," but rather by "picking a good enough alternative (that improves the decision maker's situation) by examining a sample of all possible alternatives." This was called "satisficing" and is a more accurate model to predict human behavior.
- **The TOC Pillars Webinar**: conducted[xi] in March 2018 by Humberto R. Baptista, explores in more detail the evolution, definitions, and consequences of the five pillars.

---

[i] Goldratt, E. M., & Cox, J. (1984). *The Goal: A Process of Ongoing Improvement* (2nd ed.). North River Press.

[ii] Goldratt, E. M., & Cox, J. (2004). *The Goal: A Process of Ongoing Improvement* (3rd ed.). North River Press

[iii] Goldratt, E. M. (2000-2002). *Necessary and Sufficient*, Goldratt Marketing Group

[iv] Goldratt, E. M. (1999). *The Satellite Program*, TOC Marketing Group

[v] Goldratt, E. M. & Goldratt-Ashlag, E. (2010). *The Choice, revised edition*, North River Press

[vi] Goldratt, E. M., Scheinkopf, L. (presenter) (2011).*TOCICO 2011 International Conference Keynote*, TOCICO

[vii] Goldratt, E. M. (1999). *Introduction to The Science of Management*, https://app.toc.tv/player/543, accessed on 01/Feb/2021. Also, with comments on: https://www.linkedin.com/pulse/science-management-introduction-commentary-humberto-baptista/

[viii] Vilfredo Pareto, Wikipedia entry, https://en.wikipedia.org/wiki/Vilfredo_Pareto accessed on 01/Feb/2021

[ix] Originally from an alternate conclusion to *Principia Mathematica*, can be seen in context in:
Hall, A.R. & Hall, M.B. eds (1962). *A Selection from the Portsmouth Collection in the University Library, Cambridge*, p. 321, Cambridge University Press

[x] Popper, K (1959). *The Logic of Scientific Discovery*, Abingdon-on-Thames: Routledge

[xi] Baptista, H.R. (2018). *The TOC Pillars*, TOCICO. Webinar: https://www.tocico.org/page/SpringWEBINARHumbert accessed in 01/Feb/2021

TOC-ICO

Body of Knowledge addition (Sept 2021)

'Mystery Analysis'

Overview:

Dr Goldratt used the term 'mystery' to describe an unexpected outcome, highlighting the limitation of current reasoning and the opportunity to learn. Yuji Kishira (2018) has taking this further in developing a systematic process using the TOC TP and CLR tools. In addition to the paper Kishira has presented at TOCICO (2016).

We also have included Kishira's (2019) Goldratt Consulting presentation which uses the 'standing on the shoulders of giants' concept (Goldratt, 2009) in explaining the mystery associated with the boundaries of Lean applications and the distinguishing DBR assumptions.

TOC-ICO Dictionary definition:

Mystery Analysis: Systematically exploring unexpected outcomes by structuring the associated hypothesis using the TOC TP and CLRs.

Leading reference

Kishira, Y., 2018. An examination of Goldratt's theory of constraints as a scientific theory: Using the thinking processes to propose the "structure of a hypothesis" and the mystery analysis processes. International Journal of Current Research, 10, (04), pp.68443.

Full paper: An examination of goldratt's theory of constraints as a scientific theory: using the thinking processes to propose the "structure of a hypothesis" and the mystery analysis processes | International Journal of Current Research (journalcra.com)

Video presentation (Kishira, 2019): 'Why doesn't Lean work in Japan' (4th presentation in series)

https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fgoldrattgroup.com%2Fevent%2Futah2019%2F&data=04%7C01%7Croy.stratton%40ntu.ac.uk%7C35ae2c5bf0d14b4b392308d96803862d%7C8acbc2c5c8ed42c78169ba438a0dbe2f%7C1%7C0%7C637655186620926539%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=xEWkhGP3cgEJMu313pIT9nCitcp7jIbpx%2FJm7HoRcyc%3D&reserved=0

Magic Druids

A Thinking Process tool for clarifying and solving recurring problems or conflicts

Theory of Constraints Body of Knowledge White Paper
By James Powell and Peter Cronin

(Note: Magic druids are also known as figure-8 loops, druid loops, or just druids.)

Sections:

Part 1 – Overview
- Background
- Current TOC Approach
- Application Testing and Adoption

Part 2 – Magic Druid Diagram
- Description
- Example

Part 3 – Case Study
- Abstract
- Introduction
- Method
- Results
- Discussion

Appendices
- Appendix A – Druids Which Made Up the Original List of Conflicts
- Appendix B – Grouped Causal Chains, Separated into Similar Themes

Part 1 – Overview

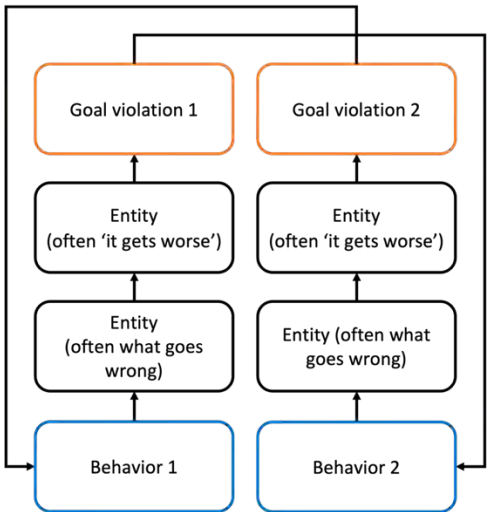
Background

The magic druid tool was originally created by extracting the mental process utilized by an expert in the Thinking Processes when working with a client. This mental process was developed into a framework that could be replicated by anyone, using logic structures that are part of the Thinking Processes (TP).

Druids do not address a deficiency in the toolset for TOC experts. They came about from observations in tool-use competency and adoption of learners new to the TP, as well as speed increases (with no quality loss) for experienced TP users.

The observation is that, while the evaporating cloud makes immediate sense to the uninitiated, it requires some focused practice to find sufficient fluency and confidence for people to use the tool themselves. Especially with other people, this leads to the new user deferring the attempt to use the tool until they have time to try to get it 'right.'

As experts, we find it very easy to get participants in a conflict to articulate why the opposing behavior drives a need / goal violation. We tested teaching a person new to the TP to follow the process of describing why the other person's behavior caused increasingly negative outcomes that culminated in a goal violation (equivalent to a need violation of a B or C in a cloud). We found that both sides could quickly and collaboratively do this. The resultant figure-8 loop consists of two negative causal branches (similar to NBRs) which are linked in that the goal being violated on one side compels the other side to do the behavior at the base of the opposing branch – known as the 'magic druid.' This is demonstrated in the diagram below.



It is then very easy to get a good quality cloud from the druid if necessary (see Appendix A). We found that the parties were also more collaborative and understanding of each other, as well as exhibiting an increased tendency to then use the tool immediately in a business context, with no further training or encouragement. This would spread around the company, resulting in it 'going viral.'

Current TOC Approach

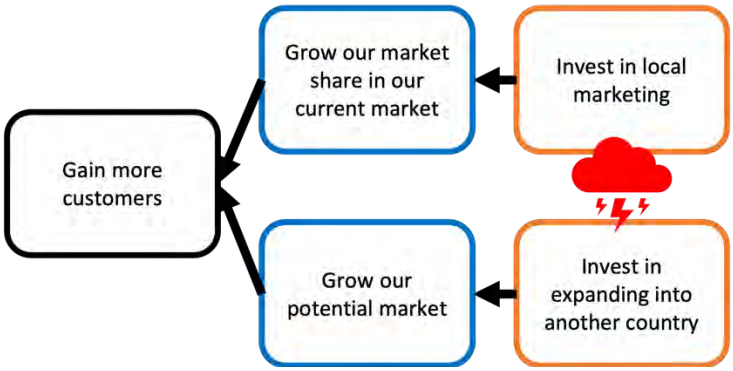
Clouds

The cloud is an effective tool for capturing and resolving conflicts. The cloud focuses on achieving win-win solutions, where the needs of both parties or both alternatives are met, in addition to the goal or common objective. However, the cloud does not provide the detail of current problems and how they go wrong, nor does it document the looping effect of recurring issues. Our experience shows that the druid is easier to use for those with no TP experience. We speculate that people find it easier, and quite natural, to use the druid to explain how a cause-and-effect branch of other's behavior causes things to go wrong. We also note that despite this accusatory approach to the initial use of the tool, once the druid is diagrammed, the same 'both sides together against the problem' mindset comes through, like with a cloud.

While a cloud or druid can be used for a conflict or dilemma, as shown in Appendix A, we have found that they are better suited for different situations once people are experienced in both. The druid is often the best choice when the scenario is understood quite well, is played out multiple times, and has a recurring loop. When one side is implemented, the negative effects cause people to switch to the actions and logic of the other side, resulting in a vicious loop.

Thus, a druid is best used where the scenario has played out multiple times and you really know the details. You can fill out the details of the steps along the way; you can add assumptions; you can apply the categories of legitimate reservations and get a clearer picture of exactly what's going on.

The cloud, however, is more suited to when you've got a forward-looking decision or a decision that doesn't have to be made all the time. When using a druid for such a situation, we must be careful we are not making up the detail/causality; we are essentially looking at NBRs. An example of this is a business considering its first major expansion efforts. The situation is forward-looking and focused on the benefits:



Comparing and Contrasting a Druid and Evaporating Cloud

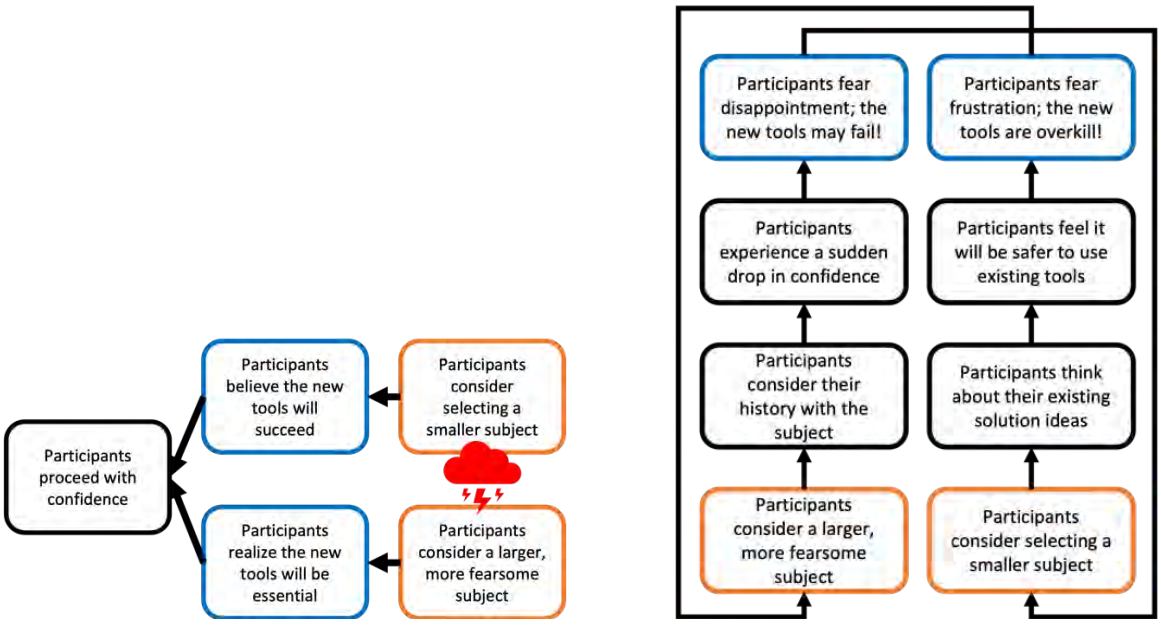
While the above states where clouds and druids tend to be best used; it may help the readers' understanding to see the similarities and differences of the cloud and druid compared directly.

An example of a dilemma faced by new students of the Thinking Processes on our Black Belt in Thinking course is used to illustrate this. Students consider the size and importance of a

subject to be analyzed using a Current Reality Tree (and solved with the rest of the Thinking Processes). Given this their first use of the tools, many would fear the tools would not be enough to solve their subject. On the other hand, they worry that a small subject would be a waste of a whole week of analysis. The situation can be presented as a cloud or a druid.

The conflicting behaviors of a druid are equivalent to the D and D' of a cloud. This is indicated in orange in the example below.

The goal violations of a druid can be represented as the B and C of a cloud. As they are written as a positive in a cloud, they must be worded as such and are delivered by the opposing behavior / D & D'. This is indicated in blue, below.



CRTs

The Current Reality Tree (CRT) documents the thorough detail of a negative situation in cause-and-effect. The tool provides an effective analysis of what is going wrong and why, and unless we identify a set of injections to solve it (and implement those injections), we are stuck in this situation. There is no substitute for this analysis on a system level.

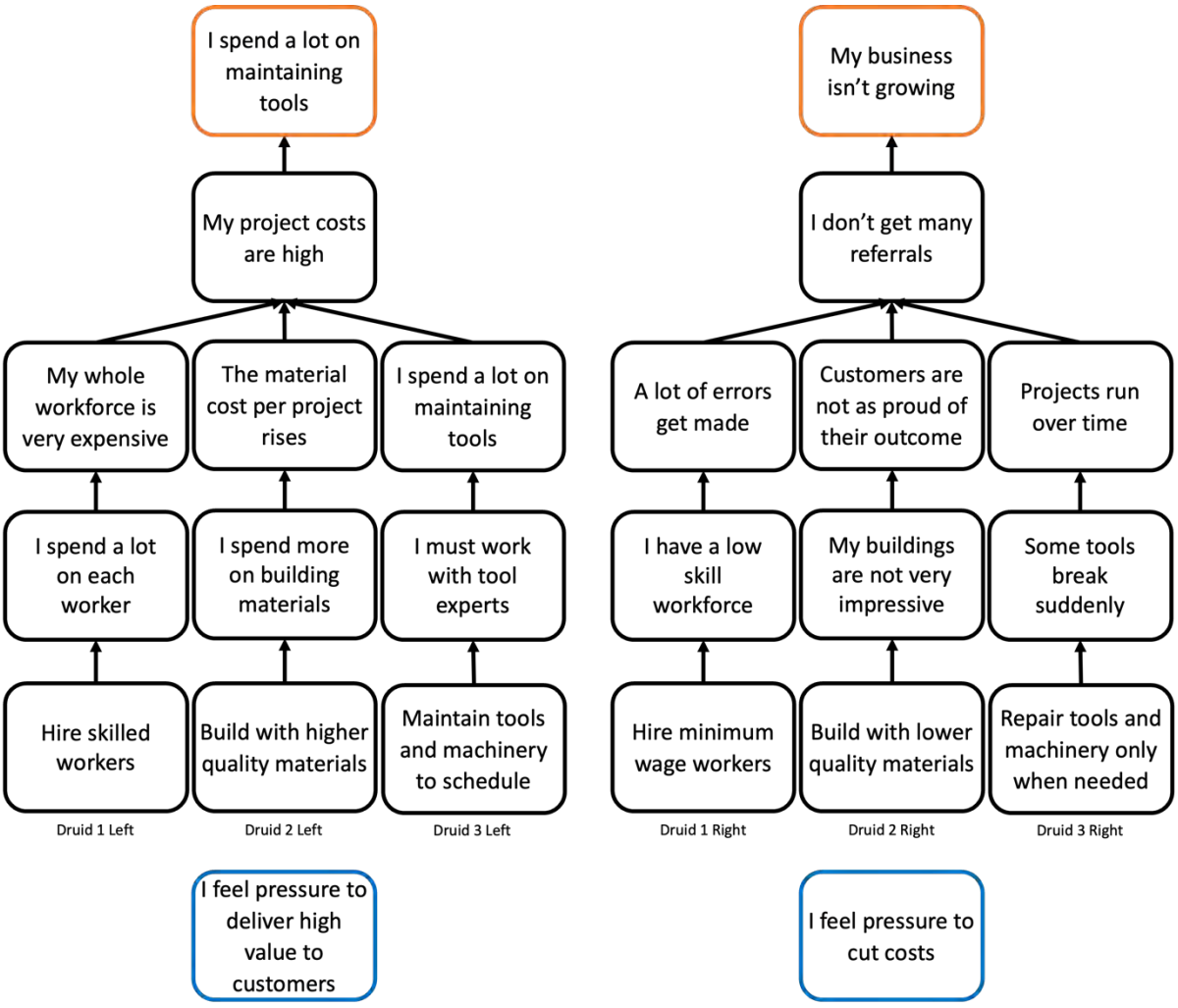
However, the tool is too heavy for many to employ on a day-to-day basis. It takes substantial time to construct a CRT and it also requires considerable training, which many will not invest in for all staff. It would typically only be for strategic staff or management. The complexity of the tool also makes it difficult for many to use with an uninitiated audience or it leads to those formally trained in CRTs to never construct one again after the training.

Druids can be used to rapidly build a CRT. Multiple druids (usually 3 to 5) in a subject area are essentially a set of cause-and-effect branches for a CRT. The druids can be split in half, and then individual branches can be grouped by goal violations. Using the CLR, the branches can be expanded as well as interbranch links being created (these are called crosslinks). At the top of the CRT, two common and high-level goal violations (these are called system goal violations) are identified.

At the base of the CRT, the pressures that drive the behaviors can be summarized in a similar approach to the process in the three-cloud merge method. The system goal violations and pressures are then used to create the core problem cloud, leaving only the 'A' to be added.

Example

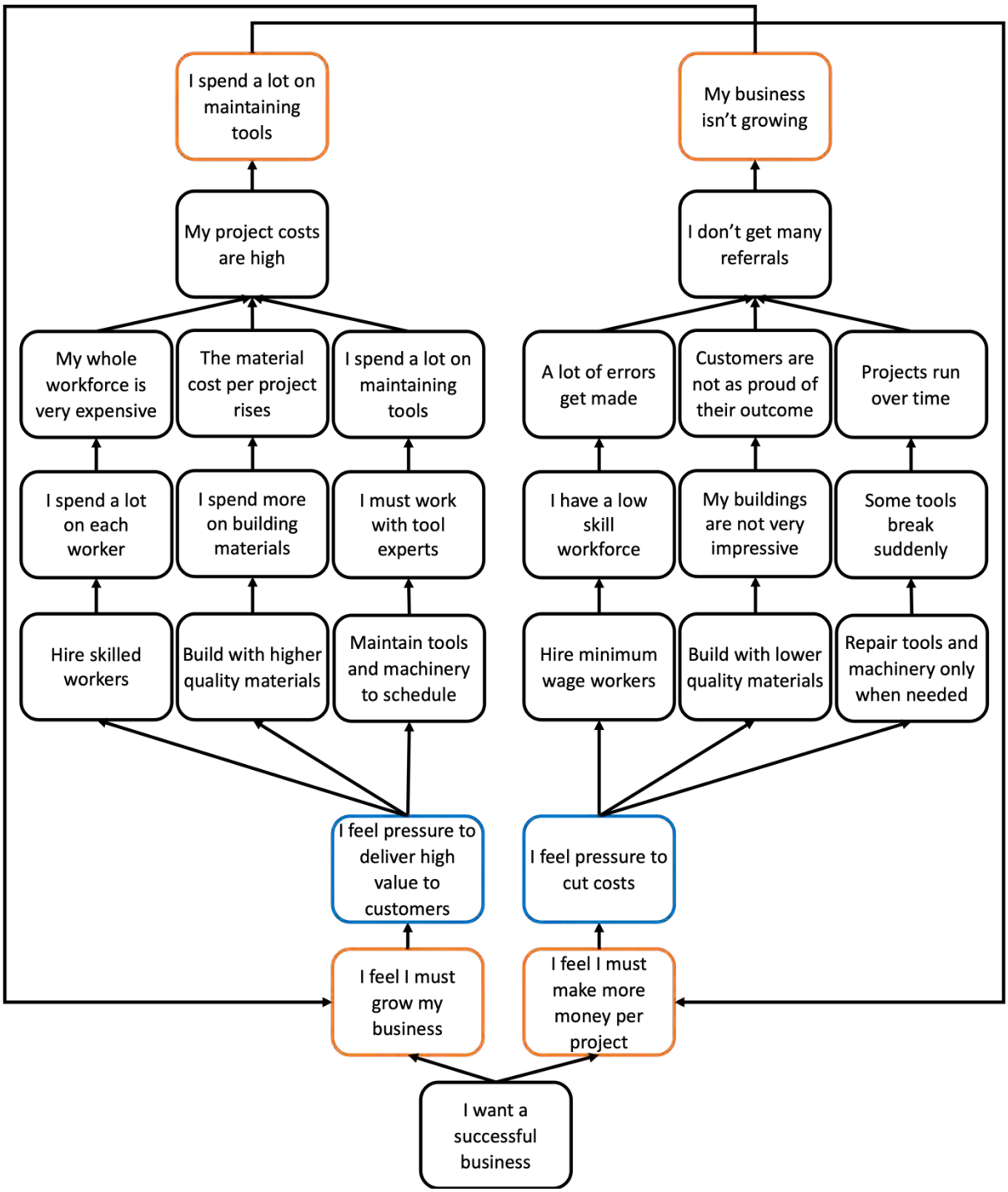
This is a basic CRT constructed from three druids. The CRT is kept very basic for this example to focus on the druids and how they come together to form a CRT. In practice, there is more detail to be added, and scrutiny applied via the categories of legitimate reservations. This ensures the logic of the analysis is robust.



Each side contains three branches, which are each half of a druid. These branches have been grouped based on commonalities in theme or goal violation. The branches are labelled to show which opposite branch they were originally paired with (as a druid). We can see in this example that there is a common goal violation on each side, making less money from projects on the left and the business not growing on the right. We can assume these to be the core needs the business is seeking to protect so we use these to determine the B and C of the core conflict.

The behaviors at the base of each druid branch can be used to determine the D and D' of the core conflict. The behaviors are summarized into core pressures which bridge the gap between the core needs (B and C) and the behaviors that drive each druid branch. In this case, the behaviors at the base of the left group of druid branches can be summarized as a pressure to deliver high value to customers. On the right-hand group, there is a pressure to cut costs. These pressures are the D and D' of the core conflict, caused by the core needs (B and C) and causing many individual behaviors, some of which are represented in the druid branches.

Once put together we get a CRT with a core conflict at the base, like so:



A drawback to this method is that some struggle with the crosslink stage, whereas the older UDE linking jigsaw shows the interconnectedness of the problems as a more obvious 'UDE soup.' In the example above, the six branches are independent and look like pillars, it is an additional step to add the detail of how entities within the tree cause each other. Experienced users find they can use druids to quickly form a CRT and still find crosslinks readily.

Our experience is that people who have been taught the druid CRT method use CRTs more frequently post-course, due to two reasons. Firstly, they can recall the process easier, as well as remember it as a more simple and approachable process. Secondly, the ability to easily scale down the CRT, say using only three druids, means people can quickly understand and solve the core problem in a smaller area that they would not use a larger process for.
In the last step of our training, participants form a three-druid CRT, identify injections, and test the logic as an FRT in a two-hour window.

Application Testing and Adoption

At the time of writing this paper, we have trained around five hundred people in the druid tool as part of either the Black Belt in Thinking Foundations (a day-to-day Thinking Process training course) or the Jonah-style Black Belt in Thinking Boot Camp.

After completing a live CRT build using druids, James Powell and Peter Cronin realized how effective the druid tool is and decided to try it on a BBIT course. To their surprise, it took a day off the CRT build stage, and increased quality! They have continued to use the druid-made CRT extensively and is far more dependable for new users – that is, less instructor oversight is required, and more graduates are using the tool after the training.

Those who had learned the previous way were shown the druid CRT method and switched to this method entirely. The previous way seemed less process-driven, and more time-consuming, although it does tend to show better interaction between the UDEs within the CRT.

WiseTech Global pivoted from clouds as the primary TOC tool for solving and documentation, to druids due to bringing in the CRT aspects to give more detail of the looping causality.

Part 2 – Magic Druid Diagram

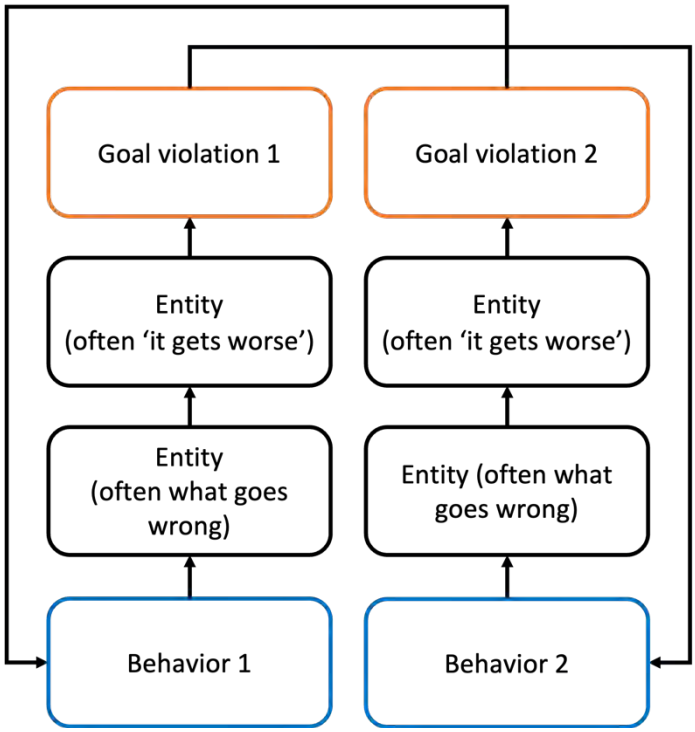
Description

The druid diagram is structured using sufficiency logic. The structure has two branches detailing the cause-and-effect. We use four entities on each side as a guide, as we found for most situations, only using three entities left out useful detail, and using five didn't add too much. The branches can have more or less than four and can be lopsided with more entities on one side than the other. Assumptions can also be added.

The base entities are behaviors, and the top entities are goal violations (often UDEs).
The branches are linked by the loopbacks. The loop goes from goal violation on one side to the behavior on the other. For simplicity, the assumptions / additional entities are often not shown. It is usually taken as accepted that we have seen many times when 'X' goal is violated a person will do 'Y' behavior.

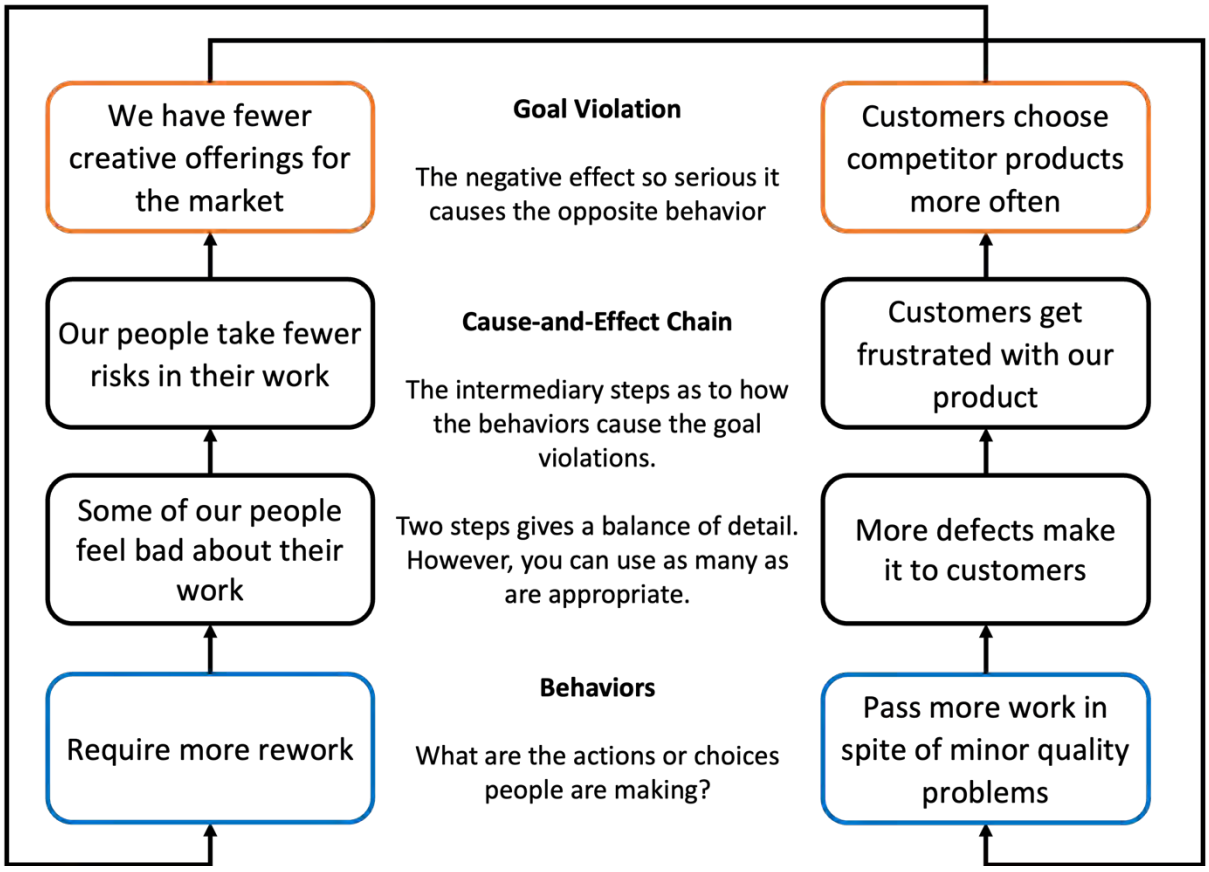
It can also be said, "If X goal is violated, and we have a policy or goal to protect X, then I will do Y, as Y is the best course of action I know to protect X."

For this reason, 'Policies, Measures, Consequence, Behaviors' can be used to explain the loop (with the behavior being the base entity, and the policy being the goal that is being violated). To solve this, the usual process of surfacing assumptions and identifying an injection is used, as with an NBR branch.



Example

In this example, a team is caught in a recurring dilemma between letting quality issues slide; and being stricter on quality. Over time, they have implemented stricter controls, only to find it leads to the team shutting down and harming creativity. Because of this, they have relaxed the controls, which then leads to customers turning away from their lower quality product, and around the druid they go.



Part 3 – Case Study

Abstract

This case study demonstrates not only the ability of the druid to break down problems and create a quick and effective Current Reality Tree, but also, the ability of a relatively new learner of the tool, to break down their problems and identify common themes on their own accord. This case study is based on solving real-life business problems and a new learner of the tool being able to create nine druid loops on various problems she was facing in her role.

Following a reality engineering process, those nine loops were then formatted in such a way that when presented to an expert in the Thinking Process tools, together (learner and expert) were able to identify the core problem, which in the learner's words became 'very obvious.'

Introduction

Cassie oversees marketing and product design at MyTreat and had been having issues to do with a lack of time in the business. There seemed to be a lot of work that needed to be done but not enough time to do it. So, she was trying to come to the business owner, James, with the problem and reasons why she was squeezed for time.

Cassie had started to learn the Thinking Process tools through the Black Belt in Thinking Foundations course, clouds, druids, etc. and it was suggested to her by a colleague that she put some of her new learnings to work and communicate the issues with James in his own language – druids. An important point to note here is that James did not ask for this way of communication. The idea to solve the situation using the tool and the resulting content was done by Cassie.

Method

Cassie created nine druids based on each of the nine issues that she was experiencing (Appendix A). The content of those druids is not important to this case study, although we have included the druids for your interest. What is important is constructing the druids, which compelled Cassie to give considered and balanced thought to what was bothering her prior to taking it up with her boss. She documented the two actions/behaviors of the recurring problems that she was facing. Following the druid construction process, Cassie proceeded to map out the logic of those actions; what went wrong, what got worse and finally what caused her to do an alternative action. She then proceeded to follow the same steps on the alternative action until she had her druid loop.

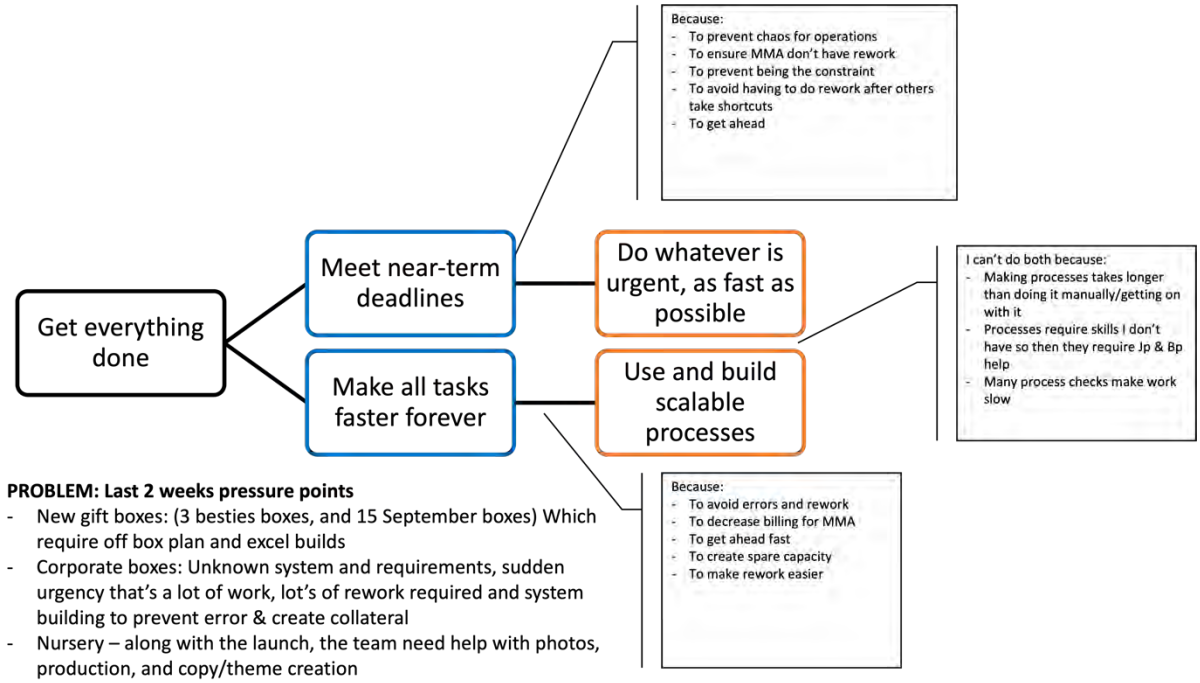
Working with her colleague, who had experience in the Thinking Process tools, Cassie then separated the nine druids in half (creating eighteen causal chains) and placed them on either the right or left side depending on what 'theme' she thought they fit in (Appendix B). This process enabled Cassie to group issues in the business that were similar, or that were causing similar negative side effects.

It was at this point Cassie shared her work with James. During this conversation, they worked together to review the separated druids in their 'left hand, right hand' groupings. They made minor changes, flipping the side a few causal chains were on, and color coding the themes.

Reading across the branches, two major themes/actions were then identified.
'Do whatever is urgent, as fast as possible' and *'Use and build scalable processes.'*

Taking these two major actions, they were then built into a cloud, with Cassie authoring the needs for those actions as well as the overall goal. Using the logic "In order to… we must… because…" Cassie was then able to create a list of assumptions on the connections that could then be used to break the cloud, knowing that she could now come up with a solution to the conflict whilst also protecting the overall goal and both needs.

Core Cloud – Expresses the Common Theme Across the Nine Druids



Results

Instead of providing a list of wants, or a list of obstacles, James got a considered picture of reality that showed why the answer was not obvious – because there are two sides to the story, which is demonstrated on nine fronts (through the nine druids).

From the theme grouping of the causal chains (left-hand, right-hand side), it was said to be glaringly obvious what the two themes of the problem were. Seeing the common themes separated in such a way, James and Cassie were able to dissect that the actual issue was that there was a sudden influx of tasks to Cassie that James was not aware of.

It was also identified that Cassie did not know that it was this influx that was causing all these problems to happen. Since neither had taken into consideration how much capacity those tasks would take, it made all the negatives (lack of time, errors, etc.) happen a lot quicker.

Using the druid tool, Cassie and James got to a core problem cloud very quickly, which provided Cassie with a way to produce a solution (through raising assumptions) that protects both needs. James, as a business owner, also benefits, as providing the structure for Cassie to solve the problem herself was a time-effective way of coming to a solution. The negative of not having this problem-solving ability is that Cassie would otherwise want James to adjudicate between the two actions. Now, both needs are protected, and James does not have to manually interfere for the right action to occur.

Discussion

From Cassie's point of view, the tools helped her simplify her situation and words. Instead of saying, "These are all my complaints," and giving a long list of reasons, she was able to put her problems into the framework, explaining the causality of the situation. The druid tool takes away a lot of pressure to carefully word the problem, as you are essentially filling in the framework and you share both sides of the issue with very little to no bias.

As someone who has newly learnt the tool, Cassie identified that communicating using druids was helpful, not only when communicating with someone else who knows the tools, but also, from an individual standpoint in terms of breaking down your problems.
"Instead of creating a storm about your problems and venting, the tools break down the problem into what is happening," said Cassie.

As a business owner, what James was always bothered by was, when in situations, people would ask him, "Do you want me to do this, or that?" and the answer is, "I want you to do both." When posed with that answer, most people respond by saying that they can't do both, which is then followed by a long-convoluted tale of woe that bears no resemblance to reality because it's not thought through. So, when comparing that with what Cassie did in this situation, it's a considered and careful analysis of the consequences of choosing one option over the other. James also has the ability to leave Cassie with the responsibility of protecting both sides instead of having to do that himself.

That's why it was powerful for James, he didn't have to make a ruling that he knew was going to have negative consequences.

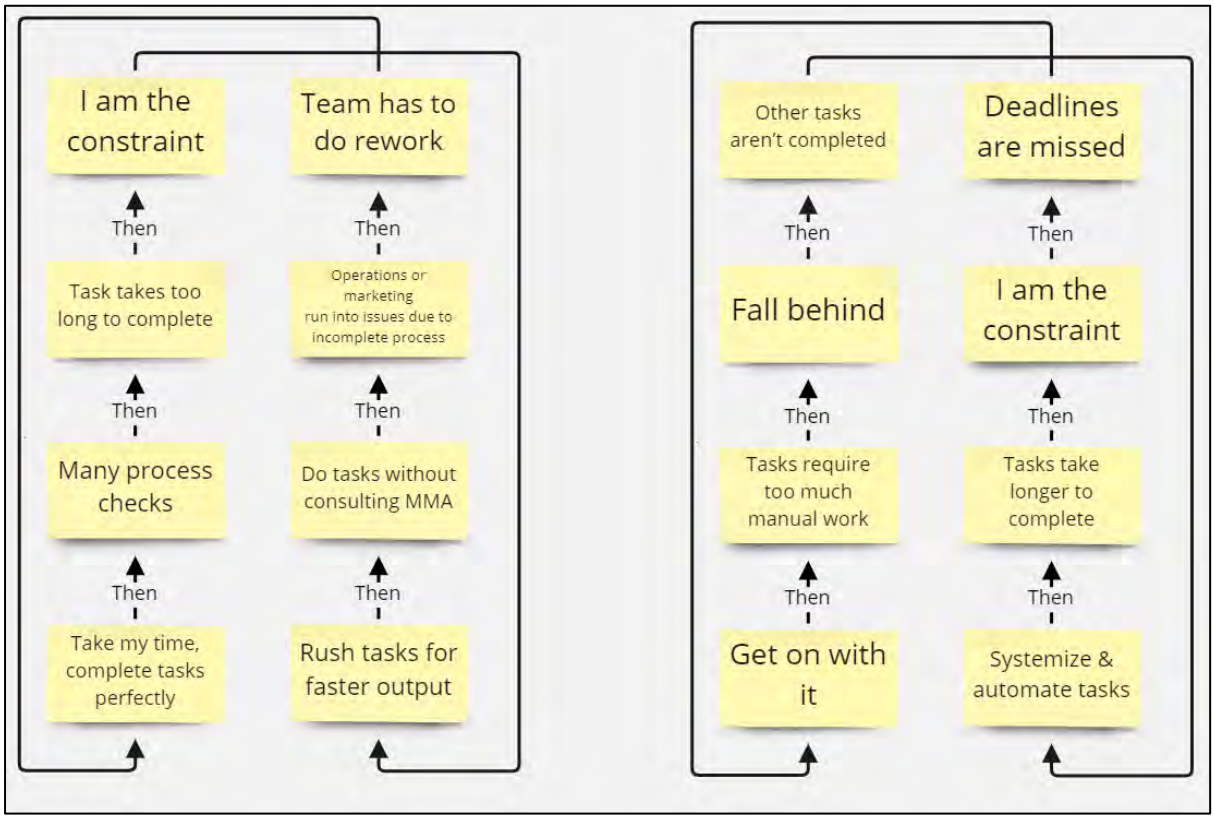
James Powell's 2019 TOCICO presentation provides additional insights on the topic:
https://www.tocico.org/page/2019VideoPowell

Appendices

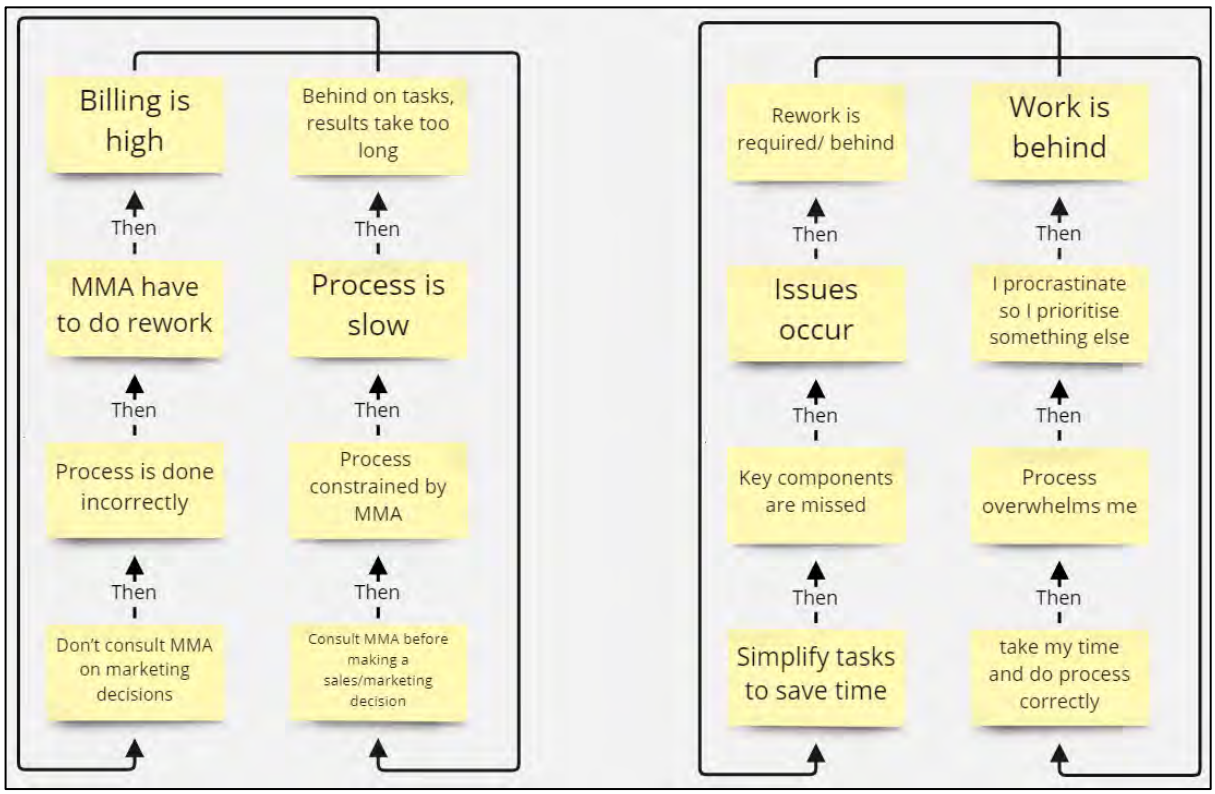
Appendix A

Druids which made up the original list of conflicts

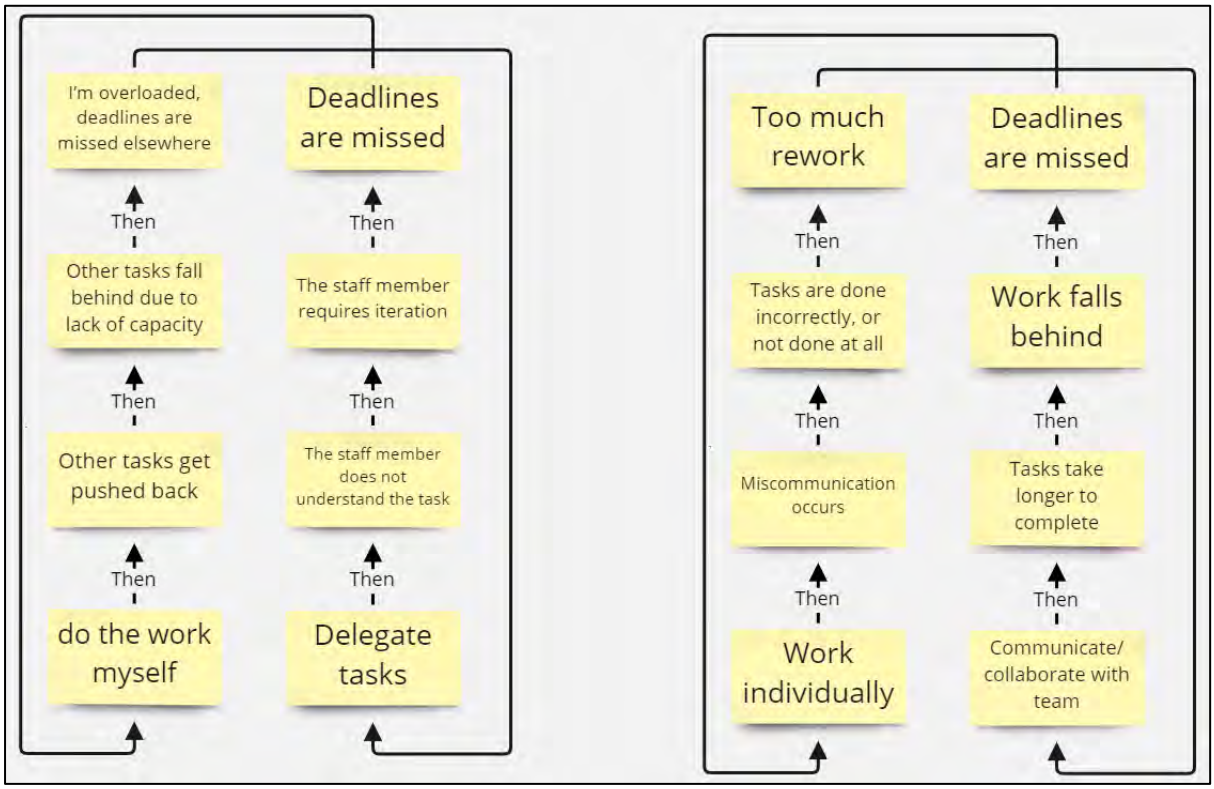
Druids 1 & 2



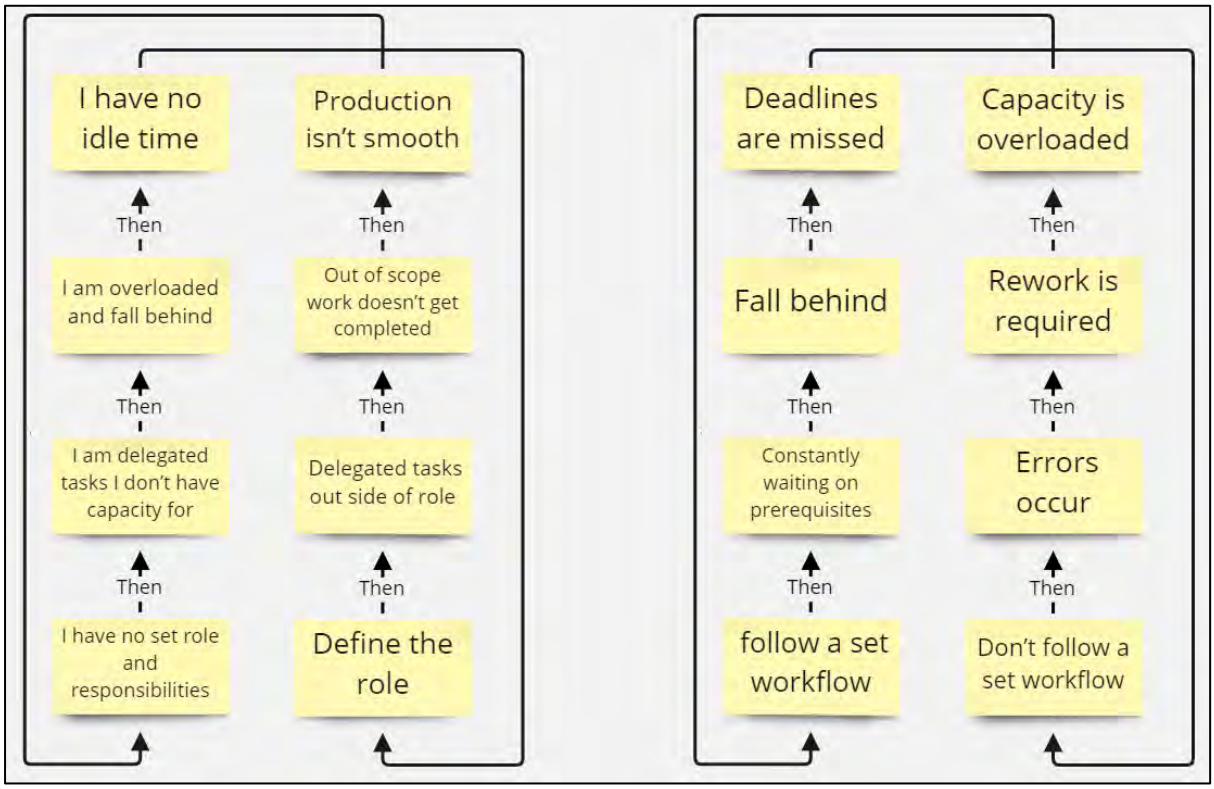
Druids 3 & 4



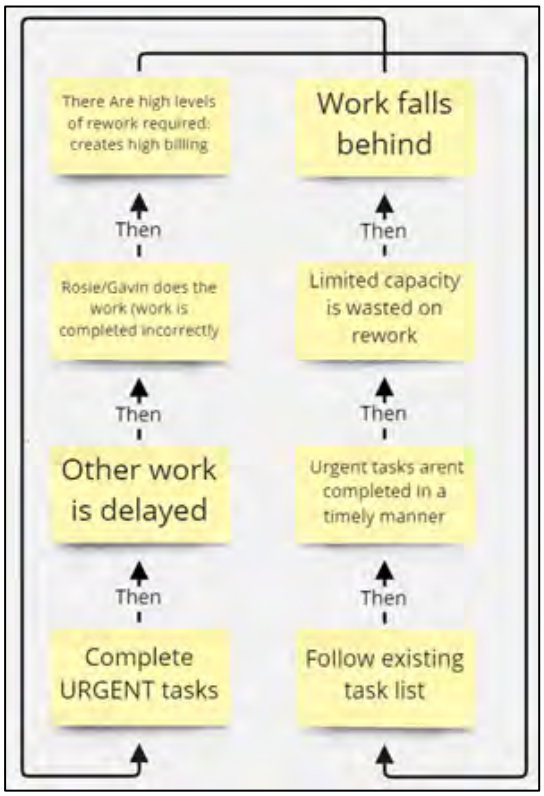
Druids 5 & 6



Druids 7 & 8

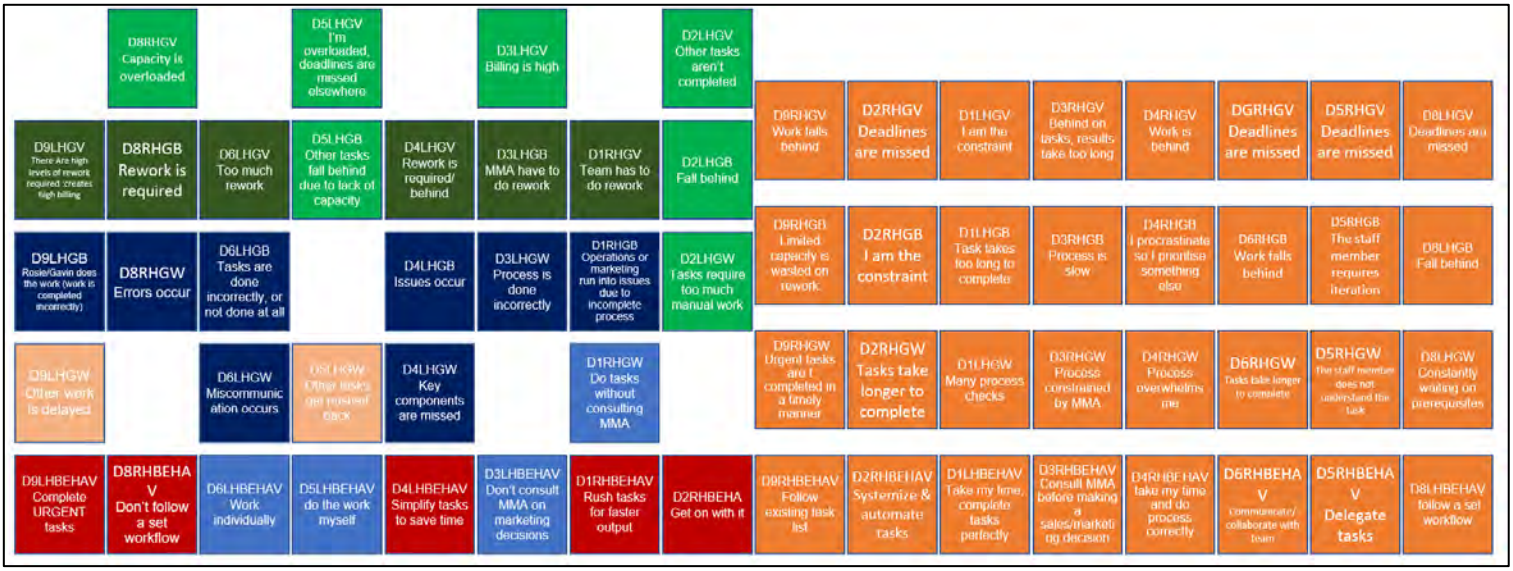


Druid 9



Appendix B

Grouped causal chains, separated into similar themes



Using Throughput Economics to make better and safer business decisions

By Eli Schragenheim, Henry Camp and Rocco Surace

Using the steps of Standing on the Shoulders of Giants.

1. **Identify a giant, not a choopchik**

Eli Goldratt is the giant that brought the concepts of T, I and OE (Throughput Accounting) to focus management's attention on the right areas to be able to diagnose the current achievement towards the Goal and to make better decisions. Eli exposed the flawed assumptions behind current management accounting practices, including Activity-Based-Costing (ABC) and showed an effective way to make decisions that significantly and reliably improve the bottom line.

While the term 'Throughput' has an approximate equivalent in 'contribution margin,' the emphasis of focusing on the total T generated within a period of time is the major contribution of Throughput Accounting. This means that no decision should be made based only on the local impact of a specific sale on T; always the full impact on the total T is considered.

2. **Identify the enormity of the area not addressed by the giant.**

The current Throughput Accounting practice assumes the financial performance is limited by one constraint, which could be a resource, the incoming demand or, very rarely, a scarce material. The resulting understanding is that a decision should be viewed by its ΔT generation relative to its impact on the constraint.

Practically, this means that, when the one constraint is known, every decision should be assessed according to the capacity limitation of the constraint, or when there is no internal active constraint, then any additional demand, generating positive T, is welcome.

In most cases, **this practice is valid only for minor decisions**, which won't make a non-constraint into a constraint itself! When you also consider the possibility that a non-constraint will penetrate its protective capacity and by that become an interactive constraint, that threatens the delivery performance, then the basic Throughput Accounting approach is flawed.

Another area not clearly addressed by Throughput Accounting is how to consider the uncertainty of the impact of a decision on demand from the market. While time and stock buffers, together with protective capacity, keep Operations ready to handle internal uncertainties, these concepts don't apply for evaluating the potential uncertain impact of a more significant change, like launching a new product, a price increase or penetrating into a new market segment on the incoming demand.

Thus, the value of using Throughput Accounting for evaluating the global consequences of decisions, which aim at increasing sales, improving the total T of the product mix or considering investing in additional capacity (elevation), is limited and the enormity of the area not addressed is huge.

Copyright © 2021 by Eli Schragenheim, Henry Camp, and Rocco Surace

3. Get on the giant's shoulders.

Goldratt has demonstrated many times how clear logical analysis should be used – always starting from a significant problem which limits achieving more towards the goal.

While Goldratt emphasized the need to change the current performance measurement system, he stopped doing so from about the year 2000, when *Necessary but Not Sufficient* (Goldratt, Schragenheim and Ptak) was written. In the book, Goldratt refers to the "three engines of TOC: DBR, CCPM and replenishment." Eli Schragenheim asked him what about Throughput Accounting and Goldratt answered: "*I have a problem with Throughput Accounting, people expect me to give them a number and I cannot give them a number*."

My interpretation of Goldratt words is that he recognized that the uncertainty in demand from the market and understood that a non-constraint could penetrate into its protective capacity. The current level of guidance from Throughput Accounting was simply not enough. The 'number' – how much additional profit would be generated has no clear answer.

Eli told Eli Schragenheim later that Throughput Accounting was a topic he would go back to but he passed away before he could.

4. Identify the conceptual difference between the reality that was improved so dramatically by the giant and the area untouched.

The focus of the early days of TOC was on the short-term. The expectation that the constraint won't move from one day to the other, was a necessary assumption that made it valid to focus on exploitation of and subordination to a single constraint. Said another way, the assumption was that the impact of a single business' initiative on the free capacity of non-constraints was small. The elevation step seemed like a faraway possibility and not too much was said about how one should evaluate the operational and financial impact of elevating the constraint. The implicit assumption was that elevating the capacity of the constraint would require a substantial investment. An obvious question is, how much more throughput would be generated by the elevation and whether the resulting ROI is well justified. However, in those early days, say until the mid-1990s, this question was not raised, at least not in public.

Under the circumstance of a single active CCR, focusing on exploitation and subordination, an important topic is choosing the best product-mix, given the capacity limitation of the one and only one CCR. In this case, prioritizing products based on Throughput per Constraint unit (T/Cu) was very beneficial.

When Goldratt moved his focus to Viable Visions, using the Strategy and Tactics approach to deploy a decisive competitive edge (DCE), the perspective changed. The Viable vision templates don't mention T, I and OE. Even the term 'constraint' is not mentioned. Goldratt came with an observation of two different schemes of improvements: 'minus-minus' and 'plus-plus', where the later looks to the longer term and is a more substantial improvement, being based on introducing a DCE, like VMI with a commitment to pay penalty if a shortage occurs.

Once you extend your managerial efforts from the immediate flow of products and services to solving significant problems for clients, dealing with the possibility of the emergence of new constraints is unavoidable. When entering new markets, backed by a DCE or just through constraint elevation, we get into an area that Throughput Accounting, as it was conceived in the mid-1980s, cannot address because every such move could easily cause the emergence of a new constraint, making T/Cu problematic. Which constraint's units should guide you?

Going into new markets raises the question: how much additional demand is expected? This means considering not only the fluctuations in the current market demand but also assessing: how much increase in demand might be, whether there is enough capacity or it is possible to purchase additional capacity within the required timeframe? Information about the size of the new market is required for ensuring enough capacity, including protective capacity, to meet commitments to the market.

Acting on any decision that causes the constraint to move is an untouched area, so far.

5. Identify the wrong assumption.

The invalid assumption when larger decisions, for mid- to long-term periods are considered, is that ***it is enough to check the current weakest-link to determine whether to act on a new decision.***

Two additional assumptions must be checked again:

- Can we respond fast enough? Then, there is no need to forecast demand, as it is possible to react to any realistic level of demand.
- An imbedded assumption is that the capacity of the CCR is known and it is properly exploited. So, if there is a need to increase it, then only a step change in elevation is required. In other words, the possibility of 'temporary micro-elevation' of the constraint was not considered.

6. Conduct the full analysis to determine the core problem, solution, etc.

When evaluating the potential impact of a decision which could have significant ramifications on the demand and capacity requirements, the core problem is facing **uncertainty that cannot be protected by either time or stock buffers**.

6.1 The top objective of the decision process:

Starting with some business proposition, the management team evaluates the available relevant information on the reasonable financial ramifications, for both the short and long terms, of the proposed actions and reaches a mutual decision, taking into account the potential impact of uncertainty on demand, operations and supply, then translating into financial terms the range of possible outcomes, while supporting an analysis of various alternatives in order to reach the best set of actions

The solution proposed here, is to create two different scenarios for the outcomes of such a decision: a scenario based on conservative estimations and an optimistic scenario. Each are used to come with accurate enough predictions of the net impact on the bottom-line. Both estimations must be 'reasonable,' meaning *"paranoid but not hysterical,"* quoting Goldratt.

It is always necessary, when using human intuition or even a computerized forecast, to assess potential uncertain outcomes, however, considering protecting against extremely rare possibilities does not make sense. It is possible that the interpretation of what is 'reasonable' might significantly vary for different decisions. For instance, should a commercial organization consider the probability of an earthquake destroying the central warehouse when outlining its supply-chain practices? However, the government in coming up with standards for the construction of buildings, should consider the possibility of an earthquake up to a certain level, demanding engineers to design in the appropriate protective measures.

The scenarios within an operating business are created by a group of the relevant managers of the functions that are impacted by the decision at hand. At a minimum, the team should include managers from Sales, Operations and Finance.

When this interim objective is reached, management can assume that the actual outcome will, with good-enough confidence, lie somewhere between the two answers.

6.2 Creating a scenario means the team checks and discusses various alternatives until consensus on the best scenario is reached.

While checking the financial and operational ramifications of a decision, either through the optimistic assessment or the conservative one, alternatives to the original proposals should be raised to improve the impact on the bottom-line. This happens mainly when the assessments of the demand, considering the planned actions, is expected to overload the system by penetrating into the protective capacity of one or more resources. When this happens, two different possible changes to the proposed actions must be checked:

I. Finding a way to temporarily increase the capacity of the relevant critical resource(s). Such an approach results in ΔOE.
II. Reducing sales of certain SKUs to free capacity. That approach reduces total T and the ΔT from accepting the decision at hand. Alternatives of changing the product-mix of the current sales might be considered, depending on the predicted loss of T relative to capacity freed at the relevant resource.

More proposed changes to the original decision can be raised by the team members, looking for improving NP which is the difference, ΔT – ΔOE.

During the intuitive assessment process of determining the impact of the decision on market demand, it is necessary to expand the terms used by Throughput Accounting in order to face the possibilities not currently addressed.

6.2.a Critical Resources

Throughput Accounting is based on the assumption that one, and only one, capacity constraint resource (CCR), can be active in a relatively stable production shop floor. The DBR approach, as demonstrated in The Goal and especially in the analogy of the scouts, is focused mainly on the short-term, and thus significant changes in the product mix are not initiated, which could cause other resources, currently non-constraints, to become constraints.

But, when not-too-small new moves that should generate significantly more T are considered, then it doesn't make sense to only check the implications on the one weakest-link. There is a valid need to check the ramifications of every not-too-small move on the capacity of several critical resources.

A critical resource is one for which a not-too-small change in the product-mix could push the load on the resource to penetrate its protective capacity.

It doesn't make sense that many resources can be critical. If that were the case, then even mild changes in the product mix might have unexpected negative impacts on delivery performance to clients. When the group of critical resources is from three to seven, then the system can be under good control. It is advisable to implement the Planned Load Control (see Chapter 9 in the TOC Handbook) on each of the critical resources, to remain under control.

6.2.b Capacity Buffers

Capacity Buffers include all the various options to add relatively small amounts of capacity, generating ΔOE, but helping to generate a greater amount of ΔT. The authors believe that maintaining readily available capacity buffers is a strategic asset, ensuring that a certain amount of extra capacity can be used within the required timeframe whenever needed. Capacity buffers can be overtime, temporary workers acting as freelancers and outsourcing, where the temporary capacity is purchased outside the system. Consider the use of a capacity buffer as a ready 'micro-elevation.'

Capacity buffers are part of the protective capacity. Actually, the level of protective capacity that seems to be necessary in order to protect the delivery performance from the normal statistical noise (Murphy), should be defined as the 'red-zone' of the overall available capacity buffer.

An important point to realize is, even with a certain available capacity buffer, there is a limit to the amount of additional temporary capacity that can be practically utilized. This suggests that having a true capacity constraint means the incoming demand could periodically load the CCR very close to its limit!

When the organization cannot afford to disappoint the market due to the limited capacity of the CCR and realizing there is no practical way to subordinate the market demand to the exploitation scheme of the CCR, then even the CCR must maintain a certain level of protective capacity to ensure meeting all the commitments to the market. Practically, expect that the required level of protective capacity of the CCR should be significantly lower than what is required from the other critical resources, because non-constraint resources must have flexibility to ensure smooth flow of inputs into the CCR, on top of the urgent red orders that customers need soon.

The conclusion is that managing a true capacity buffer, along its green, yellow and red zones, is highly beneficial for any critical resource.

6.2.c T-generators

The term 't-generator' was conceived to answer a need: distinguishing between ***a product, produced by the organization***, and ***what is eventually sold to a customer***. While many times what is produced is exactly what is sold, in many occasions what is sold is a package, consisting of various products, sometimes even including products and services that were produced by another organization. Even when the same basic product is sold into two different markets for different prices, it is practical to separate the two related, but definitely not identical products.

A 'product' is an item produced by the organization to be sold.

A 't-generator' is whatever is actually sold to a customer at a certain price. It must include, at the very least, one unit of some product. It can also be built from a set of products and services, like a warranty or transportation to the desired location, all for some price.

The price for the t-generator can now be analyzed to ascertain its throughput (T). The list of products within that t-generator can be analyzed to calculate the capacity requirements from every product included in the t-generator.

6.3 The analytical process for creating a reasonable scenario

As a starting point for a meeting of the management team, have the expected baseline Sales Profile for the relevant period of time, the Capacity Profile of the critical resources for the same period and one or more of ideas for how to improve the attainment of the organization's Goal, mainly the predicted bottom-line.

6.3.a The Sales and Capacity Profiles of the Critical Resources

Every suggested idea should be evaluated relative to the current state, which we assume we can maintain as it is now. Two main areas that define the current state:

I. What we currently sell to our customers. We suggest using current sales – all the t-generators sold in the last period – as the reference Sales Profile. The assumption is: we predict that if we don't change anything, then next period will show sales very similar to the Sales Profile we have outlined. If we expect the next period to have different sales, due to seasonality, certain known trends or new customers, then construct a good enough forecast for the next period and use this as the Sales Profile reference for new ideas and proposed actions.
II. To support the Sales Profile, there is a need for capacity from the critical resources. Of course, there are more capacity requirements, but we can assume that all the non-critical resources will have enough capacity. However, the critical resources must be checked to ensure they have sufficient capacity to produce the Sales Profile.

Comments and assumptions:

While the Sales Profile is a forecast, precision is not required, because it only serves as a reference. It should be more typical, than accurate.

The Capacity Profile calculations should include good-enough estimation of setups, downtime and maintenance, still leaving enough protective capacity. When additional capacity is required, we assume that capacity buffers are ready to be used.

It is usually unnecessary to consider current inventory levels, as long as the levels are about right and there is no special need to increase or reduce inventory levels. When this assumption is invalid, certain considerations are required but they are beyond the scope of this paper.

From the above, plus general financial information, it is possible to calculate the total T the Sales Profile would generate. The current level of OE should be known, generally speaking, as it reflects the money the organization spends to maintain the existing available resources. The difference T – OE gives the expected NP for that period. The question whether the NP is actually the EBITDA, depends on whether the depreciation, amortization and interest costs are included in OE or not. There might be some revenues that were not generated from regular sales and, in that case, they are not included in the reference T and OE. Again, there is no need to be precise with the Sales Profile and the exact amounts of total T and OE. The focus of the decision-making process is to discover $\Delta NP = \Delta T - \Delta OE$.

ΔI is relevant whenever the suggested decision involves investment, including a significant increase in inventory or receivables. The way to check the ROI, regardless of how you determine the desirability of an investment, is through checking the annual predicted $\Delta T - \Delta OE$ generated by the considered decision. ROI can be checked through the two scenarios, outlining the conservative and the optimistic returns.

6.3.b Calculating the direct and indirect ΔT generated by the decision at hand

When a new idea is put on the table, the first question is: will it generate positive ΔT?

The direct ΔT is straight-forward, requiring estimation of the additional sales, less required truly variable costs (TVC).

The indirect aspect includes impact on sales outside the decision itself. In other words, if sales of other t-generators is somehow impacted by the decision. For instance, if the direct impact takes so much capacity that there is a need to limit the sales of other SKUs or that market demand for other SKUs is impacted due to decision.

As an example, suppose a promotion is announced for several SKUs with price reduction of 10%. The promotions is announced with the expectation of selling many more units. During the promotion, normal T-generators, at the usual price, will not be sold. Instead, a new group of t-generators with 90% of the regular price are sold. The direct ΔT comes from the new t-generators with the reduced T per unit relative to the normal T per unit. Please note that the reduced T per unit of the new t-generator is significantly less than 90% of the original t-generator. The expectation is that the promotion will result in enough additional units sold so the overall ΔT is positive.

Another possible indirect negative impact on ΔT is that the promotion could continue to impact the sales of that group of SKUs for some period of time **after the promotion!** Regular customers of the relevant items might buy more during the promotion and reduce their regular purchasing for some time afterwards. This could impact the validity of the promotion. That potential loss of ΔT should be reflected in the assessments of the decision at hand.

A last indirect impact on ΔT, this time positive, is whether the promotion would attract more customers permanently, being impressed with what they bought during the promotion.

If both the directly and indirectly generated ΔT is negative, then there is no point checking the idea further and it should be rejected, except in the rare case when ΔOE is even more negative.

6.3.c Verifying that there is enough capacity to deliver the new Sales Profile and including valid alternatives

At this stage, there are already two scenarios within the new Sales Profile based on the conservative and optimistic assessments of the impact of the decision-at-hand on the sales, translated to T. At this point, each scenario should be checked to insure that it is possible to deliver the new Sales Profile, meaning that no critical resource lacks capacity or, if it does happen, there is a way either to free capacity, by giving up some sales or to add capacity for some ΔOE. Of course, as an end result, the ΔT – ΔOE should remain positive. The only reason to accept a pessimistic scenario that is negative is that the other scenario, the optimistic one, is so good that the management is game to take the chance.

So, for each scenario a capacity check is carried out. The result of the load on each critical resource should leave adequate protective capacity. When one or more of the critical resources seems overloaded, then a decision must be made.

Comment 1: It is possible to come with a computerized algorithm that would yield the best alternative of utilizing the critical resources and/or reducing certain sales, optimizing ΔT – ΔOE. The problem is that **it is not clear that the optimized solution is realistic**.

When using capacity buffers, several conditions may realistically apply. Capacity is usually purchased in certain minimum chunks, like overtime in one hour increments. Workers who are willing to do overtime may want to restrict it to no more than four hours of overtime in a day and a maximum ten hours per week. This can be negotiated, verbalized and regulated.

However, reducing sales of current t-generators makes it necessary to check whether there are no other negative effects, such as clients being so annoyed by not getting all the items they want that they look elsewhere not just for the items their supplier decided to limit but for everything they usually buy. **There is a need to get an educated opinion from someone knowledgeable that such a move won't have such undesirable effects**.

Thus, an optimized AI tool could suggest a solution but the human managers should make the final call.

Comment 2: It seems obvious that the conservative scenario will always show less ΔNP than the optimistic one. While in most cases this is true, there are cases where the additional capacity required for the optimistic scenario costs so much, either in additional capacity or lost current sales that the conservative scenario yields more profit.

Comment 3: We have so far ignored the role of the supply. A higher level of sales certainly requires more raw materials. While in most cases there is no problem in getting all the required supply, the question should be asked and answered. It could also be the case that while the additional supply can be acquired, it might take too long and impact the optimistic scenario. Additional inventory and receivables also mean a temporary reduction of cash. Cash is another resource and it could well be one of the critical resources. In such a case, a detailed analysis of the available cash must be included in the overall critical resource capacity check.

Comment 4: When there are several new ideas to be considered, each idea should be checked first as a stand-alone idea. Then, the attractive ideas are checked again in combination. Don't forget to check the capacity of the critical resources, including cash. It could be the case that some of the ideas must be rejected as the overload on one or more of the critical resources cannot be resolved profitably.

6.4 Making the final decision

Eventually a decision must be made or not. The actual financial outcome of the decision, the added net profit, is given as a reasonable range between the conservative and the optimistic scenarios.

Sometimes there might be complexity when the steps for using additional capacity and/or reducing sales of certain t-generators, requires different actions between the high and low scenarios. In such a case, the main issue is the timing of when the decision about a potential action, like using the capacity buffer, or limiting the sales of a t-generator, must be finalized. Most of those actions should be decided prior to taking the action itself, as the involved parties may benefit from being informed.

It could be that to use the capacity buffer as an answer to the optimistic demand, the decision must be made before the actual demand is known. Practically, this means that the ΔOE could be higher, while the demand is considerably lower. When this might happen, the team should consider the very conservative case of:

$\Delta T_{conservative} - \Delta OE_{optimistic}$ to validate whether such a worst case result doesn't invalidate the decision to move ahead.

Conclusions

While the above process requires effort, due to the number of calculations, the logic and flow is simple, straightforward and common-sense. Any new idea is checked theoretically by adding it to the current business. The financial calculations, require Sales, TVC and all the OE, which behaves non-linearly, including the OE required to provide protective capacity to ensure meeting all the commitments to clients. There is no real difficulty in calculating the ΔNP for the pessimistic and optimistic scenarios well enough, whether you use a dedicated IT tool or a spreadsheet.

What is not straightforward is assessing the future demand resulting from the decision. Estimating the level of uncertainty is usually based on human intuition, which is far from being precise and is exposed to various biases. However, human intuition can be effectively used to assess the boundaries of what we don't know. When human intuition assesses a situation as 'too crazy to be realistic,' then it is possible to come up with two scenarios that contain the vast majority of the realistic possibilities, while the 'too crazy' situations are left out. Realizing the range of conservative to optimistic provides, by far, the best information for making decisions under uncertainty!

While the intuition of managers is satisfactory to broadly define the reasonable range of demand, it is typically not good enough to predict the impact on net profit. It is often counterintuitive to many people that the impact of a mild increase in Sales can substantially increase the net profit. The recognition that ΔT could be very different from ΔSales is a new insight and intuition is slow to adapt to new concepts. Consequently, the recognition that 10% additional sales would probably generate ΔOE

that is a fraction of 10% of the OE, is another revelation. From our experience, many times ideas that at first glance seem frightening are often surprisingly profitable. Using the above decision-making process readily indicates when a new idea is a loser and when it is great, even in the worst case. Following these steps will hone the intuition of managers to better understand how to exploit the current potential of the organization, before spending to elevating the constraint. For example, it is typically quite expensive to acquire another company that potentially elevates both the market demand and the OE spent for capacity of the critical resources but is it necessary yet or at all?

Our book, *Throughput Economics*, contains very detailed examples, including the discussion between the key managers, evaluating the possible consequences of certain moves. These examples demonstrate not just the process itself, but how decisions that seem like 'bad ideas', can be highly profitable, even according to the pessimistic scenario, while other ideas would result mediocre impact on the bottom line.

A PDF file of Chapter 8 of our book, describing a detailed example, is available on the TOCICO website.

A recording of the webinar, *From Throughput Accounting to Throughput Economics*, is also available on the TOCICO website.

The Origin of the Goal Tree

by H. William Dettmer

"Once upon a time..."

Don't all old-time stories start like that? Well, this one does.

Once upon a time, back in late 1992, I learned about a training course in New Haven, Connecticut, called the Jonah Program. I was an adjunct faculty member at the University of Southern California (USC) at the time, teaching systems thinking and systems management to graduate students—working professionals.

A Goldratt Institute certified associate in Los Angeles recounted for my boss at USC, the director of the institute in which I was teaching, Goldratt's background and the gestation of the Theory of Constraints. In his infinite wisdom (from my perspective!), my boss decided to send me to the course. At the time, Goldratt was offering concessionary rates on tuition for his courses as a way of spreading the word through academia.

I went for my two-week Connecticut sojourn in February 1993, expecting to learn all about drum-buffer-rope (D-B-R) production control. Imagine my surprise when I got to 442 Orange Street and heard the instructor say, "Welcome to the Thinking Processes." *Not* what I'd bargained for.

But I set aside my doubts and waited to see what would happen. This was only the second Jonah course that taught the Thinking Processes (TP) exclusively. Prior to the first one, the preceding November, it had always been a drum-buffer-rope course. And that's what I'd signed up expecting. But over the next ten days, I discovered something infinitely more valuable than the D-B-R course.

It was clear to me early on that the Thinking Processes offered far more value to me, as a systems management practitioner, than D-B-R ever could. A kind of universal problem-solving tool, the TP were not limited to production systems. They could be equally well applied to any kind of system, anywhere.

"Ready! ... Fire! ... Aim!

I left the Jonah course in New Haven "with my hair on fire." As I flew back to California, I remember looking at all the passengers around me and thinking, "I know a secret that you don't know ... and it could change the world!" (Okay, I was more than a little starry-eyed at that time. But I was also unaware that I'd come crashing back to earth soon enough.)

I returned to my teaching duties at USC just in time to start a new graduate course in project management at Edwards Air Force Base, California. I resolved to start introducing the TP into my regular curriculum courses, and this would be my first opportunity.

And I fell flat on my face. The students, God bless 'em, were more patient with me than I had a right to expect. They listened with rapt attention—and quizzical looks on their faces—as I tried to explain how to build a Current Reality Tree. These were all working professionals, many of them engineers, looking to broaden their horizons and enhance their careers with a Master of Science degree in systems management. And they tried. They really did.

© H. W. Dettmer, 2022

I was quick to recognize the reason for my failure—I had no teaching materials worthy of the name to hand out to the students. All I had was a binder full of logic trees and a few checklists that I'd been given at the Goldratt Institute. But whereas the "brute force" approach to learning the TP had the luxury of time to work at 442 Orange Street, at USC I usually had no more than 30 minutes of a two-and-a-half hour class meeting to introduce anything new. I needed the rest of the time to cover the sanctioned project management course material. (Harold Kerzner's biblical tome was the required reading for that, if any of you project management mavens remember it.) For me, beginning to teach the TP, even to an intelligent, receptive audience, was very much a matter of "Ready! ... Fire! ... Aim!"

To the rescue...!

In disillusion, I called Bob Fox, then the North American president of the Goldratt Institute. I cried on his shoulder (figuratively speaking), recounting my tale of woe. Bob said, "I think you need to come back for the Jonah's Jonah course." *What was that?* I wondered. "It's the course to teach you how to teach the Thinking Processes," Bob replied.

So, four months later, I found myself once again at the Goldratt Institute, sitting in that marvelous Victorian conference room with the high ceilings and tall windows, and the table big enough to land an airplane on. Over the next *three* weeks (one week added, this time), Alex Klarman and Tracey Burton ran me and the other eight participants through the train-the-trainer course.

Sitting next to me were two other aspiring TP trainers: Craig Morgan, a publishing executive from Chicago, and Dr. Van Gray, a business school professor from Baylor University. They were pretty laid back. I had my nose buried in my notes, which I scribbled intensively throughout the first two weeks of the program. At one point, Craig Morgan said, "What are you doing? Writing a book?" I had some 80 pages of hand-written notes and diagrams ... added to the 60 I'd accumulated in the original Jonah course. I thought for a moment and replied, "Yes, I guess I am." And that was the beginning of my first book on logic trees.

It took me another year to consolidate all my notes into an inch-thick softcover "course reader" printed by the USC bookstore in Los Angeles, specifically to support my graduate courses. I was now ready to really teach the TP to my students! And this time, the students ate it up. Some did exceedingly well, others not so well, the majority somewhere in the middle. But my objective was achieved: All of them were enthusiastic about using the tools.

Flounder: More Than Just a Fish

Getting to the point of actually being able to teach the Thinking Processes effectively seemed a lot like cutting and slashing my way through the jungles of Darkest Africa ("Doctor Livingston, I presume...?") My students floundered with the construction of Current Reality Trees. For that matter, I did, too. And that didn’t really change over the next several years, in spite of my neat, peachy-keen course reader.

My first attempt at a Current Reality Tree was on the topic, "Why Total Quality Fails in Organizations." It took me the better part of five days in New Haven to finish this tree. And the result was somewhat depressing: perhaps 150 entities and 40 Undesirable Effects (UDE) on small Post-it notes, stuck on three or four huge sheets of butcher block paper. But, damn it, I had a core problem! A single core problem that said, in essence: "It's the fault of bad leader-

© H. W. Dettmer, 2022

ship."

What a revelation—not! In truth, almost *all* problems in complex organizations can be laid at the feet of leadership. I didn't need a 150-entity logic tree to tell me that! Just as bad, I found the logic trees my grad school students had built were equally vague. Lots of entities, lots of Undesirable Effects, and over-broad core problems. As the years went on, I realized that the same was true of my clients.

What was lacking?

Focus

I'm glad you asked that question. The answer is focus. My Current Reality Trees, as well as those of my students and clients, were "all over the waterfront."

It shouldn't be this way, I thought. We drown in Undesirable Effects, many of which didn't really seem all that important. We're saddled with broad statements of core problems that took on many of the characteristics of ... marshmallows. To a "systems" guy, there seemed to be precious little ... well, system ... in it all.

I tried to think of a way to impose some focus on the whole process. In my Thinking Process courses for clients, I started them aiming for a well-defined problem by having them create a title for their Current Reality Tree that started with *why*. "Why does our organization [enter your own choice of negative outcome]?" From there it was easy enough to get the participants to create statements demonstrating that the negative outcome was happening. It was a start.

But even then, the guidance for determining Undesirable Effects was too broad. The Goldratt Institute answer to "How to come up with UDEs?" was to write down "anything you don't like that's happening in your system." Well ... *that* doesn't exclude very much— I can bitch and moan all day about things I don't like in *my* system. And others could do the same.

There was another problem with Current Reality Trees, too: *How do you know when it's time to stop "drilling down" in the cause-and-effect chain?* The "book solution" (from 442 Orange Street) was, "Stop when all your cause-and-effect branches have converged into a single entity— a *core problem*.

Sorry, but *that* wasn't much help, either. If I wanted to merge all the branches of reality in *any* situation, I knew the core problem for that. It sounds like, "And God said, 'Let there be light.' " If that isn't the single root cause of everything wrong with any organizational system in the world, then I don't know what is. But there's a problem with that statement of a core problem: it's not exactly *actionable!*

So, clearly, for any CRT on any subject to be actionable, we have to draw the "drill-down" line *somewhere*. And that "somewhere" is almost guaranteed to be *above* the level of a unitary core problem. But what does that leave me with? Multiple branches of the logic tree that *don't converge* into a single core problem.

This whole challenge of getting problem analyses—that is, Current Reality Trees—focused was becoming a real pain in the ass. There had to be a better way...

A Clean Sheet of Paper

© H. W. Dettmer, 2022

The only thing I could think of to do was to start over, from scratch, with a system perspective. Fortunately, the Theory of Constraints provided me the "seed" for doing that in a book called *The Goal*. And what was that seed? The goal, of course! (Duuuhhh...) I began by asking, *What's the goal of the system?* Sorry, but it's not as simple as parroting "To make more money, now and in the future." There are a lot of systems out there, and many—perhaps most—of them are *not* in the business of making money.

Nevertheless, defining the goal of the system to be analyzed seemed a good way to start. Fine. But what comes next? It was at this point (around 2001) that I recalled something I'd seen in a short program at the Goldratt Institute in 1995. As I sat around the conference room table with a half-dozen others, I noticed something on an easel that was not part of the program. It looked like a very "busy" Prerequisite Tree, but it didn't have any obstacles. I asked about it and was told, "That's an Intermediate Objectives Map." I thought no more about it ... for six years.

Then, as I struggled with what to do next with the goal statement I'd started with, I remembered the Intermediate Objectives (IO) Map. *What happens if I put the goal at the top of an IO Map,"* I wondered? Boy, that was easy! But now... what? Think, Dettmer! *What's directly under the objective in a Prerequisite Tree?* Well, whatever it is, it's the *last thing* that must happen before the objective is attained. So, what's the last thing that must happen before the goal of a system is realized?

Critical Success Factors

Without warning, from deep in my memory banks, the title of a *Harvard Business Review* article from 1979 crawled into my consciousness. "Chief Executives Define Their Own Data Needs." [1] It was the very first mention of "critical success factors" that I ever saw. I dug it out and re-read it ... for the first time in 20 years. And to my dismay, though it used the term, it did not define what a critical success factor was! It offered something more like "I'll know it when I see it." Not much help there. But it *did* get me to thinking, since the article wasn't any help, how would *I* define a critical success factor?

One criterion seemed obvious—if it were to be truly critical to goal attainment, it would have to be something that happened *just before* the goal was realized. In other words, it had to be the summary outcome of all contributing activities in the system. A *terminal outcome*. And that terminal outcome would have to constitute an important component of the goal itself. Now, we're getting somewhere!

But ... how many critical success factors does it take to attain a goal? Clearly, it can't be a lot. The more things one designates as "critical," the more diluted criticality becomes. If you have ten things you consider critical, then *none* of them are truly critical.

Let's go back to the goal for a minute.

Goldratt suggested that the goal of a company (for-profit, we'll assume) was to "make more money, now and in the future." Okay ... in the final analysis, how does that happen? Well, Throughput Accounting gave us a pretty good answer to that: Maximize throughput, minimize inventory, and minimize operating expense. [2] *There you have it,* Dettmer. What are these but critical success factors that define a goal — profitability! They're most assuredly terminal outcomes of many subordinate activities. They're definitely high level, because they happen *just before* the goal is attained. And there are damned few of them!

© H. W. Dettmer, 2022

But what if a system's goal is not to maximize profitability. Take, for example, a fairly autonomous sub-unit of a larger corporate entity that completes important work enabling other parts of the system to complete their work. Like, maybe, Henry Ford's Rouge River steel plant, which smelted the steel for all those Model-Ts that Ford sold between 1908 and 1927. Rouge River could have been said to have a goal and critical success factors, couldn't it?

Yes, it could. But that goal and critical success factors wouldn't necessarily have been financial, would they? At least not all of them. The goal would likely have been tons of steel, and in place of throughput (a financial term) there would have been some other non-pecuniary metric. Inventory and operating expense could still be relevant as fiscal metrics. We won't get into those details here. It's enough to say that even in a non-financial situation, the number of critical success factors would be limited. For me, three seemed a good starting point.

A Goal and Critical Success Factors — Now what?

Okay, now I've got a goal and three critical success factors. *What do I do with them,* I wondered? Here's this Intermediate Objectives Map sitting here, doing ... not much. What if I arrange the goal and critical success factors, in two layers, and plop them on the IO Map as the top two layers? Then what are all the layers below? Clearly, like intermediate objectives in a Prerequisite Tree, these elements are necessary in order to realize the critical success factors. *Necessary conditions*. And there's a logically dependent network of them below the top two levels of this new type of tree.

So there we have it: A system goal, dependent on three (or perhaps more) critical success factors, which themselves are dependent on a substantial network of necessary conditions. I wondered, *What do I call this?* It's not a Prerequisite Tree, because its purpose is not to overcome obstacles. And it's a very high level tree. After all, it culminates with the system's goal. Since it was an adaptation of what I knew as an IO Map, and since it clearly overarched the system — however you define that — I referred to it as a "strategic intermediate objectives map" ... or S-IO Map.

And that's the way it first appeared in print, in my book *Strategic Navigation* (2002). It wasn't until eight years later, when I was constructing one of these trees with Deloitte Consulting, that Martin Burns, a Deloitte partner, began referring to it (to senior management) as a "goal tree." And once again, I had that "Duuuhhh..." moment. *Why didn't I think of that?* So, realizing which side of my bread the butter was on, it became a "goal tree" there ever after.

Emerging From the Rabbit Hole

Nice story, that, about how Goal Trees came to be. But I got woefully off-course. Before I went down that rabbit hole, I was trying to improve the quality, and to a lesser extent the speed of completion, of Current Reality Trees. My intention was to make them easier and faster for people to "get right" the first time. How does a Goal Tree help do that? Back on course, now...

If you recall, the disorganized nature of Current Reality Trees was an entirely predictable outcome of the over-broad definition of an Undesirable Effect. With the Goal Tree now in hand, it was time to compare it with reality. And the first, most obvious take-away from that was that a new definition of Undesirable Effect was essential. No more "anything you don't like about your system." Instead, to keep attention focused on the system (instead of petty aggravations), an Undesirable Effect would be a *failure to satisfy a critical success factor, or the goal*.

© H. W. Dettmer, 2022

And since there were very few critical success factors (usually no more than three), there really couldn't be more than the same number of *system* Undesirable Effects.

Whoops! Add *one more*. According to the definition of a critical success factor, failure to achieve it automatically results in failure to achieve the goal. Since all the CSF are critical to success, a failure on *even one* means goal attainment is compromised. After all, that's the essence of necessary condition logic. So, if your system is failing at one critical success factor, there are really two Undesirable Effects — one for the CSF and one for the goal its failure-to-achieve prevents. A *really bad* system might fail at all of its critical success factors, in which case it would have that number of Undesirable Effects-plus-one.

Boy, did this simplify Current Reality Trees! Instead of 30 or 40 Undesirable Effects, there were usually no more than four, and possibly only two! How easy should *that* make Current Reality Trees?! Pretty easy, as it turns out. What used to take four to five days to complete could be accomplished in *four to five hours*. What was the difference? *Focus!* Instead of trying to connect 30 or 40 UDEs, people were only having to connect four or fewer. That's *bound* to take less time.

Not So Fast …

There are, however, a few new considerations in this method of defining Undesirable Effects. With the "old" way of constructing Current Reality Tree, the objective was to drill down to a *core problem*. By definition (of 442 Orange Street), a core problem was one that accounted for 70% of the UDEs in a system. At first blush, that might sound okay—if you can't get 'em all, focus your efforts on the majority.

But there are a few problems with that. First is that it assumes that "all UDEs are created equal." That is, each of them are equally bad. When the criterion is "anything you don't like," that may be okay. But what if 70% of your core problem's UDEs are of the "my in-box is too full of paperwork" variety, and the failure to generate enough sales for the quarter ends up in the remaining (untouched) 30%—the ones you're ignoring because they don't result from your core problem?

The second consideration is that with the new definition of UDEs—a failure to achieve a Critical Success Factor—is that if one such UDE can prevent Goal attainment, then *any* of them can. This means you can't deal with only 70% (a core problem). You have to get rid of *all* Undesirable Effects. Fortunately, there won't be as many … no more than the total number of Critical Success Factors, plus one. That's a much more manageable number.

A third consideration is the motivation to search for a core problem—the one major deficiency that can be "shot with a silver bullet." As I intimated earlier, the search for a core problem might result in a very "fuzzy" problem statement. That's bad enough. But it also might lie beyond the authority of the chief decision-maker to do anything about. What do you do if you have three branches in your CRT, you're dying to merge them into a nice, neat core problem that you can make go away and solve all the system's ills, but you "ain't got no control"…?

The answer is, you're faced with working on several root causes. And to the extent that these causes ultimately produce UDEs 'way up above, they're critical to resolve. You might call them *critical root causes*. At least, that's what I call them.

© H. W. Dettmer, 2022

So, if you're applying this later-generation approach to building CRTs, you have two requirements to keep in mind. First, you have to eliminate *all* UDEs, not just 70% of them. (Fortunately, there aren't as many as there were before.) Second, you must accept the fact that in all likelihood you're going to have to deal with *multiple critical root causes*. Maybe only two. Maybe three or four, but it's not likely to be more than that. Not if you only have three or four UDEs at the top.

But ... but —

I know what you're thinking: *Where did all that detail from the original CRT approach go? It can't have just disappeared!*

No, it can't. And much of it didn't. (Some of it did, because it wasn't necessary-and-sufficient for the new, more streamlined CRT.) Instead, if it was truly relevant to the streamlined causality, and much of it was, it found its way into the chain of cause-and-effect lower in the tree, not at the UDE level.

Lest you think that CRTs became superficial pictures of complicated reality, think again. They could very often still have 50 or 100 entities. But the branch structure was far more robust and less confusing. By way of example, here's the "silhouette" of a post-Goal Tree Current Reality Tree. (**Figure 1**) It describes the problems of a $10 billion financial corporation. Was it too confusing? Hardly. The CEO's reaction: "I've been looking for this for 25 years..."

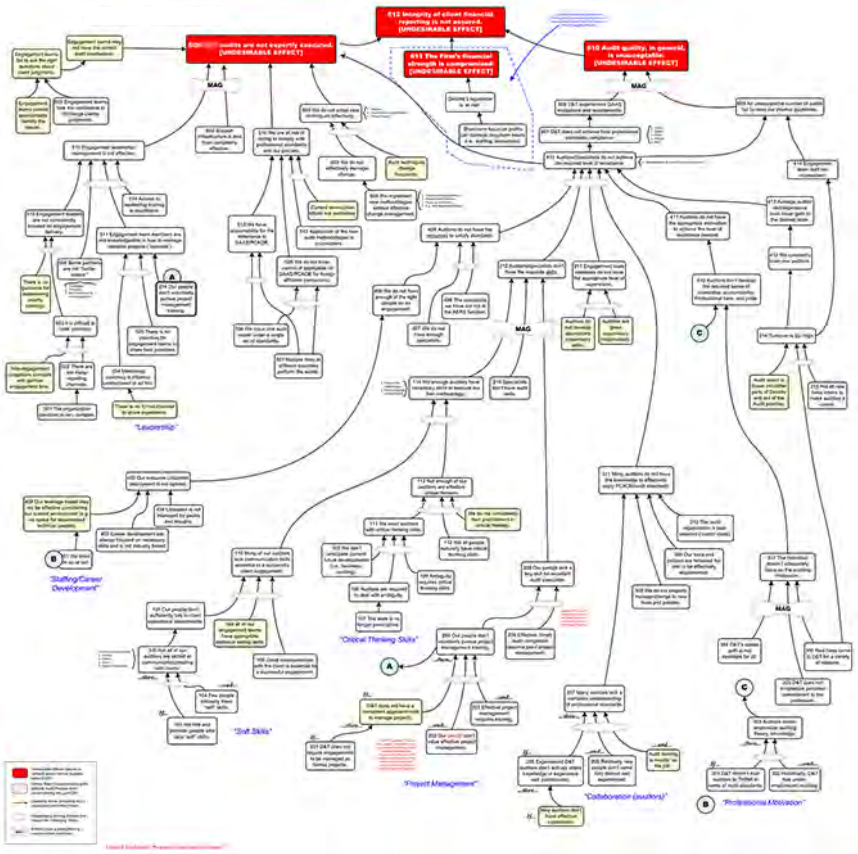


Figure 1. Current Reality Tree — Financial Services Company

© H. W. Dettmer, 2022

The Bottom Line

That, as Paul Harvey would have said, is the rest of the story. Now you know how the construction of Current Reality Trees went from five days to five hours. And how I was able to compress a 10-day Jonah course into five days.

But along the way, the Thinking Processes "morphed" from the configuration and structure originally conceived by Goldratt into a newer, faster, easier-to-accomplish model — one that brings with it better system focus the first time and more satisfied customers in the final analysis. My approach was so radically different from anything that any other students of the Goldratt Institute Jonah Program were doing, I felt the need to distinguish it from the original. So, I refer to what I teach as the *Logical Thinking Process* (singular), instead of the Thinking Processes (plural).

Versatility Magnified

Moreover, I found a curious thing happening. Although I originally intended the Goal Tree to be merely the precursor to cleaner, more robust, focused Current Reality Trees, as time went on I discovered *other* benefits to it, too. I found that the Goal Tree could stand alone — without a complete thinking process analysis following it. It could serve as a constant "beacon" for organizations to maintain their day-to-day focus on what they ought to be doing to succeed in their chosen field. A good example is Aerosud SA, an aviation subcontractor in South Africa. Their managing director had their Goal Tree printed in large scale (**Figure 2**). It now greets visitors and employees alike in the lobby of their corporate offices — a constant reminder to both of their focus on what it takes to succeed.



Figure 2. Johan Steyn, Managing Director of Aerosud SA, and Andre Tustin, Continuous Improvement and Supply Chain Synchronization Manager, and the company's Goal Tree

© H. W. Dettmer, 2022

I discovered, too, that the top two layers of the Goal Tree — the goal and the critical success factors —could be applied to the development of Evaporating Clouds for conflict resolution within systems, making their creation faster, easier, and more effective the first time. (**Figure 3**) And the same two layers of the Goal Tree provided part of the "skeleton" of a Future Reality Tree, making that tree faster, easier, and more effective in creation.

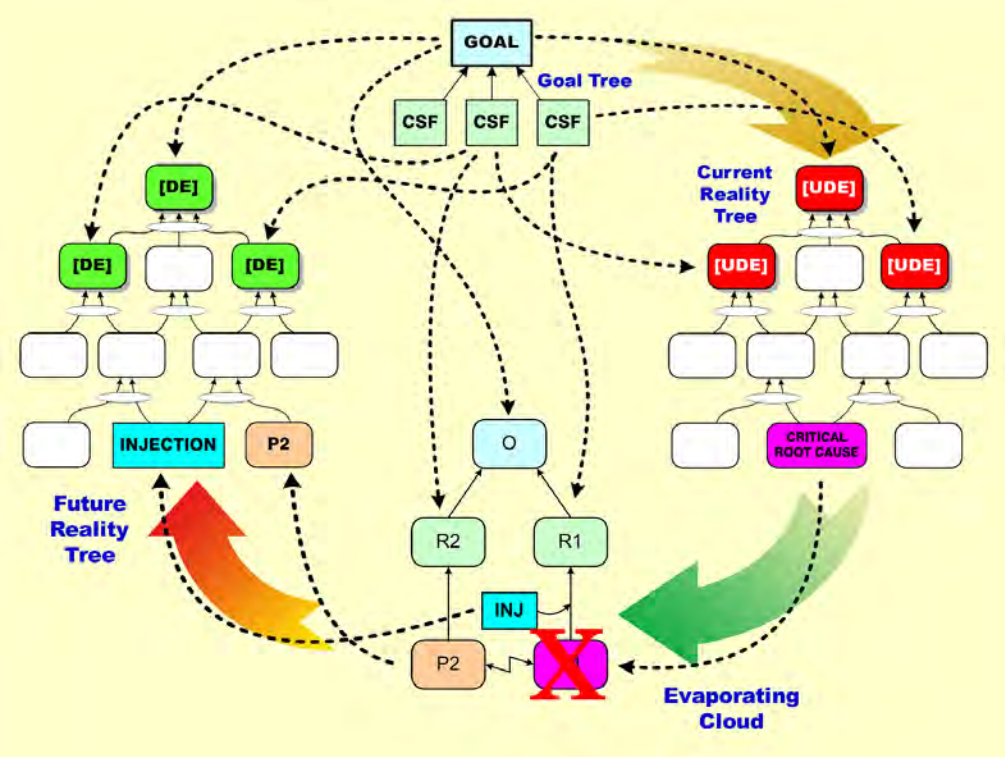


Figure 3. The Goal Tree informs not only the Current Reality Tree, but the Evaporating Cloud and the Future Reality Tree as well. It's the key to the entire Logical Thinking Process.

Summary

What do I want you to take away from this little history lesson?

- First, the Goal Tree is the core of the Logical Thinking Process. It informs *every other* logic tree.
- Second, the Goal Tree has many of the same characteristics of a Prerequisite Tree: it culminates in a single outcome (the Goal); it starts with a network of sequential necessary conditions; and it may have parallel branches that cross-connect.
- Third, it employs the concept of Critical Success Factors—a limited set of *terminal outcomes* (necessary conditions) that define goal attainment. In doing so, it provides the system -level focus absent in the original thinking processes.

It's worth noting that, contrary to what some people might think, the vertical placement of necessary conditions and Critical Success Factors in the Goal Tree implies *nothing* about their importance relative to one another. The nature of the necessity-based logic makes the lowest necessary condition in the tree equally important as the Critical Success Factor … because if

© H. W. Dettmer, 2022

you fail to accomplish a lower level necessary condition, none of what transpires above it, including a Critical Success Factor, will happen. That makes the key distinction between a Critical Success Factor and any other lower-level necessary condition the fact that the former is a terminal outcome of the preceding activities.

The Goal Tree really *is* the foundation for all the trees in the Logical Thinking Process. And after nearly 30 years, I can still say that the Logical Thinking Process is the best policy analysis tool ever created. And the lion's share of the credit for that goes to a physicist who didn't let the field of physics constraint his creativity — Eli Goldratt. ♦

ENDNOTES:

1. Rockart, J.F. "Chief Executives Define Their Own Data Needs." *Harvard Business Review*, March 1979.

2. These were Goldratt's original words, from *The Haystack Syndrome* (1990). Over time, I (and others) have concluded that "optimize" would be a more accurate characterization than "minimize."

© H. W. Dettmer, 2022

Published at *Journal of Operations Management* https://doi.org/10.1002/joom.1234

Justice in Time: A Theory of Constraints Approach[1]

Shany Azaria, Boaz Ronen, Noam Shamir

Abstract

If there is some truth to the adage that justice must not only be done, but must be seen to be done, then surely it must be seen to be done in a timely manner. Yet court congestion and delays – which threaten to undermine the justice system – have become global phenomena with significant adverse implications for social welfare, economic development, and civil rights. This work describes an application of the Theory of Constraints (TOC) to the judicial system for the purpose of designing an intervention to alleviate court congestion – an intervention that won the 2012 Goldratt Foundation New Knowledge Award. In cooperation with the Jerusalem District Court in Israel, the judicial process was reviewed through the lens of TOC, and a set of operational changes was implemented to reduce case processing time. Data collected before and after this intervention indicate the potential of achieving lead-time reduction by applying TOC to judicial environments.

- Judicial systems suffer from operational inefficiencies that result in significant delays.
- We offer a systematic approach to analyze such systems through the prism of the Theory of Constraints.
- Several suggestions for improvements are discussed and initial data are presented.

[1] The authors acknowledge with thanks the honorable judges of the Israeli court system: Dorit Beinich, Moshe Gal, Mussia Arad, Zvi Zilbertal, Itzhak Inbar, Jacob Zaban and the Judges of the Jerusalem District Court.

1. Introduction

Delays in legal proceedings and the suspension of the delivery of justice are hardly novel phenomena. More than five centuries ago, Hamlet included "the law's delay" in his list of life's miseries. Hamlet's – or, rather, Shakespeare's – indignation at delays in legal proceedings is not surprising: after all, such delays are detrimental not only to the injured party but also to social welfare. The legal maxim of "justice delayed is justice denied" (William Ewart Gladstone, in Platt, 1989) has been rightfully recognized as an essential characteristic of a sound justice system. If citizens are to trust the judicial system to be the watchdog of their rights and liberties, they should be able to expect a speedy outcome, so that the passage of time would not *ipso facto* render a just judgment null.

From an economic perspective, judicial delays increase the cost of doing business, negatively affect entrepreneurship (Chemin, 2009), discourage investments, and impede financial growth (Chemin, 2010). In fact, not only is the *efficiency* of the judicial system negatively affected by delays, but the *efficacy* of the ensuing decisions may be impaired as well. Research shows that long proceedings may impede a judge's ability to reach a just resolution, either because witnesses become weary and disappear (President's Commission on Law Enforcement and Administration of Justice, 1967: p.129; Nagel and Neef, 1978) or because judges invest less time in reaching settlements (Helland and Klick, 2007). Thus, the consequences of court congestion and delays for judges' decision-making may be severe (Best and Tiede, 2015).

Despite the crucial importance of a timely judicial process for social welfare, severe congestion and delays in judicial systems are worldwide phenomena (Church et al., 1978; Dakolias, 1999; CEPEJ, 2015; CEPEJ, 2016; Voigt, 2016). To complicate matters further, evidence suggests that the demand for judicial intervention is increasing, along with its costs (Decker, Mohlen and Varela, 2011; CEPEJ, 2016). Increasing the expenditure on court systems may seem like a straightforward solution, but this strategy may not be feasible, and even when implemented, may not result in the desired outcome of reducing court congestion. For example, Beenstock and Haitovsky (2004) showed, using panel data from Israeli courts, that increasing the number of judges does not result in a higher rate of processed cases. Peyrache and Zago (2016) investigated the effect of court size in the Italian judicial system and

found that a major part of the court's congestion problem stems from the suboptimal structure of the justice system rather than from a lack of sufficient resources.

This JOM Forum article describes an application of the Theory of Constraints (TOC, Goldratt and Cox, 1988) to the judicial system with the goal of alleviating court congestion. The intervention that arose from this endeavor was adopted by the Jerusalem District Court in Israel, and later won the 2012 Goldratt Foundation New Knowledge Award. The key guiding principles of TOC were used not only to analyze the judicial process, but also to design the intervention (described below). The objective was to improve the operational performance of the judicial process, defined as reducing the average lead time of a case, without increasing the resources allocated to the court. Specifically, the intervention consisted of applying three main operational modifications to the judicial process: (1) introducing a new planning stage (which may seem counterintuitive, given the already congested system), to ensure the availability of all essential information prior to the most time-consuming phase of the trial; (2) modifying the scheduling policy from an unplanned ad-hoc policy to a case-level FIFO (first-in, first-out) policy; and (3) encouraging the transition from written to oral closing arguments. Descriptive data pertaining to periods before and after implementation of the intervention are presented, which indicate that the above-mentioned operational modifications show promise.

2. Overview of the Israeli Judicial System

To allow for a better understanding of the mechanisms and strategies implemented and evaluated in this research, we provide the reader with a general grasp of the nature of judicial proceedings in Israeli courts. These proceedings, with slight variations, are similar to those employed in the courts of other common law judicial systems.[2]

The Israeli courts system is divided into three layers: magistrate courts, district courts, and the Supreme Court. The thirty magistrate and six district courts are dispersed geographically, with the Supreme Court presiding from Jerusalem. The district courts comprise the middle layer of the system, with over 50,000

[2] Common law constitutes the basis of the legal systems of countries such as the United States, the United Kingdom, Australia, Canada, India, Ireland, and South Africa.

incoming cases per year over all six districts; these consist of both first-instance cases and appeals on the decisions rendered by the lower courts. In comparison, the magistrate courts receive about 600,000 cases annually. Thus, the district courts manage less than 8% of the cases; yet they employ more than 25% of the judges in the system (~160 judges in the district courts). Therefore, a substantial proportion of the judicial effort and resources is devoted to a relatively small proportion of the demand, which is a testament to the complexity of these cases (Israeli Judiciary, 2011).

The intervention described in this paper, initiated by the President of the Supreme Court for the purpose of piloting new managerial methodologies, focuses on first-instance civil cases. Research on the average judicial time by case type in Israel has found that civil cases in the regular procedure constitute the most time-consuming case type in the district courts (Aviv and Erental, 2021), and they are estimated to comprise approximately 20% of all first-instance cases managed by the district courts (Weinshall-Margel, 2013). Like most courts in Israel, the Jerusalem District Court implements the "one case one judge" policy for civil cases. The case is assigned to a judge as soon as the defense statement is submitted (up to 30 days after the claim is served to the court, according to the civil procedure), and that specific judge is responsible for the case during its entire life cycle. Descriptive statistics of the Jerusalem District Court case flow are presented in Table 1.

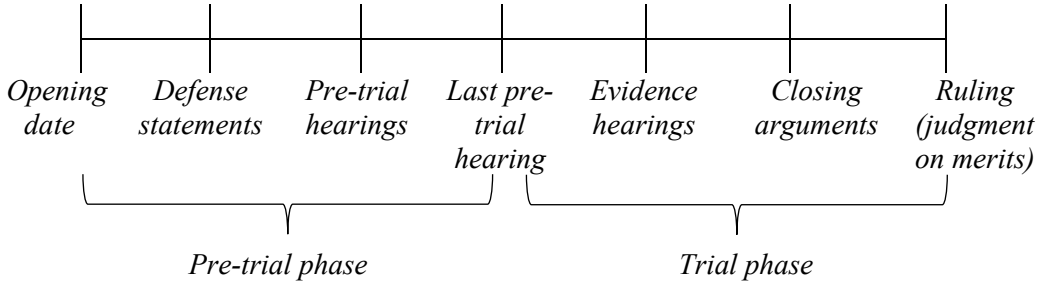
Table 1
Descriptive statistics: Jerusalem District Court case flow

Average number of incoming cases per year	5873
Average number of resolved cases per year	5680
Average annual inventory level (number of pending cases)	3987
Average number of judges (civil, criminal, and administrative)	23

Source: Israeli Judicial Administration semiannual statistics reports 2005-2011.

A typical case consists of two main parts: (1) a pre-trial phase (with an average of three sessions, each lasting about 10-20 minutes); and (2) a trial phase consisting of approximately three evidence sessions, each lasting about six hours, followed by closing arguments (Weinshall-Margel and Taraboulos, 2014). A generalized sequence of events in the life cycle of a civil case is depicted in Figure 1. Not all cases that enter the pre-trial phase continue to the trial phase, because at any stage, a case can be discontinued for various reasons such as a settlement agreement. Only 27% of civil cases heard by the district courts as a first-instance case end up with a judgment on the merits (Weinshall-Margel and Taraboulos, 2014).

Figure 1: Sequence of events in the judicial process



The operational performance of the Israeli judicial system is considered rather poor in comparison with that of other systems worldwide (CEPEJ, 2016). On average, for each judge in the Jerusalem District Court, there are around 60 open cases in the trial phase, making this a substantial part of the judge's Work-In-Process (WIP). The common scheduling scheme in civil cases is to plan each subsequent session upon completion of the preceding session, in the first available time slot in the calendar, which—due to the large number of cases managed by a single judge simultaneously—is usually about three to six months away. This long waiting time between sessions prolongs the duration of cases. Such an environment leads to case-juggling and multi-tasking, where these terms refer to situations in which the worker switches from one project to another. Prior empirical research has shown that efficiency is impaired in such an environment, due to delays in case resolution and the additional effort invested by the judge in reacquainting herself with the details of the case (Coviello, Ichino and Persico, 2014; Coviello, Ichino and Persico, 2015).

3. The Intervention

The main premise of TOC is that only a small proportion of the resources involved in a system's process are responsible for inefficiencies and delays. Consequently, TOC offers a methodology for identifying these limiting resources, improving their efficiency, and re-structuring the process around them.

Mabin and Balderstone (2000) reviewed TOC implementations in industries such as aerospace, energy, defense, and electronics, and reported that these implementations resulted in substantial operational improvements, such as a 65% reduction in manufacturing cycle time (a mean based on 14 studies). An

important development in TOC was the transition from considering production systems to examining service organizations (Reid, 2007), healthcare providers (such as hospitals, clinics, and health maintenance organizations), the retail industry, and supply chain management (Blackstone, 2001). Although the design of TOC was initially tailored to for-profit organizations, over the years, it has been generalized such that it is now also applicable to not-for-profit organizations (Scheinkopf, 1999; Cox, Blackstone and Schleier, 2003). A detailed review of the development of TOC research and its implementation can be found in Watson, Blackstone and Gardiner (2006). Based on the knowledge accumulated from these previous successful implementations of TOC, and because the judicial process is characterized by a high level of WIP and a high level of uncertainty, this method was deemed appropriate for the current intervention, as we outline below.

3.1. The Five Focusing Steps for Court Systems

TOC is based on two major characteristics: the so-called "five focusing steps" and a scheduling mechanism. In the following subsections, we outline the way in which the five focusing steps were applied to the judicial process, while in Section 3.2, we describe the scheduling mechanism that resulted from these efforts.

3.1.1. Step 1: Identify the System's Constraints

The TOC Dictionary defines a constraint as a factor that limits the performance of a system or an organization (Cox et al., 2012: p.28). A resource constraint (bottleneck) is defined as a resource whose capacity is less than or equal to the demand placed on it for the specified time horizon (Cox et al., 2012: p.9). In the adjudication system we identified the judges as the bottleneck, based on the following evidence: first, a previous study of the Israeli judicial system (Bar-Niv, Lieber and Ronen, 2010) suggested that the judges constitute the constrained resource. Second, studies of other systems found that the most expensive resource in the process usually constitutes as the bottleneck; in our setting, this resource is the judges. Finally, we confirmed this intuition by conducting an analysis in which we compared the demand placed on the judges with their capacity.

3.1.2. Step 2: Exploit the System's Constraints

Exploitation means "doing more" with the existing resources. Expressed more formally, "to exploit is to get more goal units by taking actions that make the best use of or take the best advantage of the constraint" (Cox et al., 2012: p.53). To achieve this objective, the time spent on actions that do not add value to the system should be reduced. In our setting, examples of such ineffective actions include preparing for hearings that are cancelled, hearing redundant witnesses, accepting last-minute requests that change the schedule, and cancelling hearings because of missing documents or information.

To improve the use of the judges' in-court time, we introduced a new planning stage. At the end of the preliminary hearings, prior to the beginning of the trial phase, the judges were asked to conduct a final, detailed pre-trial session. This additional planning step was designed to ensure the availability of all essential information and documents required to successfully complete the trial phase. Furthermore, it facilitated the process of scheduling all subsequent hearings (see Section 3.1.3) based on the parties' expectations of the time needed to complete the trial phase.

3.1.3. Step 3: Subordinate everything else to the above decisions

According to TOC, once a resource constraint has been identified and its time usage has been improved, all other resources and stakeholders in the process should operate at the rate of the constraint. A common way of achieving this goal is to adopt a scheduling mechanism that releases tasks into the system based on the pace of the bottleneck. Accordingly, tasks are detained in front of the constrained resource, thus limiting the amount of WIP for the bottleneck (Schragenheim and Ronen, 1990).

Prior to our intervention, the common scheduling practice in the Israeli court system was an unplanned ad-hoc scheduling approach or, expressed differently, a hearing-level FIFO system. According to this policy, a new hearing was scheduled only upon completion of the prior hearing. As mentioned, this policy resulted in the situation where a single judge was simultaneously managing a high number of cases (around 60) that were in their trial phases, which in turn yielded a waiting time of three to six months between consecutive hearings. Following the TOC concept of subordination, it was decided that the scheduling policy would be modified to a case-level FIFO scheme, which limits the number of

cases in the trial phase handled by the judge. Based on the plan drafted in the final pre-trial session (see Section 3.1.2), all the approved sessions associated with a given case are scheduled at one-week intervals. In so doing, the number of active cases in the trial phase is limited to five (on average); all other cases are placed on hold, and each of these cases is only permitted to enter the trial phase once another case has been completed.

Shifting to a case-level FIFO policy has two opposing effects on the total duration of a case. First, considering one case in isolation, once the trial phase has started, the duration of this phase will be shorter than under the hearing-level FIFO policy, due to the shorter waiting times between consecutive hearings. However, according to the second effect, the fact that fewer cases are heard simultaneously means that the number of cases waiting to enter the trial phase will increase. Our prediction was that the former effect would outweigh the latter such that the total duration of the trial phase would be shorter following this policy change. It is also worth noting that this heuristic and its implications are consistent with Little's law (1961). This law predicts that in a steady state, for a given demand rate for judicial services, reducing the number of units in the system (in our setting, the number of cases in their trial phases) will reduce the average time a case spends in the system.

The aforementioned modification to the scheduling policy is related to the work of Bray et al. (2016). These authors compared the hearing-level and the case-level FIFO policy within the context of the Roman Labor Court of Appeals. They modeled the scheduling problem as a multi-armed bandit and found that the hearing-level FIFO policy is optimal when the case-completion hazard rate function monotonically increases. In our setting, since the preliminary proceedings exhaust the judge's efforts for reaching a settlement (and even more so with the new final pre-trial session described above), the probability that a new trial-phase case will be completed in the subsequent session is lower than it is for an old trial-phase case. Thus, our scheduling policy is also supported by the theoretical findings of Bray et al. (2016).

3.1.4. Step 4: Elevate the System's Constraints

Elevating the system's constraints refers to actions that do not exploit the constraint, nor do they subordinate to it, but they use some other mechanisms to yield a higher throughput (Cox et al., 2012: p.49). Prior to our intervention, it was common practice in the Israeli courts to require attorneys to submit their closing arguments in written form. This practice represented a departure from the previous procedure of oral closing arguments and was invoked to divert effort to an offline channel, thereby reducing the in-court time. However, *de facto*, this practice had the opposite effect; the transition to written closing arguments nurtured a culture of submitting lengthy documents that required more time to prepare and inspect. While it is true that the resources (i.e., judges) were not idle during the preparation of these documents, the procedure still had the effect of increasing the level of WIP. Therefore, to reduce the overall lead time of cases, judges were instructed to schedule a pre-planned session for presenting oral closing arguments.

3.1.5. Step 5: When a Constraint has been Relaxed Go Back to Step 1

This step addresses the notion that an improvement process tends to be recursive in nature and calls for continuous modifications by tackling bottleneck after bottleneck. However, the global trend of increased demand for judicial intervention, together with the ubiquitous problem of limited budgets, led us to conclude that judges will remain the major bottleneck in the judicial process for the foreseeable future.

3.2. The Intervention Process

To launch the implementation of the aforementioned changes, a one-day workshop was scheduled during the annual court recess. During this workshop, which was attended by all judges at the Jerusalem District Court, the TOC methodology was introduced along with the set of proposed changes to the judicial process. All judges were requested to implement these changes, for all civil cases, starting from the first day after the court recess. That is, for each civil case that had already passed through its preliminary stages, the judge was asked to conduct a final pre-trial planning session and to schedule all evidence sessions in advance according to the new scheduling policy. In addition, the judges were

requested to provide oral closing arguments rather than using the traditional written form. As for cases that were already in the trial phase, the judges were instructed to conduct a short planning session at the end of the next evidence session and to schedule all future evidence sessions according to the new policy.

3.3. Evaluating the Intervention - Indicative Results

To evaluate the aforementioned operational modifications, we gathered data regarding case duration before and after the intervention (see Table 2). There were 64 civil cases that ended with a judgment on merits[3] prior to the intervention and 107 cases that ended with a judgment on merits post-intervention.

Table 2
Pre- and post-intervention statistics

	Mean lead time (months)		
	Before	After	Difference
Trial time	22.19	10.57	-52.37%
	(13.75)	(10.37)	
Total time	55.21	41.01	-25.72%
	(30.79)	(19.00)	

Note: Standard deviations are in parentheses.

The data show that post-intervention, there was a reduction of more than 50% in the "trial time", which corresponds to the part of the case that underwent intervention. On average, the total life cycle of a case decreased by more than 25%. While it would be imprudent to draw a causal inference from these results, they show initial promise for the potential value of such an intervention.

4. Summary

This paper describes a field study, conducted in cooperation with the Jerusalem District Court in Israel, in which the Theory of Constraints was applied to a judicial process, resulting in an intervention that won the 2012 Goldratt Foundation New Knowledge Award. After describing the unique environment

[3] As opposed to a settlement, cancellation, or alternative dispute resolution.

of the court system from an operational standpoint, we lay out the reasons for choosing TOC for this intervention. We then describe the five "focusing steps" of TOC, which are the core elements of its practical implementation, both from a theoretical standpoint and in terms of how they were applied to the current system. Thus, we detail the way in which each step was translated to operational changes in the judicial process. We then describe how the judges implemented the intervention process in practice.

The complexity of judicial systems stems from several factors, including decentralization, high process variety, and uncertainty about the duration and effort level required to reach a resolution. In addition, judicial systems suffer from low flexibility, because all major changes to processes and procedures must be anchored in legislation or regulation; in fact, only minor operational procedural adjustments can be introduced by judges or court officials. These considerations highlight another important practical contribution of our research, namely the ability to replicate the proposed strategies in other court systems, because the intervention does not require complex legislative initiatives. Rather, the changes proposed in this research are within the scope of the courts' authority at the local level, without the need to undergo complicated, lengthy, and costly regulatory debates and proceedings.

On a final note, although court systems, due to their inherent complexity and high congestion, can serve as fertile soil for research using Operations Management (OM) tools, relatively little attention has been devoted to this topic (some notable exceptions include Simons and Russell, 2002; Falavigna et al., 2015; and Bray et al., 2016). This paper illustrates the strong potential of applying OM methodologies to the public policy space in general, and to judicial environments in particular.

References

Aviv, G. and Erental, D. (2021). *The burden of the judicial work in the Israeli court system*. Jerusalem, Israel: Israeli Courts Research Division. Available at: *https://www.gov.il/he/departments/publications/reports/research_27072021_a*.

Bar-Niv, M., Lieber, Z. and Ronen, B. (2010). Focused Management in a court system: Doing more with the existing resources. *Human Systems Management*, 29(4), pp.265–277.

Beenstock, M. and Haitovsky, Y. (2004). Does the appointment of judges increase the output of the judiciary? *International Review of Law and Economics*, 24(3), pp.351–369.

Best, J. and Tiede, L.B. (2015). Vacancy in justice: Analyzing the impact of overburdened judges on sentencing decisions. [online] papers.ssrn.com. Available at: https://ssrn.com/abstract=2417348.

Blackstone, J.H. (2001). Theory of constraints - A status report. *International Journal of Production Research*, 39(6), pp.1053–1080.

Bray, R.L., Coviello, D., Ichino, A. and Persico, N. (2016). Multitasking, multiarmed bandits, and the Italian judiciary. *Manufacturing & Service Operations Management*, 18(4), pp.545–558.

CEPEJ (European Commission for the Efficiency of Justice) (2015). *The 2015 EU Justice Scoreboard*. [online] Belgium: CEPEJ. Available at: https://ec.europa.eu/info/sites/default/files/justice_scoreboard_2015_en.pdf.

CEPEJ (European Commission for the Efficiency of Justice) (2016). *European Judicial Systems. Efficiency and Quality of Justice, CEPEJ STUDIES No. 23, Edition 2016 (2014 data)*. [online] CEPEJ. Available at: https://rm.coe.int/european-judicial-systems-efficiency-and-quality-of-justice-cepej-stud/1680786b58.

Chemin, M. (2009). The impact of the judiciary on entrepreneurship: Evaluation of Pakistan's "Access to Justice Programme." *Journal of Public Economics*, 93(1-2), pp.114–125.

Chemin, M. (2010). Does court speed shape economic activity? Evidence from a court reform in India. *Journal of Law, Economics, and Organization*, 28(3), pp.460–485.

Church, T., Carlson, A., Lee, J.L. and Tan, T. (1978). Justice delayed: The pace of litigation in urban trial courts. *State Court Journal*, 2(4), pp.3–8.

Coviello, D., Ichino, A. and Persico, N. (2014). Time allocation and task juggling. *American Economic Review*, 104(2), pp.609–623.

Coviello, D., Ichino, A. and Persico, N. (2015). The inefficiency of worker time use. *Journal of the European Economic Association*, 13(5), pp.906–947.

Cox, J.F., Blackstone, J.H. and Schleier, J.G. (2003). *Managing Operations: A Focus on Excellence*. Great Barrington, MA: North River Press.

Cox, J.F., Boyd, L.H., Sullivan, T.T., Reid, R.A. and Cartier, B. (2012). *The TOCICO Dictionary, Second Edition*. New York: McGraw-Hill Inc.

Dakolias, M. (1999). *Court Performance Around the World: A Comparative Perspective*. Washington, DC: The World Bank.

Decker, K., Mohlen, C. and Varela, D.F. (2011). *Improving the Performance of Justice Institutions*. Washington, DC: The World Bank.

Falavigna, G., Ippoliti, R., Manello, A. and Ramello, G.B. (2015). Judicial productivity, delay and efficiency: A Directional Distance Function (DDF) approach. *European Journal of Operational Research*, 240(2), pp.592–601.

Goldratt, E.M. and Cox, J. (1988). *The Goal*. 2nd ed. Great Barrington, MA: North River Press.

Helland, E. and Klick, J. (2007). The effect of judicial expedience on attorney fees in class actions. *The Journal of Legal Studies*, 36(1), pp.171–187.

Israeli Judiciary (2011). *Annual Report for 2010*. [online] Jerusalem, Israel. Available at: https://www.gov.il/BlobFolder/reports/freedom_of_information_report2010/he/%D7%93%D7%95%D7%97%20%D7%97%D7%95%D7%A7%20%D7%97%D7%95%D7%A4%D7%A9%20%D7%94%D7%9E%D7%99%D7%93%D7%A2%202010.pdf.

Little, J.D. (1961). A proof for the queuing formula: L= λW. *Operations Research*, 9(3), pp.383-387.

Mabin, V.J. and Balderstone, S.J. (2000). *The World of the Theory of Constraints: A Review of the International Literature*. Boca Raton, Fla.: St. Lucie Press, C.

Nagel, S.S. and Neef, M. (1978). Time-oriented models and the legal process: Reducing delay and forecasting the future. *Washington University Law Quarterly*, 1978(3), pp.467–527.

Peyrache, A. and Zago, A. (2016). Large courts, small justice!: The inefficiency and the optimal structure of the Italian justice sector. *Omega*, 64, pp.42–56.

Platt, S. (Ed.), (1989). Entry 954: William Ewart Gladstone (1809-98). *Respectfully Quoted: A Dictionary of Quotations Requested from the Congressional Research Service*. Library of Congress. pp. 276.

President's Commission on Law Enforcement and Administration of Justice, 1967. *The Challenge of Crime in a Free Society*. US Government Printing Office.

Reid, R.A. (2007). Applying the TOC five-step focusing process in the service sector. *Managing Service Quality: An International Journal*, 17(2), pp.209–234.

Scheinkopf, L.J. (1999). *Thinking for a Change: Putting the TOC Thinking Processes to Use*. Boca Raton, Fl: St. Lucie Press.

Schragenheim, E. and Ronen, B. (1990). Drum-Buffer-Rope shop floor control. *Production and Inventory Management Journal*, 31(3), pp.18–22.

Simons, J.V. and Russell, G.R. (2002). A case study of batching in a mass service operation. *Journal of Operations Management*, 20(5), pp.577–592.

Voigt, S. (2016). Determinants of judicial efficiency: A survey. *European Journal of Law and Economics*, 42(2), pp.183–208.

Watson, K.J., Blackstone, J.H. and Gardiner, S.C. (2006). The evolution of a management philosophy: The theory of constraints. *Journal of Operations Management*, [online] 25(2), pp.387–402. Available at: https://www.sciencedirect.com/science/article/pii/S0272696306000337.

Weinshall-Margel, K. (2013). *Judicial Workloads in Israel (Case Weights) Dataset*. Jerusalem, Israel: Israeli Courts Research Division. Available at: http://elyon1.court.gov.il/heb/Research%20Division/doc/fw.xls.

Weinshall-Margel, K. and Taraboulos, I. (2014). *Israeli Civil Proceedings Dataset*. Jerusalem, Israel: Israeli Courts Research Division. Available at: http://elyon1.court.gov.il/heb/Research%20Division/doc/Israeli_Civil_Proceedings_Dataset.zip.

Conditional Reality Tree (Cond. RT)

Abeer Youssef, PhD

Adjunct Research Fellow

Wellington School of Business and Government

Victoria University of Wellington

Wellington, New Zealand

Lecturer

Graduate School of Business (GSB)

The Arab Academy for Science, Technology and Maritime Transport (AASTMT)

Alexandria, Egypt

Victoria J Mabin, PhD

Emeritus Professor

Wellington School of Business and Government

Victoria University of Wellington

Wellington, New Zealand

Creative Commons license: CC BY 4.0 Youssef & Mabin (2024)

Table of Contents

Table of Figures 2
Executive Summary 3
Background 4
SOSG Step 1 – Identify a giant, not a chupchick 5
SOSG Step 2 – Identify the enormity of the area not addressed by the giant 6
SOSG Step 3 – Get on the giant's shoulders 6
SOSG Step 4 – Identify the conceptual difference between the reality that was improved so dramatically by the giant and the area untouched 12
SOSG Step 5 – Identify the wrong assumption 12
SOSG Step 6 – Conduct the full analysis to determine the core problem, solution, etc. 15
Corollary to the Conditional Reality Tree 21
Conclusion 21
Acknowledgements 22
References 23

Table of Figures

FIGURE 1: THE CRT (SCHEINKOPF, 2010).....7
FIGURE 2: THE FRT (DETTMER, 2007).....8
FIGURE 3: THE 6-BOX CHANGE MATRIX (ZULTNER, 2023). 13
FIGURE 4: THE 8-BOX CHANGE MATRIX (ADAPTED BY THE AUTHORS FROM ZULTNER, 2023). 14
FIGURE 5: A COND. RT 17
FIGURE 6: COND. RT 1 SHOWS THE IMPACTS OF EXPECTED POPULATION GROWTH BY 2030. 18
FIGURE 7: COND. RT 2 SHOWS THE EXPECTED IMPACT OF AN INTERNATIONAL WATER DISPUTE OVER A SHARED WATERCOURSE. 19
FIGURE 8: COND. RT 3 SHOWS THE EXPECTED IMPACT OF A LACK OF ACTION BY A BUSINESS OWNER FACING A POSSIBLE NEW MAJOR COMPETITOR. 20

Executive Summary

A conditional reality tree (Cond. RT) is developed to address problems that will arise or are expected to arise in the future if certain conditions prevail. It clarifies the expected undesired effects (UDEs) of a situation by exploring the root causes (RCs) of the key problems.

The Cond. RT is used for negative situations/conditions/cases that are expected to take place, with consequences yet to be seen. It can be used as a "do-nothing" reality tree to show what will happen if no action is taken. "Do nothing" often leads to the worsening of problems that need addressing. However, Cond. RT can also be used to analyse the likely impacts if an expected positive change were to occur. It can be used as a tool for 'what if' analysis.

Background

The Theory of Constraints (TOC) Thinking Processes (TP) encompass a comprehensive set of analytical tools, including the Current Reality Tree (CRT) and the Future Reality Tree (FRT). These tools provide a structured approach to understanding and addressing complex problem situations (Cox et al., 2012).

The CRT is used to clarify the undesirable effects (UDEs) of an existing situation by analysing its current state and exploring the root causes of these UDEs, while the FRT constructs a map showing the likely results of the proposed corrective actions (injections). These actions should lead to a desirable future. An FRT is built to check that this is the case before the actions are implemented (Dettmer, 2007). Any further UDEs envisaged due to implementation are averted using the Negative Branch Reservation (NBR) process.

However, there are limitations to what these trees can cover: The CRT is limited to addressing current, existing issues. The FRT/NBR focuses solely on the anticipated outcomes of the injections/solutions that we devise and introduce to produce the desired future.

There are situations of concern that these trees are not designed to handle, in particular, 2 types of problems:

1. Increasingly problematic situations whose impacts are not fully understood and are being met with an inadequate or "**Do nothing**" response. These may become very serious situations which threaten the organisation or system's future.
2. Situations caused by **potential external changes** that are beyond our direct control, yet would significantly impact our reality.

For instance, a local supermarket chain might be facing a situation where a big international supermarket chain is considering entering the country. The ramifications when no action is taken by the local chain could be dramatic. Or it may be a seemingly positive change, such as a competitor going out of business, but which leads to such a huge spike in sales that the system is overwhelmed, having a negative impact on the business.

External changes accompanied by lack of understanding and suitable action pose serious threats in numerous other contexts besides business, including national/international, societal, organisational, or personal situations.

Thus, there is a large class of situations where external changes are about to occur and where internal actors are not taking sufficient corrective actions, and actions (if any) exacerbate rather than improve the situation.

The existing TP tools are not suited to work on such problematic situations that will arise in the future if certain conditions prevail with consequences yet to be seen. Because they lie in the future, the CRT cannot be used. And because they lead to a worsening of the situation, the FRT/NBR is not appropriate.

Therefore, there is a need for a new TP tool that can grapple with these conditional situations and their prospective consequences. It needs to deal with any significant external changes that are expected to take place, with consequences yet to be seen. It needs to deal with a 'do nothing' response to a worrying future. Such a tool should help to develop solutions and galvanise action by clearly laying out in diagrammatic form the potential dire impacts of non-action.

This paper describes a new tree called the Conditional Reality Tree (Cond. RT) that has been developed for this purpose (Youssef, 2023). The Conditional Reality Tree is designed to show clearly how an undesirable future, comprising many UDEs, is expected to arise in the future, especially where the change is caused by an external force, and where no action/change is being taken to mitigate the effects. This would then provide decision makers with a strong basis for constructing injections (interventions) and motivation to put them into action.

The Conditional Reality Tree is conditional based on a negative or positive situation that, while imminent, does not exist yet. These negative or positive situations are not caused within the system, they arise because of external factors. The ensuing outcomes are the result of these external changes and of ineffective or non-action within the system. They are not due to taking effective action, implementing injections, or solutions.

A step-by-step development of the rationale and structure of the Conditional Reality Tree is provided next, following the 'Standing on the shoulders of giants' (SOSG) process used by Dr. Eli Goldratt (Goldratt, 2009) and later spelt out (Goldratt, 2011).

SOSG Step 1 – Identify a giant, not a chupchick

Human knowledge is created by building on existing ideas and extending old theories by identifying and developing new perspectives from previous research. We naturally build on others' efforts. If we stand on the shoulders of giants, we have a head start, we can see further than if we start from our own vantage points.

The giants on whose shoulders we stand in this research are Dr. Eli Goldratt, Bill Dettmer and the TP. The two reality trees, CRT and FRT, in the TP provide the base to build on. These have been developed by Dr. Goldratt and a number of his close associates in the Theory of Constraints community, too many to name individually. However, Bill Dettmer was the first to transcribe and codify Goldratt's methods for teaching purposes in 1994, making this publicly available (e.g., Dettmer, 1997, 2007), and for that we owe a great debt.

We also draw on Goldratt's Change Matrix and the Expanded Change Matrix (Zultner, 2023) in developing a deeper understanding of the causes of inaction or inadequate action.

SOSG Step 2 – Identify the enormity of the area not addressed by the giant

As stated above, in our experience (and in that of many colleagues and client organisations), there is a large class of situations for which the existing RT's are not suitable: in which we would like to be able to demonstrate clearly through logic how current trends or events expected in the near future, are expected to lead to an undesirable future or will bring dramatic, often bad, change not because of changes we make, but because of underlying trends, new threats – e.g., a huge reduction in supply of an essential resource which will bring many undesired effects in the future. It also could be situations when we do not take action(s) needed to avert disaster or 'nip a problem in the bud'.

Why are existing Reality Trees not sufficient?
The CRT works on situations that already exist and serves to clarify the chain of cause-and-effect that leads to those UDEs. While the FRT is concerned with the future, it assumes this is a desired future, described by a tree of DEs, not UDEs, and it assumes that these are caused because of implementing injections. So, the FRT describes the future after the change has taken place.

This leaves a gap in RT's that can describe a future undesirable situation, due to outside forces or insufficient actions, or both.

So, there is a clear need for constructing a new tree that can clarify UDEs in the near future, that are not caused by implementing change/injections/solutions: A tree that is conditional based on a situation that, while imminent, does not exist yet.

SOSG Step 3 – Get on the giant's shoulders

In this step, we take a historical perspective to understand the giants' solution better than they did.

The TOC Thinking Processes (TP) contain two reality trees: the Current Reality Tree (CRT) and the Future Reality Tree (FRT) (Cox et al., 2012).
In brief:

- **CRT** - identifies the likely cause(s) of the UDEs for a **current** situation that needs improving.
- **FRT** - shows the situation once we've implemented our solution (from the EC) and eliminated all the UDEs.

In order to gain a historical perspective and understand the giants' solution, we examine the definitions in the literature, focusing on what the CRT and FRT were designed to do and how we understand and use them. This section discusses both trees and their usage. Additionally, it describes situations for which neither tree is suited.

When the CRT was introduced by Goldratt in the 1990s (Goldratt, 1990; Goldratt, 1994), before the development of the Goal Tree (GT) (Dettmer, 2022), it was the entry point into the Thinking Process, and answered the question, "What to change?". This was originally the first question in the "change questions" sequence but is now the second question (Mabin & Davies, 2010).

Dettmer (2007) explains that the CRT clarifies the undesired effects (UDEs) of an existing situation by analysing its current state and exploring the Root Causes (RCs) of the key problem. Using the traditional 'snowflake' method of constructing the CRT advised by Dettmer (2007), the tree starts from the bottom with RCs and moves upward to the UDEs as shown in Figure 1.

The UDEs are negative aspects of the current reality. They are undesirable to the goal of the system (Goldratt, 2010a). The CRT uses sufficiency logic and is a "cause-and-effect" tree.

The TP protocols dictate that all entities are worded using the present tense. Every entity has to be present/has to exist. CRTs employ bottom-to-top sufficient cause thinking, which can be read "If _____, then _____" or "If _____and _____, then_____", or "If _____, because of _____, then_____.

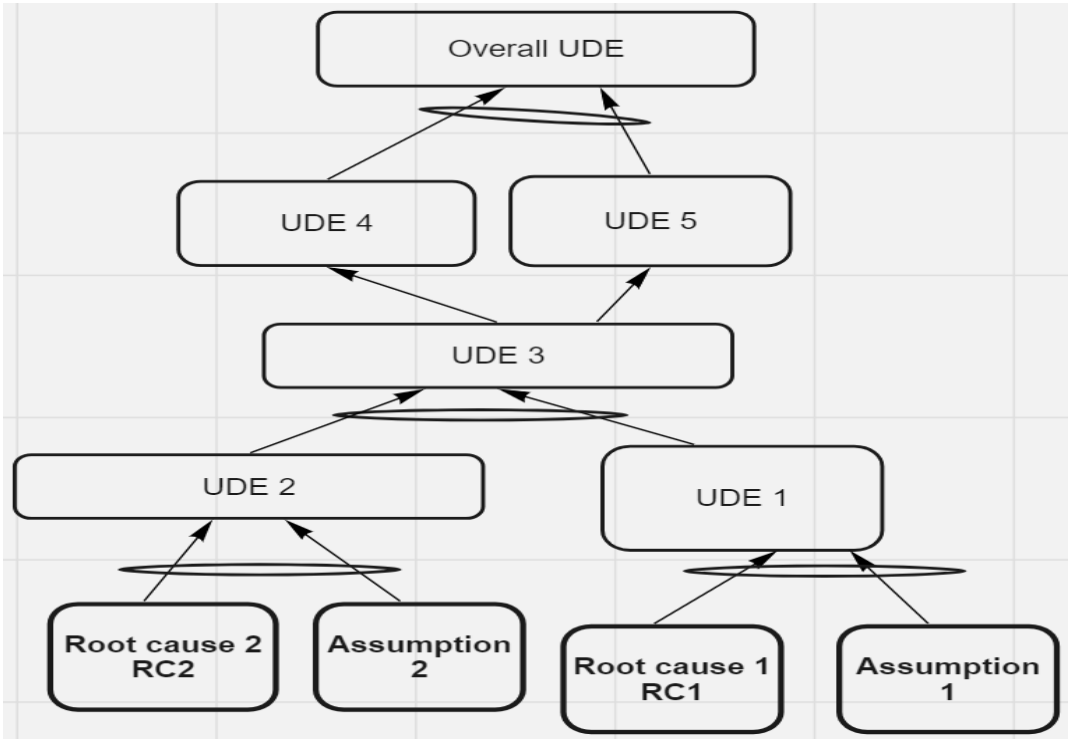


Figure 1: The CRT (Scheinkopf, 2010).

The next step in the TP is to develop solutions to address the situation and remove the UDEs. The Evaporating Cloud (EC) acts as a bridge between "What to change?" and the third question "What

to change to?", by clarifying the conflict that is leading to the UDEs and identifying solutions (injections) to resolve the conflict (Cox & Schleier, 2010).

The FRT uses sufficiency logic to construct a map showing the likely results of the proposed actions (injections). These actions should lead to a desirable future. An FRT is built to check that this is the case before the actions are implemented (Mabin & Davies, 2010). The FRT answers the third question "What to change to?". It focuses on the impacts of this proposed change. The FRT helps in creating solutions that, when implemented, mean that DEs take the place of the existing UDEs (Goldratt, 1994). The tree starts from the bottom with injections to RCs of different problems. These injections should turn all UDEs into DEs, while the tree is proceeding to move upward, as shown in Figure 2 (Dettmer, 2007).

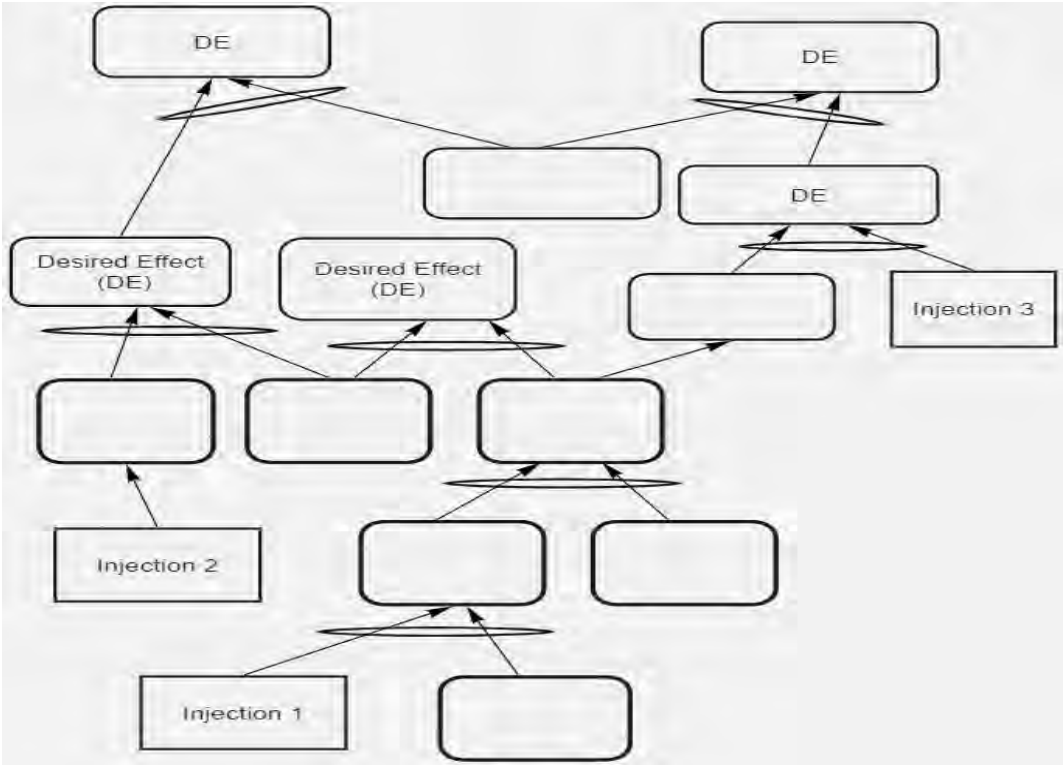


Figure 2: The FRT (Dettmer, 2007).

In order to appreciate how we understand and use these trees, definitions/descriptions of the CRT and FRT from the literature have been collated in Table 1 (**Bolding** is ours).

"Reality is that which, when you stop believing in it, doesn't go away".

Philip K Dick, 1985. Quoted by Scheinkopf 1999 p 144.

Table 1: Definitions of the Current Reality Tree (CRT) and Future Reality Tree (FRT)

Source	CRT	FRT
Goldratt (1994)	Ch 15 of *It's Not Luck* describes developing the CRT for Bob's company by connecting pairs of entities. p112-130, Ch 17. Uses an example of Sharon's problems translated into 3 clouds to suggest the 3-cloud method for constructing a generic conflict cloud. p 151.	Ch 20 is devoted to describing the construction of an FRT. "We'll start with this injection and, using if … then … arrows, we'll try to reach those two objectives. We'll use additional statements that are correct even now and if necessary, we'll add more injections, until we reach the objectives." p 179
Kendall (1998)	A diagram that provides the focus of our improvement efforts. Through cause-effect logic, it shows the connections between the undesirable effects (symptoms) in a given environment and the core problem leading to those undesirable effects. The CRT answers the question of "What to change?" p 322	The strategic solution to our core problem, identifying the minimum projects and ideas necessary to cause improvement. The FRT is a cause-effect diagram that allows us to test the validity of actions and solutions before proceeding with a proposed idea **making sure the idea will eliminate undesirable effects** without creating any negative side effects. It answers the question of "What to change to?" p 323
Scheinkopf (1999)	It is used to pinpoint a core driver – a common cause for many effects. … to identify a core problem, which can be thought of as the invisible constraint responsible for many of the system's current problems. p 144	FRTs contain 4 distinctive parts: A. **Injections** are always entry points to the tree. B. Entities that do currently exist in the systems' reality. In a FRT, this type of entity will usually be an entry point and is typically not found in the body of the tree. C. Entities that do not yet exist in the system. When entities that currently exist (B) are combined with injections (A), the (C) entities will (at least they're predicted to) exist in the future. D. Reinforcing loops are often placed in FRTs, as a means to create patterns of sustained and continuous improvement. ***The key to creating the desired future reality is implementing the injections.*** p 110

Source	CRT	FRT
Cox, Blackstone & Schleier (2003)	Quotes APICS Dictionary (2002, p27) the CRT is defined as a "logic-based tool for using cause-and-effect relationships to determine root problems that cause the observed undesirable effects of the system". p 117-8	According to the APIC Dictionary (2002, p 49) the FRT is defined as "a logic-based tool for constructing and **testing potential solutions before implementation**. The objectives are to (1) develop, expand, and compete the solution and (2) identify and solve or prevent new problems created by implementing the solution". p 174
Dettmer (2007) Earlier texts by Dettmer (1994, 1997, 1998) provide similar descriptions	CRT is a logical structure designed to depict the state of reality as it currently exists in a given system. It reflects the most probable chain of cause and effect given a specific, fixed set of circumstances. Note a CRT is not a complete picture of reality. It reflects only the part perceived to be unfavourable. So, if a system is functioning properly 80% of the time, the CRT will show only 20% when it does not. p 92 Dettmer adamantly opposes the use of the 3-cloud method which he critiques in Appendix E. pp 359-368	Sufficiency-type logic structure designed to **predict how changes** to the status quo would affect reality – specifically to **produce desired effects (DE)**. It is an expression of reality that does not yet exist. … visually unfolds the cause-and-effect relationship between **changes we make** to existing systems and their resulting outcomes. p 206
Ferguson (2010)	"The map of all the cause-and-effect connecting the core conflict or root cause to all the undesirable effects (UDEs) in the system." p 1036	"The logical map connecting **all the injections** (solution elements) through cause-and-effect to the **desirable effects (thus ensuring no UDEs of the CRT continue to occur)."** p 1036
Mabin & Davies (2010)	The CRT is a sufficiency (if-then) logic-based tool used to identify and describe cause-effect relationships that may help to determine core problems that cause the undesirable effects (UDEs) of the system (Cox, Blackstone, and Schleier, 2023, Sullivan et al 2007) Designed to answer the question What to change? taking care to avoid actions that merely deal with symptoms. p 634	The FRT process **begins with** the identification of actions, conditions, or solutions of choice, which Goldratt collectively names as **injections**, and then through the mapping of sufficiency-based logic relations, checks whether the causal links will lead to what we have decided are **desirable outcomes**, that is the removal or closing of Dettmer's 'mismatches'. p 635 The negative branch reservation (NBR) is formally a sub-tree of the FRT but can be

Source	CRT	FRT
		used as a stand-alone tool to improve critical feedback and develop half-formed ideas. p 635
Scheinkopf (2010)	A cause-effect model of an existing situation. The main use is to answer the question, What to change? so the cause-effect relationships focused on in the CRT are the UDEs – the aspects of the situation that we want to improve. p 751 Scheinkopf demonstrates 2 methods used to construct a CRT, namely the traditional 'snowflake' method and the 3-cloud approach	FRT and NBR are both processes that model **the predicted effects of injections.** The FRT is used to model the intended effects – the desired improvements – that comprise the full solution. FRTs typically contain several injections and many entities…. The NBR is used to show how an injection would lead to undesirable consequences, and then modify the idea (by **modifying an injection or adding additional injections**) to the degree that predicted undesirable consequences would be prevented. The guideline is to build the FRT first, and then use the NBR process to modify and solidify the solution to ensure that it is win-win. P 760
TOCICO Dictionary, Cox et al (2012)	The sufficiency-based logic diagram facilitates answering the question (from the CQS): What to change? By illustrating the cause-and-effect relationships between the core problem and the undesirable effects of the system, p 53. There are 2 approaches to developing a CRT – the traditional approach which starts with a list of UDEs and connects them using cause-and-effect logic, and the three-cloud approach, which starts with 3 ECs from which is developed generic cloud that becomes the basis for the CRT. p 54	The sufficiency-based logic diagram facilitates answering the question "To what to change?" by presenting a sequence of cause-and-effect relationships that links **proposed injection(s) to desired effects (DEs).** p 82

These definitions/descriptions concur that the CRT describes the situation as it currently exists; and that the FRT describes the future reality expected after injections have been implemented, including any supplementary injections identified using NBRs. Further, they state plainly that UDEs in the CRT are replaced by DEs in the FRT through the implementation of injections. These descriptions also accord with common practice.

SOSG Step 4 – Identify the conceptual difference between the reality that was improved so dramatically by the giant and the area untouched

The CRT and FRT work really well when we are adopting a process of change to bring about improvement. However, the CRT only applies to current reality – everything in the CRT must exist, now. The FRT, while focusing on the future, shows the likely results of the proposed actions, which are intended to lead to a desirable future. The FRT helps in creating solutions that, when implemented, mean that DEs take the place of the existing UDEs. A complete FRT shows only DEs.

But this is not the situation we are addressing. For example, if things are getting worse, or there is a future threat, or an adequate change is not made, some UDEs in the current reality are likely to get worse and new UDEs will arise. Therefore, the resulting future reality tree will be full of UDEs, not DEs, contrary to an FRT as we know it.

Using the Negative Branch Reservation (NBR) process, the FRT would normally be amended to prevent or mitigate potential new UDEs. However, the UDEs so addressed result from implementing the solution/injection, not from inaction, or actions/trends coming from outside.

Therefore, neither the FRT nor the NBR are useful when the chosen action is ''do nothing'' or some other undesired starting condition/action or external change.

In situations where there is no recognition of the need to change, or no desire to change, and therefore no change is going to occur to avoid a worsening of the situation, the CRT does not work and neither does the FRT.

The CRT cannot be used because the UDEs lie in the future. The FRT cannot be used because this is expected to contain mostly DEs once we have implemented the injection(s). And the NBR also assumes we implemented a change. Hence, we cannot use the existing TP trees[1].

SOSG Step 5 – Identify the wrong assumption

The wrong assumption is that people understand when they are facing a negative situation, and will think through and make appropriate changes to improve a situation.

[1] Another tree, unofficially called a 'knowledge tree' (Dettmer, pers. comm.), uses causal relationships to explain a situation, but does not aim to address a problem to be solved. It explains why something happened using cause-effect logic and may or may not terminate with an UDE or DE. For example, Dettmer uses this tree to explain how the gauge of American railroads came to be 4 feet, 6 inches wide, or how ill-advised tax policy led to the fall of the ancient Roman Republic. The cause-effect structure in a knowledge tree explains why things happened, without embodying a problem to be solved. It therefore also does not fill the identified gap.

However, this is not true, because:

- Sometimes people do not realise (till too late) the situation they are in, so do not change – 'boiled frog syndrome'.
- Even when they are aware of the situation, sometimes people/ organisations are not fully aware, and do not choose the best or even adequate options to fix a situation or avert disaster.
- Sometimes people/organisations simply choose to do nothing.

Why?

- People may not realise that conditions are about to change, and/or have not thought through the consequences and the impact they could have on them.
- People sometimes do not know what change to make or how to make that change.
- They may be scared they might not make the right choice.
- Sometimes it is hard to do the right thing, due to inertia; decision makers feel frozen, and the effort to make the change is simply too great.

We can explain some of this reluctance to act by using Goldratt's Change Matrix (Goldratt, 2010b), and specifically the expanded 6-box change matrix introduced by Richard Zultner (2023), which consists of 3 phases: lakeshore, transition, and mountain top (see Figure 3).

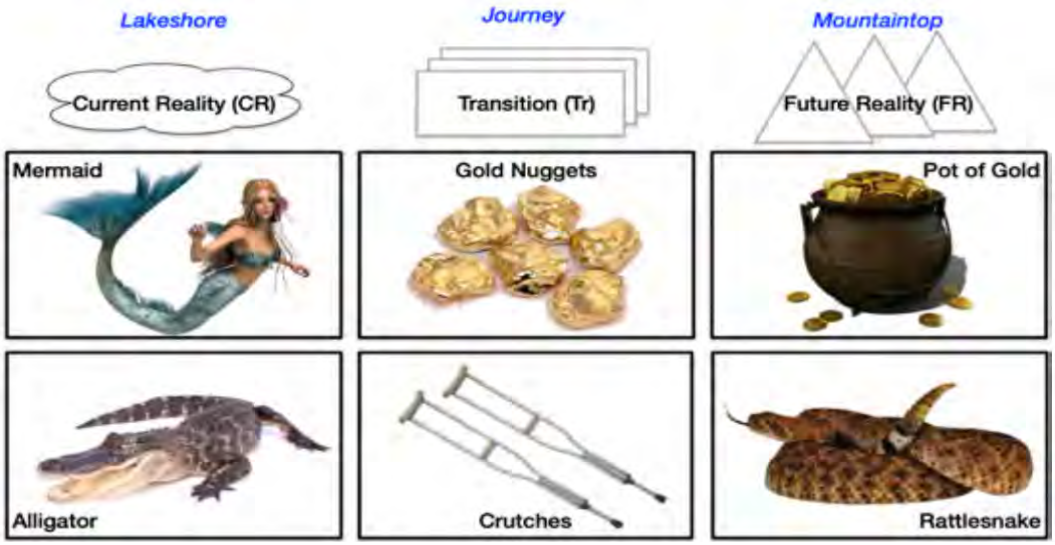


Figure 3: The 6-box change matrix (Zultner, 2023).

People sometimes resist change, because:

- It might not be in the interests of decision makers to take action to remove UDEs (they want to keep their 'mermaids')
- The effort/risk of making the change is simply too great (they fear the 'crutches' and 'rattlesnakes')

- They do not feel the pain is big enough to make the change (they are protected from the 'alligators')
- They cannot foresee sufficient benefits from changing (gold nuggets or the pot of gold) (Ferguson, 2010).

Zultner's matrix adds factors that arise in the transition from the current situation to the desired future. However, the situations we are considering involve a future scenario resulting from no positive change, hence no gold nuggets, but instead from threats/external changes that can be represented by even more alligators. Thus, we have added a 4th phase as shown in Figure 4. The new phase, 'near lakeshore', represents the expected reality that the Cond. RT works on during negative situations. It is designated 'near lakeshore' because they have taken no action or only inadequate action(s), so remain very close to the original position, in an increasingly negative situation (Youssef & Mabin, 2023).



Figure 4: The 8-box Change Matrix (Adapted from Zultner, 2023, by the authors).

In the situations described above, decision makers may take no action. Then the situation gets worse because people don't realise what's happening or choose to do nothing even when they do. In some cases, even when there is an impending disaster, the situation gets worse because people still do nothing, or take actions that are insufficient to stop the negative effects from becoming worse.

Taking no action leads to worsening problems in many situations, such as those shown in Table 2. Some of these are already very evident, such as opioid addiction, while others are believed to be looming disasters at a societal/international, environmental, business, workplace, or personal level.

Table 2: Taking no action may lead to worse problems in many situations (Youssef & Mabin, 2023).

Societal	Environmental	Business	Workplace	Personal
Population growth	Climate crisis	Bad reviews	Bullying	Conflict
International disputes and wars	Plastic pollution in landfills, rivers, oceans, food chain …	Running out of cash … … bankruptcy	Office politics/tribalism	Abuse and other relationship issues
Extreme views/ radicalism/terrorism/ Disinformation	Delaying or refusing to evacuate in a natural disaster	Sales slump	Conflicts	Addictions – drugs, vaping, alcohol, digital devices, social media
Civil unrest, political divides	Reliance on fossil fuels	New taxes, laws, policies or rules	Unethical behaviour	Eating and behavioural disorders
Corruption, inequality, modern slavery	Resource depletion eg precious metals	Recession	Corruption	Overspending

Such situations of future crises are not properly catered for in the existing TOC TP.

SOSG Step 6 – Conduct the full analysis to determine the core problem, solution, etc.

The Cond. RT has been developed to clarify the causal relationships leading to UDEs that are expected to arise in the future if certain conditions prevail, including UDEs not yet foreseen. It is a conditional tree based on a situation that, while imminent, does not exist yet. This tree can be used to highlight the UDEs related to negative situations/conditions/cases that are expected to take place if no action or insufficient action is taken now, with consequences yet to be seen (Youssef, 2023). Also, it could work on uncertain futures based on seemingly positive conditions, such as a sudden spike in sales caused by a competitor going bankrupt, where a mix of DEs and UDEs may arise.

Additionally, the results obtained by the Cond. RT, like any of the TOC TP tools, depend on the underlying assumptions and applied conditions to construct the tree. This underlines the importance of delving deeply into surface-hidden assumptions so that the future situation is captured fully and correctly, and the appropriate decisions can be made.

The Cond. RT contains many UDEs—possibly more and worse than in the original CRT which describes the present situation. The name Conditional Reality Tree (Cond. RT) reflects the fact that it is based on a future condition which is necessary for the tree to be true, while it is a reality tree using sufficiency-based logic.

The essential features of the new tool are listed next.

- TP protocols - The new tree, Cond. RT still uses the TP protocols.

- Logic – The Cond. RT combines the TOC's two TP logics, "necessity logic" and "sufficiency logic".

  The Cond. RT uses necessity logic at the base of the tree, to state the condition(s) under which the tree will hold. It then uses sufficiency logic to causally link the base to the UDEs. The necessity logic indicates that "In order to form the Cond. RT, the condition(s) assumed must be true." The condition (i.e. the context, circumstance, or situation that would create these results) must be satisfied before the UDEs formed in this Cond. RT can happen. If the condition/s is/are satisfied, the tree itself follows the normal "sufficiency logic" like other reality trees.

- Tree Construction - The tree is built from the necessary condition(s) – The Cond. RT clarifies all the RCs and UDEs regarding an expected conditional reality by using the logic, "If _____, and _____, then _____" to present unbroken chains of cause-and-effect relationships from the starting condition/s upward to the expected undesirable effects.

- In contrast to the FRT, the Cond. RT can show how an existing reality, described by a CRT, is likely to develop into a future reality which contains many UDEs, depending on specified starting conditions. So, these problems/UDEs will arise or are expected to arise in the near future if certain conditions prevail.

- Using the NBR is inadequate here. NBRs are used (as part of the FRT construction process) to deal with any potential UDEs that occur after we made decisions and implemented the injections. However, Cond. RT works in a prior phase. The Cond. RT is used for situations that are expected to take place, with consequences yet to be seen, **before** we implement change. So, neither the situation nor the consequences are there yet. It can be viewed as a tool for 'what if' analysis or as a 'do-nothing' tree to show what will happen if no action is taken.

A TOCICO Dictionary definition follows:

Usage:
The Cond. RT uses necessity logic at the base of the tree, and sufficiency logic to causally link the base to the UDEs.

It starts with the condition(s) that must be satisfied for the tree to be valid, the necessity part, building the tree upwards. The necessity logic indicates that "In order to form the Cond. RT, the (one or more) conditions assumed must be true." The conditions (i.e. the context, circumstance,

or situation that would create these results) must be satisfied before the UDEs formed in this Cond. RT can exist.

If the conditions are satisfied, the tree itself follows the normal "sufficiency logic" like all reality trees. It works out all the RCs and UDEs regarding an expected conditional reality by using the logic, "If _____, and _____, then _____" to present unbroken chains of cause-and-effect relationships, from the core problem or core conflict and the assumed conditions upward to the expected undesirable effects. These internal linkages between the RCs, sufficiency assumptions, and the UDEs present the reasoning supporting the connections, as is seen in Figure 3. This figure represents a simplified skeleton of the Cond. RT.

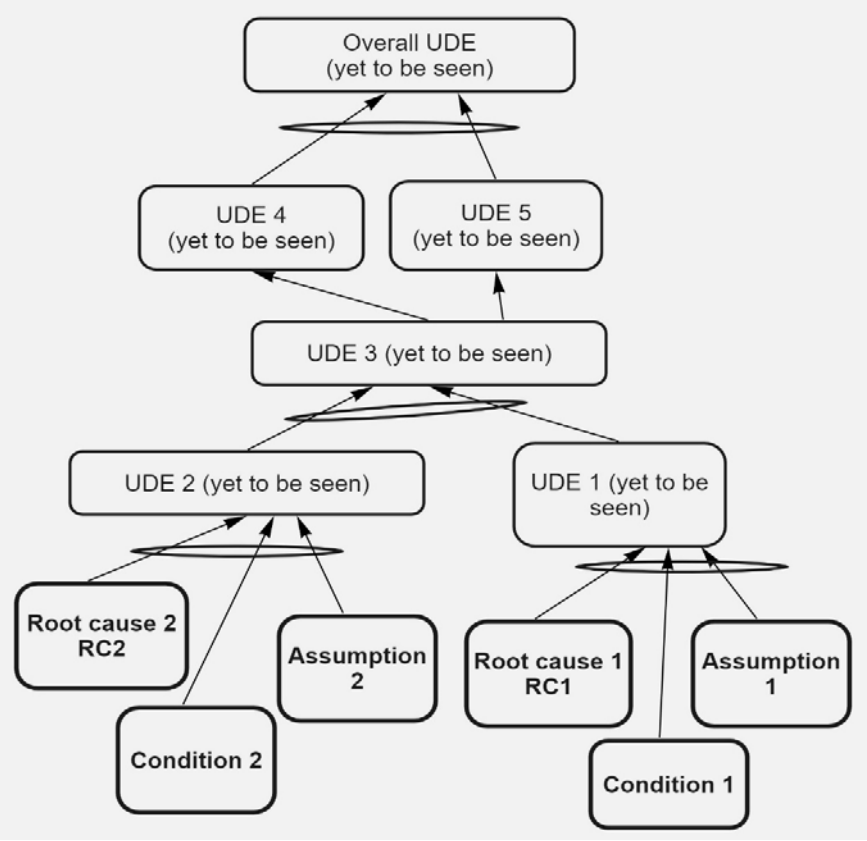


Figure 5: A Cond. RT

The process of constructing the tree:

Process Step 1. Start with a CRT (not essential but advised).

Process Step 2. State the starting condition(s) for the future reality at the bottom of the tree.

Process Step 3. Revise the CRT tree, based on the condition(s), to create the Cond. RT, adding in sufficiency assumptions.

Process Step 4. Read and scrutinise the tree, as usual, using the Categories of Legitimate Reservation (CLR). This includes checking for new UDEs not yet foreseen.

Example 1: Cond. RT for global population growth

Cond. RT 1 was developed to show the expected population growth impacts in 2030 if we do nothing/make no changes to our current actions now. The necessity logic at the base of the tree is "In order to form the Cond. RT, the condition(s) assumed must be true." The first condition is "Global population increases to over 8.6bn by 2030", along with "No changes are made to our current actions". The first condition is based on current predictions of the expected population growth that are expected to lead to a negative future situation.

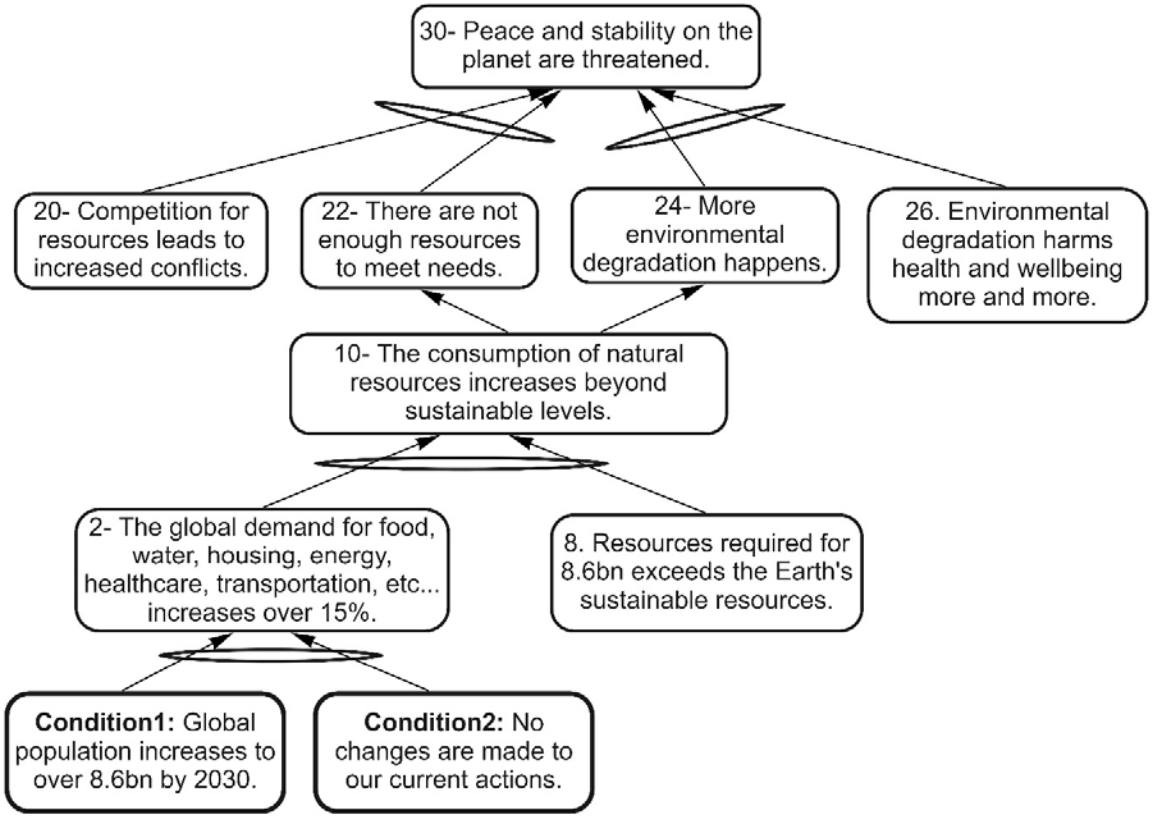


Figure 6: Cond. RT 1 shows the impacts of expected population growth by 2030.

Example 2: Cond. RT for an international water dispute

Cond. RT 2 examines the impact of an international water dispute over a shared watercourse that could arise if a newly constructed dam reservoir is filled at a fast rate. The dam is almost finished, and the upstream country has already drawn small portions of the river's water to test its lowest turbines. The upstream country is keen to complete the filling and operate the dam, so that it can reap the benefits quickly. However, if the upstream country chooses to fill the reservoir quickly, it will reduce river flow significantly till the higher turbines are covered, and downstream countries will suffer. The Cond. RT predicts the undesirable effects on one of the downstream countries if this condition holds.

The base of the Cond. RT 2 represents the following logic "In order to form the Cond. RT, the fast filling of the dam reservoir must be true." This condition must be met before the entities in the

rest of the tree exist. The fast-filling process must start before the UDEs are shown in this Cond. RT can happen. Again, a second condition, that no major changes are made by the downstream countries, is added for clarity.

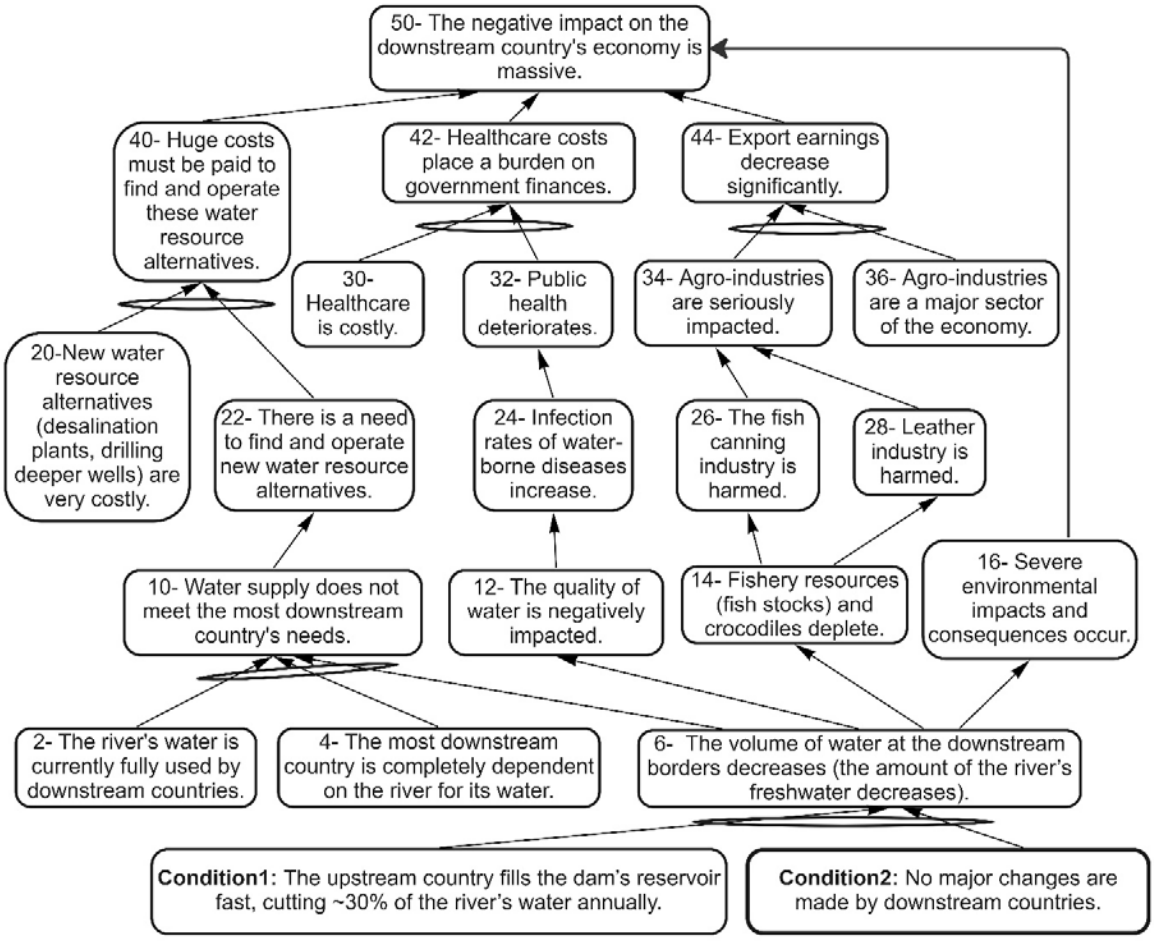


Figure 7: Cond. RT 2 shows the expected impact of an international water dispute over a shared watercourse.

Example 3: Cond. RT for a business

JA is a retailer on the Main Street in the city where there's been increasing competition over the last decade from chain stores coming in, eating into revenues for the established stores and pushing rents/rates up for everyone. So far, JA has not had any direct competition from these large chains, but there is a strong possibility that a big chain in the same industry might come and locate close by, which would be the end of JA. They've been in the same prime location for 55 years and understandably do not want to move, but the owner is still refusing to address the situation.

The Cond. RT shown for this example illustrates how the Cond. RT can be linked to a core conflict (based on an evaporating cloud, evident at the base). Above this are the 2 conditions: 1. JA

refuses to change, and 2. New big chain store in direct competition with JA, sets up a store nearby, which then lead to the severe predicted outcomes.

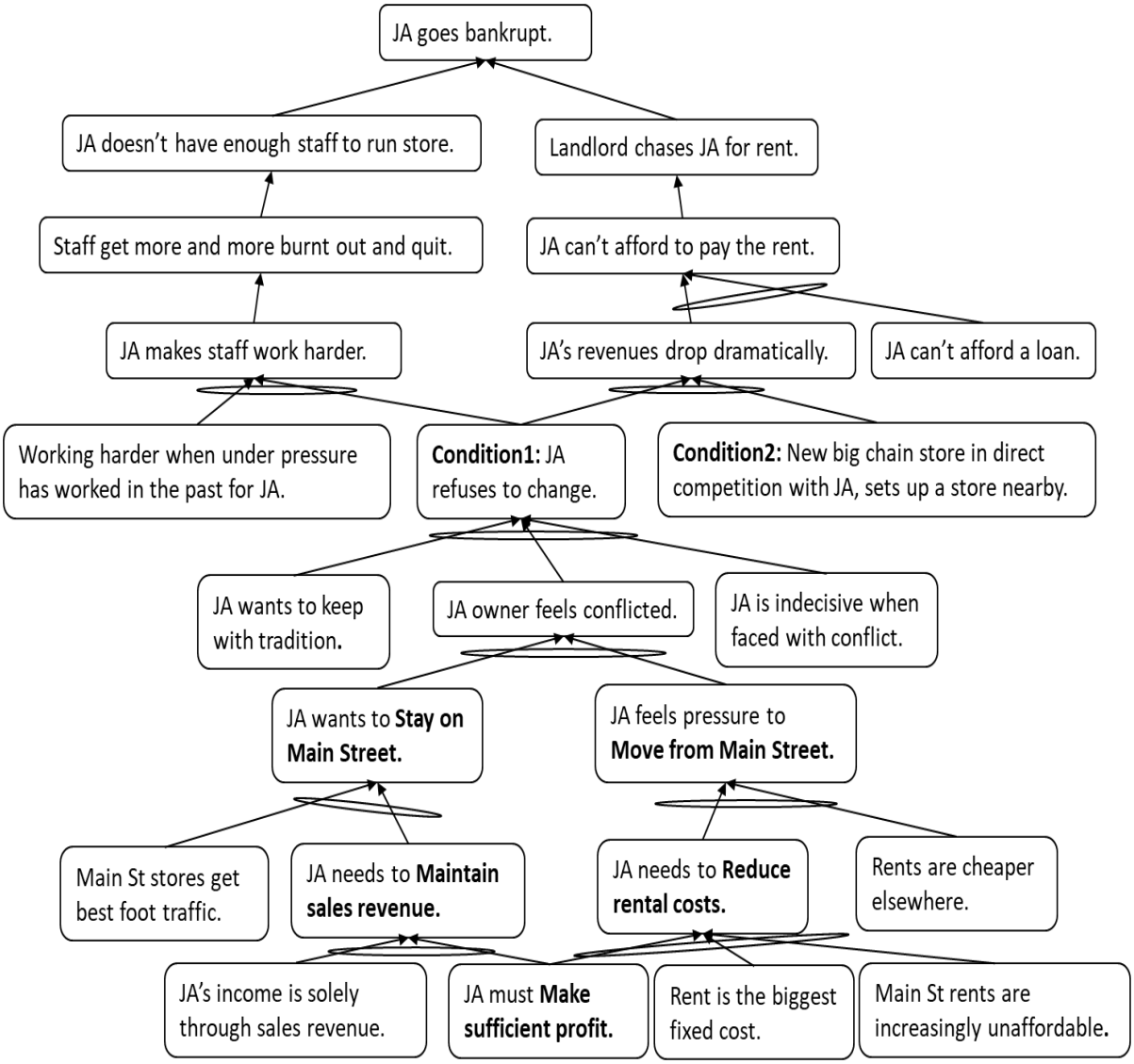


Figure 8: Cond. RT 3 shows the expected impact of a lack of action by a business owner facing a possible new major competitor.

<u>Suggested Usage:</u>

Scenarios/situations where the Cond. RT would be useful include:

- The Cond. RT is suited for impending realities due to, for example, competitive situations, resource shortages, climate change, unsustainable growth, international disputes, or political unrest,
- It analyses potential situations if an expected positive change occurs, e.g., a competitor going broke and leading to a rapid spike in sales which the remaining firm cannot cope with while maintaining service levels,

- It works on personal, workplace or local issues as well as national or global issues,
- Cond. RT helps separate facts from emotions, and
- It works well when studying disputes/conflicts on national and international levels.

Corollary to the Conditional Reality Tree

The Cond. RT can be followed by ECs, Conditional FRT, Conditional PRTs and TrTs to answer the full change questions sequence, providing a comprehensive plan for addressing the expected near future reality, and UDEs in the Cond. RT.

Conclusion

It is often said that "Necessity is the mother of invention". This is absolutely true in this case. We needed to develop this tree to analyse the case study of the doctoral thesis (Youssef, 2023), as none of the TP trees could handle the still unknown future situation.

Cond. RT. has been developed to explain the UDEs that will arise or are expected to arise in a future situation, based on specific conditions. Thus, the Cond. RT complements the CRT and FRT and addresses a particular need that neither of those trees fills.

The tree starts from the bottom with RCs and assumed conditions and moves upward to the expected UDEs. The Cond. RT as a tool works on clarifying the UDEs on a reality that does not yet exist. It works on the negative situations/conditions/cases that are expected to take place, if no action is taken now, with consequences yet to be seen. It works well as a 'do nothing' RT to show what will happen if no action is taken. "Do nothing" often leads to the worsening of problems that need addressing.

Cond. RT can also be used for 'What if' analyses to prepare for uncertain futures, based on any possible starting positive or negative conditions. It can be used at all levels – societal, environmental, national, organisational, community, workplace, business, and personal.

As has been explained in this paper, the Cond. RT shares some of the CRT and FRT characteristics. It clarifies the UDEs (like the CRT) and works in future situations (like the FRT). However, it complements the CRT which works only in current existing situations, and the FRT which shows only the DEs that result from implementing change.

The Cond. RT maps the UDEs expected to result in the future, in situations where little or no changes are made to bring good outcomes.

Also, the Cond. RT can be used to map uncertain futures based on seemingly-positive starting conditions that actually result in UDEs, either unforeseen initially, or due to inadequate decisions or failure to implement needed change.

This tool is important to deal with any significant external change. The FRT as it is defined today, deals only with new injections that we initiate. It does not deal with external changes that impact our reality.

The CRT and FRT cannot cope with such situations because the TP protocols dictate that all entities in CRTs are worded using the present tense. Every entity has to be present/has to exist. Moreover, the FRT is more concerned with DEs in the future brought about by implementing change, not UDEs, and so does not help to clarify UDEs expected to occur in the near future, or DEs that are not caused by making decisions or implementing change.

So, the need arose for constructing a new tree that can clarify UDEs in the near future or clarify expected DEs, where the expected DEs are not caused due to implementing change. This tree is conditional based on a negative or positive situation that, while imminent, does not exist yet. Cond. RT is therefore deserving of inclusion in the TOC Body of Knowledge.

Acknowledgements

We would like to acknowledge the enormous contribution of Dr Eli Goldratt, the founder of TOC and the TP, and Bill Dettmer, who first documented the TP's thoroughly to share with the world. We would like to thank the TOC BOK committee members for their support and comments which have helped to further develop the paper, particularly Roy Stratton, Eli Schragenheim, Richard Zultner, Richard Reid, and Lisa Ferguson, and audience members at our TOCICO 2023 conference session. We also wish to thank Emeritus Professor James Cox for his long-standing contributions to TOC developments, expert guidance and encouragement, valuable discussions, and advice, and for his strong support for this work in particular.

References

Cox, J.F., Blackstone. J.H., & Schleier, J.G. (2003). *Managing operations: A focus on excellence.* Volume I. Great Barrington, MA: North River Press.

Cox, J.F., Boyd, L.H., Sullivan, T.T., Reid, R.A. & Cartier, B. (2012). *The TOCICO Dictionary* [online]. TOCICO. Retrieved from: http://www.tocico.org/?page=dictionary&hhSearchTerms=%22dictionary%22

Cox, J.F., & Schleier, J.G. (2010). *Theory of Constraints Handbook*. New York, NY: McGraw Hill.

Dettmer, H.W. (1997). *Goldratt's Theory of Constraints: A Systems Approach to Continuous Improvement.* Milwaukee, WI: ASQC Press. (updated/expanded from first edition published 1994).

Dettmer, H.W. (1998). *Breaking the constraints to world-class performance*. Milwaukee, Wisconsin: ASQ Quality Press.

Dettmer, H.W. (2007). *The logical thinking process: A systems approach to complex problem solving*. Milwaukee, WI: American Society for Quality; Quality Press.

Dettmer, H.W. (2022). The Origin of the Goal Tree. *TOC Body of Knowledge.* TOCICO. Retrieved from: https://www.tocico.org/page/TOCBodyofKnowledgeTheOriginoftheGoalTree

Ferguson, L. A. (2010). Applications of Strategy and Tactics Trees in Organizations, Ch 34 in J.F. Cox III & J.G. Schleier (Eds.), *Theory of Constraints Handbook* (pp. 631-669). New York, NY: McGraw Hill.

Goldratt, E.M. (1990). *What is this thing called the Theory of Constraints?* Croton-on-Hudson, NY: North River Press.

Goldratt, E.M. (1994). *It's not luck*. Great Barrington, MA: North River Press.

Goldratt, E.M. (2009). Standing on the shoulders of giants—Production concepts versus production applications. The Hitachi Tool Engineering example. *Gestão & produção*, *16(3)*, 333-343. https://cdn.ymaws.com/www.tocico.org/resource/resmgr/standing_on_the_shoulder_of_giants/standing_on_the_shoulders_of.pdf

Goldratt, E.M. (2010a). Introduction to TOC: My perspective. In J.F. Cox III & J.G. Schleier (Eds.), *Theory of Constraints Handbook* (pp. 3–9). New York, NY: McGraw Hill.

Goldratt, E. M. (2010b). Overcoming Resistance to Change - Isn't It Obvious?

https://www.youtube.com/watch?v=hcz1aZ60k7w

Goldratt, E. M. (2011). *Never say I know: Intro*. Upgrade Workshop Materials, TOCICO 2011 Conference. https://cdn.ymaws.com/www.tocico.org/resource/resmgr/upgrade_workshop/eli_-_never_say_i_know_-_int.pdf

Kendall, G.I. (1998). *Securing the future: Strategies for exponential growth using the theory of constraints*. New York, NY: St. Lucie Press.

Mabin, V.J., & Davies, J. (2010). The TOC thinking processes: Their nature and use: Reflections and consolidation. In J.F. Cox III & J.G. Schleier (Eds.), *Theory of Constraints Handbook* (pp. 631-669). New York, NY: McGraw Hill.

Scheinkopf, L.J. (1999). *Thinking for a change: Putting the TOC thinking processes to use*. Boca Raton, FL: St. Lucie Press.

Scheinkopf, L.J. (2010). Thinking Processes Including Strategy & Tactics Trees. In J.F. Cox III & J.G. Schleier (Eds.), *Theory of Constraints Handbook.* New York, NY: McGraw Hill.

Youssef, A. (2023). *Management of Risks to Egypt's Water Supply Due to the Grand Ethiopian Renaissance Dam: A Multi-Perspective Study Using a Multi-Framing Approach.* Te Herenga Waka—Victoria University of Wellington, Wellington, New Zealand.

Youssef, A. & Mabin, V. (2023). Conditional Reality Tree (Cond RT), Video presentation, *TOC Innovation Summit 2023*, TOCICO. Margaritaville FL, October 8-11, 2023.

Zultner, R. E. (2023). *The Change Matrix: Corrected & enhanced from 4 to 6 Boxes (CM2).* Retrieved from: https://www.tocico.org/page/TOCBodyofKnowledgeTheChangeMatrixCorrectedEnhancedfrom4to6BoxesCM2

Renovated Change Matrix+:

Eli Goldratt's original 4-box "Basic" *Change Matrix*, Renovated to a 6-box "Pro" Thinking Process (TP) tool



Goldratt's original 4-box "Basic" Change Matrix

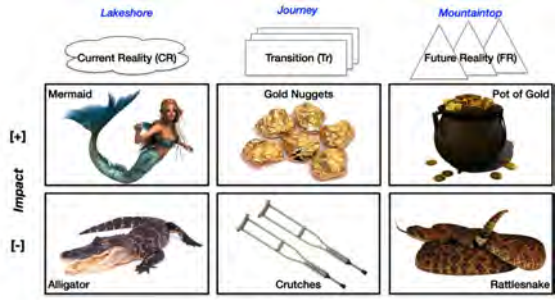
Richard E. ZULTNER

Jonah - Mechanic*

Adjunct Professor (retired)
Stevens Institute of Technology

Princeton, NJ. USA

Richard@Zultner.org



Renovated 6-box "Pro" Change Matrix+

Track: A Theory of Constraints (ToC) Academic Stream (peer-reviewed paper)

ABSTRACT

Eli Goldratt's original 4-box Change Matrix is the basis for a well known ***story*** in the Theory of Constraints community (the one with the icons of alligators, mermaids, a pot of gold, and crutches). And it is the basis for much discussion on "buy-in", the 3/5 Change Questions, and the 5/6/9 Layers of Resistance. But traditionally the Change Matrix was not appreciated as a Thinking Process tool, had no entry in the TOCICO *Dictionary*, and was not mentioned in the ToC *Handbook*. So the full potential of the Change Matrix was not realized. Renovation makes it stronger, and better.

By resolving the inconsistencies found in the "basic" 4-box Change Matrix, and renovating it to a 6-box "pro" Change Matrix+, (with two new icons: gold nuggets, and rattlesnakes), it becomes a more powerful Thinking Process (TP) tool for exploring the [+] Desirable Effects (**DEs**) and [-] UnDesirable Effects (**UDEs**) of Customers — collectively, their **Customer Needs** (CNs). A tool for those who seek to make a *Good* Change (or add good limitations) for an improvement that is eagerly embraced, and for those who strive to prevent *Bad* Changes (or remove bad limitations) for a deterioration that is firmly resisted.

KEYWORDS

Goldratt's original Change Matrix, traditional change analogy story (icons: alligators, mermaids, pot of gold, crutches), Desirable Effects (DEs), UnDesirable Effects (UDEs), Customer Needs (CNs), renovated 6-box Change Matrix+, enhanced Change Analogy Story (added icons: gold nuggets, and rattlesnakes), Bad Changes (resisted), Good Changes (embraced), [+] and [-] impacts (or valences)

1. INTRODUCTION

Situation. The Change Matrix is a Theory of Constraints (ToC) ***tool*** to discover and understand how any change is evaluated from the perspective of a "customer" (a customer, client, stakeholder, or colleague — or even yourself). [Note: Your 'customer' is the one you want to say "yes" to your offer.] The Change Analogy ***story***, presented by Eli Goldratt in a Socratic dialogue in a popular YouTube cartoon video [Goldratt 2010], is widely known in the ToC community.

---

*Jonah - ***Mechanics*** fix up old, outdated, or unused ToC elements; they ***renovate*** them — in a Process of On-Going Improvement (**PoOGI**). And they "get started now", with minimum viable experiments… and learn as much as they can, from them. Repeatedly.

Copyright © 2022 Richard E. Zultner

In the cartoon video, the ***analogy*** is made that "making a change is like climbing a mountain" [1:00]. And the primary thesis of the video is, "I resist only the changes that I have a good reason to resist. The others I accept." [0:52] So **good changes** are accepted (eagerly), while only **bad changes** are "resisted". And this is presented as a *decision*, not a *conflict*… so an evaporating [conflict] cloud diagram is not even considered.

The initial *bad* change in the video is repeatedly improved, to become an accepted *good* change. "Show me how the pot of gold is large enough for me, and the teeth of my alligator are sharp enough. And my effort and my risk [crutches] to change is not as big, and that I don't have to give up on a beautiful mermaid, then, I assure you, I will climb the mountain." [4:09]



Eli Goldratt's animated YouTube video, explaining the Change Analogy Story

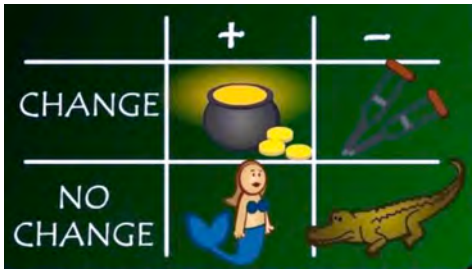
We are implored to actually *fill in the boxes* of the Change Matrix: "Have you ever tried to present all four sides of your suggestion? … Could you figure out in advance what the pot of gold is for the person you're trying to convince? Not your pot, but their pot? What are their crutches? What are the alligators, and the mermaids, for the other party?" [4:29]

And at the conclusion of the story, we are cautioned that "for different individuals… Each of the elements might be vastly different". [5:49] So we may need to fill in the boxes of separate Change Matrices, for different types of "customers", or distinct customer segments.

The ***story*** is summarized in the TOCICO *Dictionary* (under "Change Analogy") and is mentioned in the ToC *Handbook* (chapter 20) — but the Change Matrix itself as a ***tool***, is not. And despite its demonstrated value as a tool in the work of Alan Barnard, Kelvyn Youngman, Lisa Scheinkopf, Lisa Anne Ferguson, and others, the Change Matrix remains an underutilized and unrecognized member of ToC's Thinking Process (TP) tools.

Complication. The traditional 4-box Change Matrix has some *inconsistencies*, which may have obscured the power of the matrix, and Eli Goldratt's deep insights in the story behind the matrix, for more than a decade. Have these inconsistencies caused many ToC practitioners to overlook the Change Matrix as a useful ***tool***?

Question. If we renovate the original matrix, can the true power of the Change Matrix be unleashed? And the three brilliant insights behind Eli Goldratt's original change story, shine forth?



Goldratt's original 4-box "Basic" Change Matrix

2. THE 4-BOX CHANGE MATRIX

Eli Goldratt's original 4-box Change Matrix, is presented in a Socratic dialog, in his YouTube animated video [Goldratt 2010]:

Goldratt Insight #1: People don't resist **good changes**, that they think will leave them "better off". Instead, they eagerly embrace them, with zero resistance.

People do resist **bad changes**, that they think will leave them "worse off". And this decision is common sense… not "resistance".

This conclusion is clearly stated in the video. So on what basis, do people ***decide*** whether a proposed change will be good, bad, or neutral, for them?

Can the Change Matrix itself answer this question? Perhaps, with a few improvements? By what method can we make these changes?

Goldratt on inconsistencies: "We simply need to look at reality and think logically and precisely, about what we see. The key ingredient is to have the courage to face **inconsistencies** between what we see and deduce, and the way things are done. This challenging of basic assumptions is essential to breakthroughs."

— *The Goal*, 1984, Introduction to the first edition

An inconsistency means the model doesn't ***accurately*** match our reality… Can we find inconsistencies in the Change Matrix?



Original Change Matrix, rotated

2.1 Inconsistencies?!

So where exactly does the traditional Change Matrix not match reality? In three places…

Copyright © 2022 Richard E. Zultner

Inconsistency #1 non-intuitive structure. To see this inconsistency, rotate the traditional **4-box Change Matrix** 90 degrees:

Rotating the matrix does not change the content or meaning, but it does make it easier to see all the inconsistencies and then, to correct them. So what are the axes of this rotated matrix?

The vertical axis, is **impact** (or valence): with the [+] positives above the [-] negatives. Having positive values above negative values is a more intuitive arrangement.

The horizontal axis, is **time**: the current state "no change" is on the left, and the possible future state "change" in on the right. Having time arranged left-to-right is a more intuitive.

Now we have a more intuitive structure.

Inconsistency #2 Where is "making the change"? Note that the columns show only two states, the current "before" state, or **current reality** (where no change has been made so far), and a potential future "after" state, a specific **future reality** (that is the result of a successful change). What is missing is the most important part — the actual "making the change". That must occur between the first column ("not doing it yet"), and and the last column ("did it"). Where is that column?

And this matrix does not match the change analogy ***story*** itself. The story makes an analogy between a challenging physical journey, to the mental challenge of making a significant change (where no physical change of location is required).

The story opens on a **lakeshore**, where there is a [+] positive "mermaid", and a [-] negative "alligator". These icons are ***metaphors*** for sets of relevant [+] Desirable Effects (DEs), and [-] UnDesirable Effects (UDEs).

The story then moves to a **mountaintop**, where there is a [+] positive "pot of gold", and a [-] negative pair of "crutches". The first crutch represents the ***effort*** (including the intensity and duration) of reaching the mountaintop. The second crutch represents the ***risk*** of not reaching the mountaintop. But if we are already on the mountaintop, we have obviously succeeded in reaching the top of the mountain — so the effort is over, and the risk of failure is now zero. The mountaintop [-] negative box should contain a negative metaphor for being on the top of mountain, just as the lakeshore [-] negative box has a negative metaphor (the alligator) for being at the lakeshore.. but it does not. So where do the crutches belong?

Inconsistency #3 Inaccurate labels. There is a further inconsistency: the column labels are not accurate. "No Change" is not an accurate description of the initial or current state of most people.. If you ask them, "is there any change you would like to see, in your life, your work, or in society?" They do not reply, "no, I don't want anything to change". Instead, they tell you about *multiple changes* they'd like to see. Everyone wants some changes to some things. Good changes. *Their* changes. What they may have a problem with, are changes that someone else thinks would be "good for them" — but they think would actually leave them worse off. Bad changes. *Imposed* changes. And the same is true in organizations…

And most people, and most organizations, have changes going on right now. Their current reality includes ongoing changes.

Regardless of what Buy-in or Change Model you prefer, there are at least three change states:

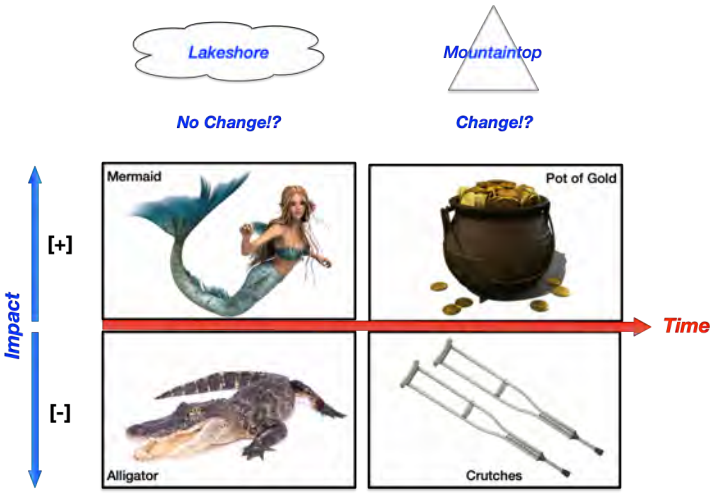
(1) **lakeshore**: the initial / before / current state; the status quo (which may include ongoing changes); "pre-change"
(2) **journey**: the transition; the transformation from the before state, to the after state; "making the change"
(3) **mountaintop**: the after / final / future state; the successful achievement of the change; "post-change"

The Change Matrix should be able to support any Buy-in or Change Model you prefer, with the necessary rows and columns. And when we are using the Change Matrix as a tool, and filling in the boxes, we should have a box for every concern our "customers" (whoever you want to say "yes" to your offer) voice… and that means we need more than four boxes.

2.2 Renovations

So what renovations should be made, to resolve the three inconsistencies?

Renovation #1 Journey column inserted. The crutches belong in the missing column between the "before change" lakeshore, and the "after change " mountaintop. A column for the physical **journey** in the change analogy story. The transformation of actually "making the change". The crutches are actually a metaphor for the [-] ***effort*** (intensi-



The traditional four Change Matrix icons

Copyright © 2022 Richard E. Zultner

ty and duration) of making the change, and the [-] ***risk*** that the change will fail. They don't apply to the initial "no change yet" state of the lakeshore, or the "change accomplished" state of the mountaintop, but only to the transitional "making the change" state between them — the journey itself.

Note that this column is the answer to Change Question #3 of "how to cause the change?". [2012 TOCICO *Dictionary*] The other Change Questions refer to the customer's current and future realities. But the feasibility of actually making the change, the transition, is of fundamental importance, and warrants a dedicated column for a full analysis of a change. And customers voice such concerns, for both [+] positive and [-] negative outcomes of their journey.

So now we have a **corrected 6-box Change Matrix**, with an intuitive vertical impact axis with [+] positives on top of [-] negatives, and an intuitive horizontal time axis, with three states of change: (1) the status quo of "no change yet", (2) the transition state of "making a change", and (3) the resulting state of a "change accomplished". What's next?

Renovation #2 Insert missing metaphors. The next correction is to fill in the open boxes with story appropriate icons:

"**Rattlesnake**" for the mountaintop [-] negative box. The "after change" mountaintop is not paradise. There are negatives. But an Eastern diamondback rattlesnake (shown) — unlike the alligators also found in the Southeastern US — will not hunt you down, kill you, and eat you. They are a smaller, more manageable UnDesirable Effect (UDE).



Eastern diamondback rattlesnake

"**Gold Nuggets**" for the journey **[+]** positive box. Along the path, those making the change periodically find small benefits from the experience of the journey itself. They learn about themselves, about their skills and stamina, and about making persistent progress toward an impressive goal. These small gains are theirs even if the journey ends before the reaching the mountaintop… and leave them better prepared for future attempts. These are small Desirable Effects (DEs) from the journey.



Gold nuggets found on the journey

The corrected 6-box Change Matrix has two rows for [+] positives and [-] negatives, and three columns for each of the basic change states: "before", "making the change", and "after". And each box has an accurate and appropriate metaphor symbol. And the last correction?

Renovation #3 Accurate labels. The change matrix columns should be labelled to accurately match the relevant change states for the change you are modeling. They should accurately describe what each column represents.

The analogy labels of lakeshore, journey, and mountaintop should be replaced with ToC relevant labels: Current Reality (CR), Transition (Tr), and Future Reality (FR). Or labels appropriate to the Change Model you are using.

We should note that there are multiple possible future realities, and it is a customer decision to chose one as their preferred future reality.

There are also multiple possible paths to the chosen future reality, and it is a customer decision to select the best transition plan to their chosen future reality. The best path for their customer's journey…

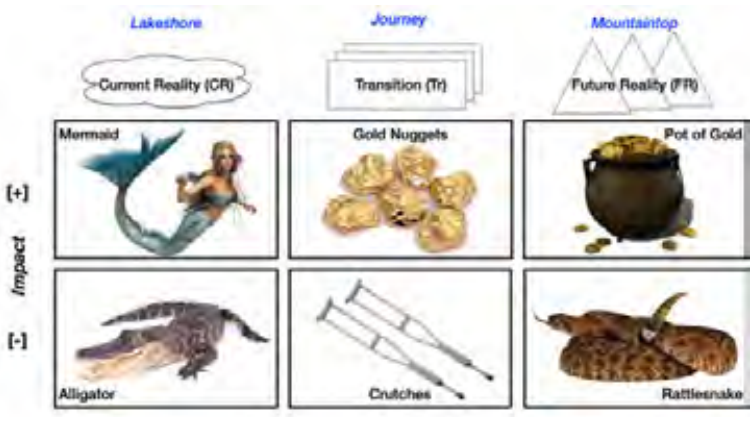
Now the inconsistencies have been renovated, are there any additional improvements that should be made?

3. THE RENOVATED 6-BOX CHANGE MATRIX+

To reveal, and leverage, the full power of Eli Goldratt's insights in the change analogy story and the corrected Change Matrix, there three further enhancements required…

Enhancement #1 Clarity about "what goes in the boxes?" To use the Change Matrix as a tool, we must *fill in the boxes*, as Goldratt admonishes us. But exactly what goes in the boxes? What should they contain?

In examining the examples presented by Goldratt, Barnard, Youngman, Scheinkopf, Ferguson, and others, what they fill in the boxes with, are positive [+] and negative [-] ***outcomes***. That is, Desirable Effects and UnDesirable Effects. And these are very familiar to ToC practitioners. Dettmer states, in his authoritative work on the Logical Thinking Process tools, that a Desirable Effect (DE) is "a result or outcome that is, in and of itself,



Renovated 6-box "Pro" Change Matrix+

Copyright © 2022 Richard E. Zultner

positive, desirable, or beneficial… The opposite of an UnDesirable Effect (UDE)". [Dettmer 2007 Glossary entry]

So what goes in the boxes, are statements from "customers" (clients, stakeholders, colleagues — or anyone you want to say "yes" to your offer) of their desired effects ("a positive or beneficial outcome"), and their undesired effects ("a negative or costly outcome"), for any change being considered.

The 2012 TOCICO *Dictionary* (2nd ed.) defines '**Desirable Effect**' as: "A positive or beneficial outcome associated with an organization's actual or future performance". So the first row of the Change Matrix should contain the customer's DEs for their current, transition, and future realities. Does it make sense, that customers, clients, and colleagues would use their important DEs to evaluate any change, to decide if it would be good for them? And that a good change would deliver significantly more DEs, to a greater extent, than their current situation? And that a bad change would deliver significantly less DEs, to a greater extent, than their current situation?

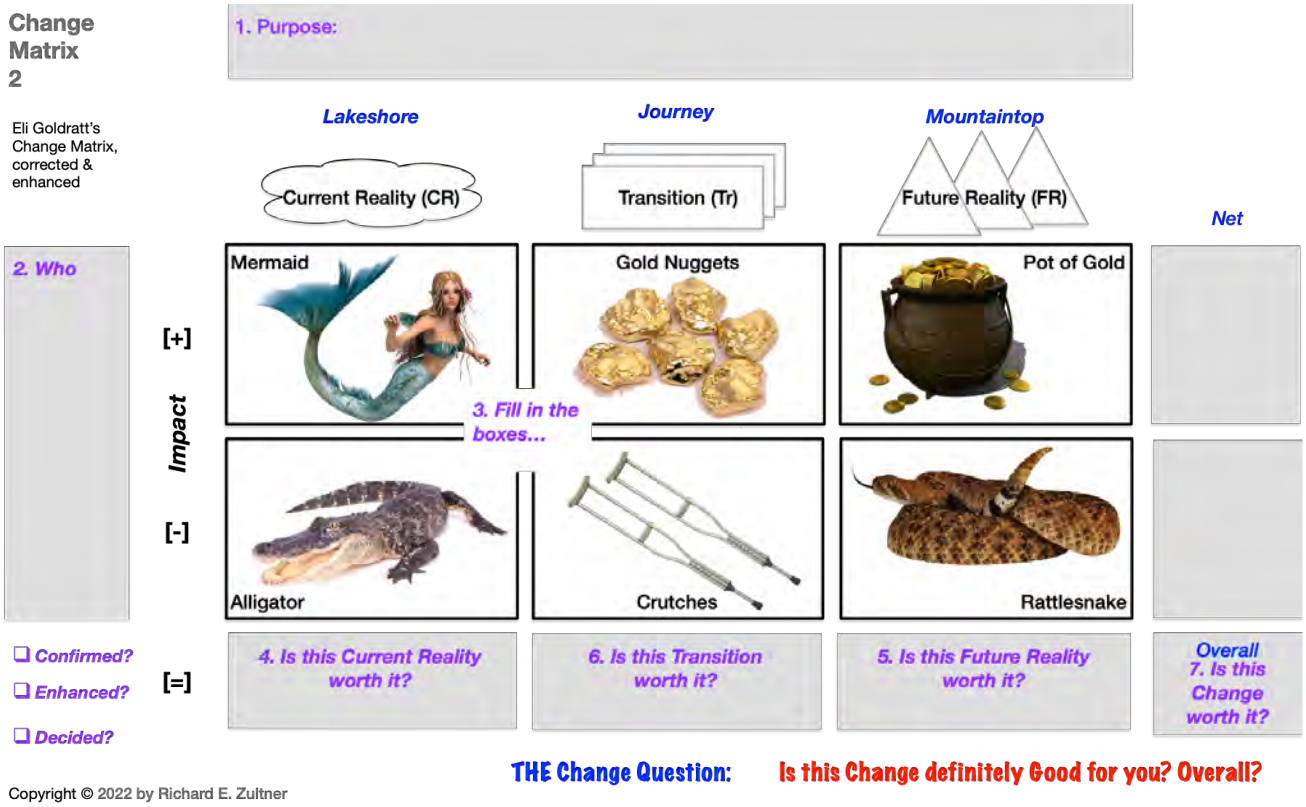
The 2012 TOCICO *Dictionary* entry for '**UnDesirable Effect**' should mirror the definition of DEs… but does not. The UDE definition is confusingly long and complex, with many restrictions on how UDEs may be stated (which should apply to DEs as well). It specifically refers only to the current reality, ignoring that UDEs can occur in the future — and these can be foreseen, and are a genuine concern of customers, clients, and colleagues. In contrast, Dettmer states, an UDE is,: "an effect that is negative or undesirable with respect to the system's goal or critical success factors". [Dettmer 2007 Glossary entry]

Both DEs and UDEs should be defined as outcomes customers care about. DEs are positive [+] outcomes — that we want more of. UDEs are negative [-] outcomes — that we want less of. And both apply to current, transition, and future realities.

Does it make sense, that customers, clients, and colleagues would use their important Desirable Effects *and* UnDesirable Effects to evaluate any change? To decide if it would be a good change, or a bad change? And accept or reject it accordingly?

Filling in the Boxes. The first step in a rigorous and logical exploration of any change, is to gather the real DEs and UDEs — and enter them into the appropriate Change Matrix boxes. It is easier to do this with a 6-box CM2 matrix, because the change states are clear and distinct:

- Are you describing a concern about what you have **now**, and will continue to have, [+] positives or [-] negatives, if nothing changes? Enter your concern in the Current Reality "lakeshore" column one
- Are you describing a concern about the way things may be, [+] positives or [-] negatives, **after** the change takes place? Enter your concern in the Future Reality "mountaintop"column three



Renovated 6-box "Pro" Change Matrix+ worksheet

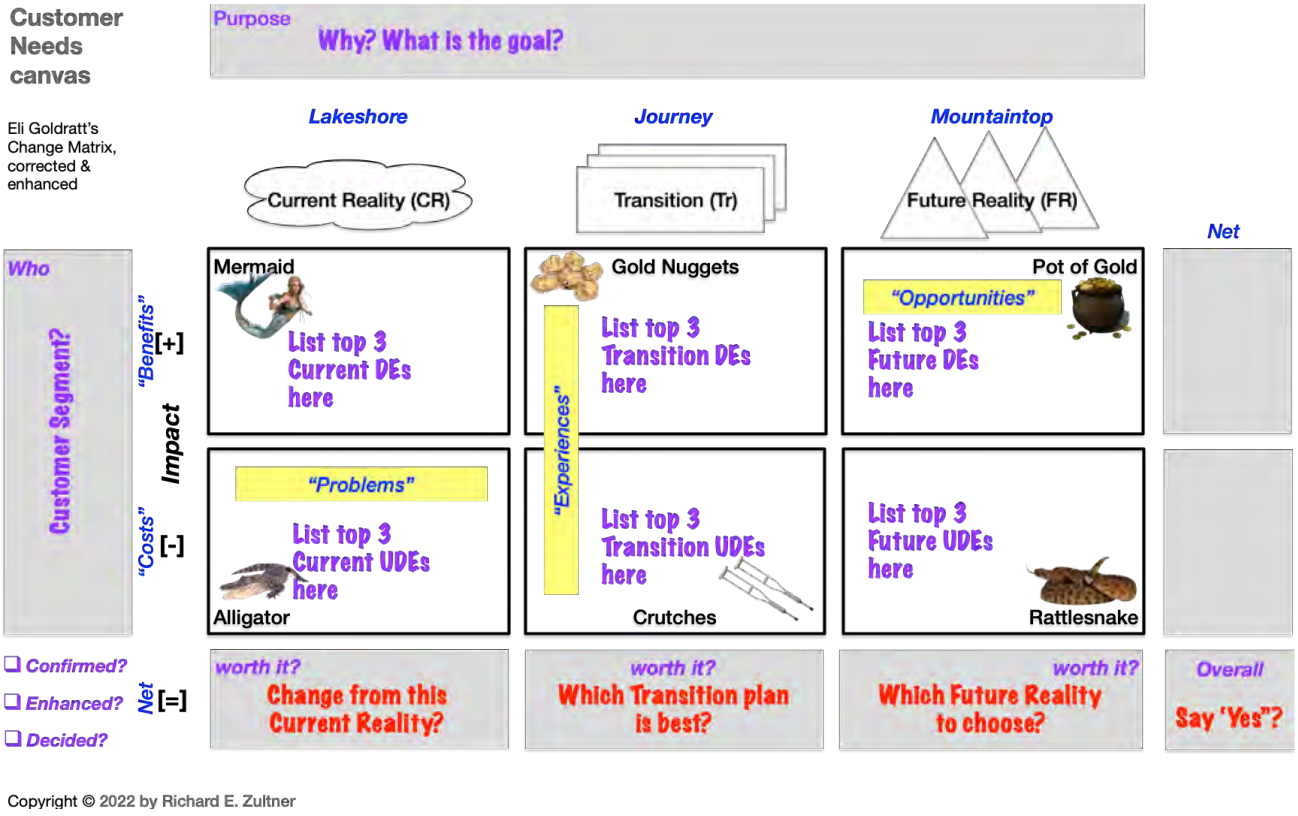
209

- Are you describing a concern about the way the change might be made? About the [+] positives or [-] negatives, from making the change? A concern which becomes moot, if the change is successfully accomplished? Enter your concern in the Transition"journey" column two

Enhancement #2 Recognition of what DEs and UDEs actually are. Collectively, DEs and UDEs are used by customers, clients, and colleagues to evaluate if a change is good ("Yes, I want that") or bad ("No, I don't want that") for them. They are the criteria used to decide Good Changes (warmly embraced) from Bad Changes (fiercely "resisted").

Outside of the ToC community, these are called **Customer Needs** (CNs). And customer needs are very very important, in many areas, for many decisions, made by customers! And this usage is consistent with the globally-accepted technical definition of 'customer needs' found in ISO Standard 16355, widely used in New Product Development (NPD) organizations, and in "Value World" methods (such as Jobs to be Done, Design Thinking, QFD, Value Engineering, Voice of Customer, etc.). Note that all products and services are "changes" that customers choose to accept ("buy" and "use") or not. Customers decide if a product or service is "worth it" or not, based on their assessment of their customer needs that will be satisfied, or not. [Zultner 2021]

And in New Product Development, customer needs (DEs and UDEs) are documented as implementation-free statements, that do not assume or presume any specific solution or technology. Because there are always multiple ways to achieve an outcome (even if the customer is only aware of one). This is similar to the long list of restrictions on UDE statements in the 2012 TOCICO *Dictionary*.



Copyright © 2022 by Richard E. Zultner

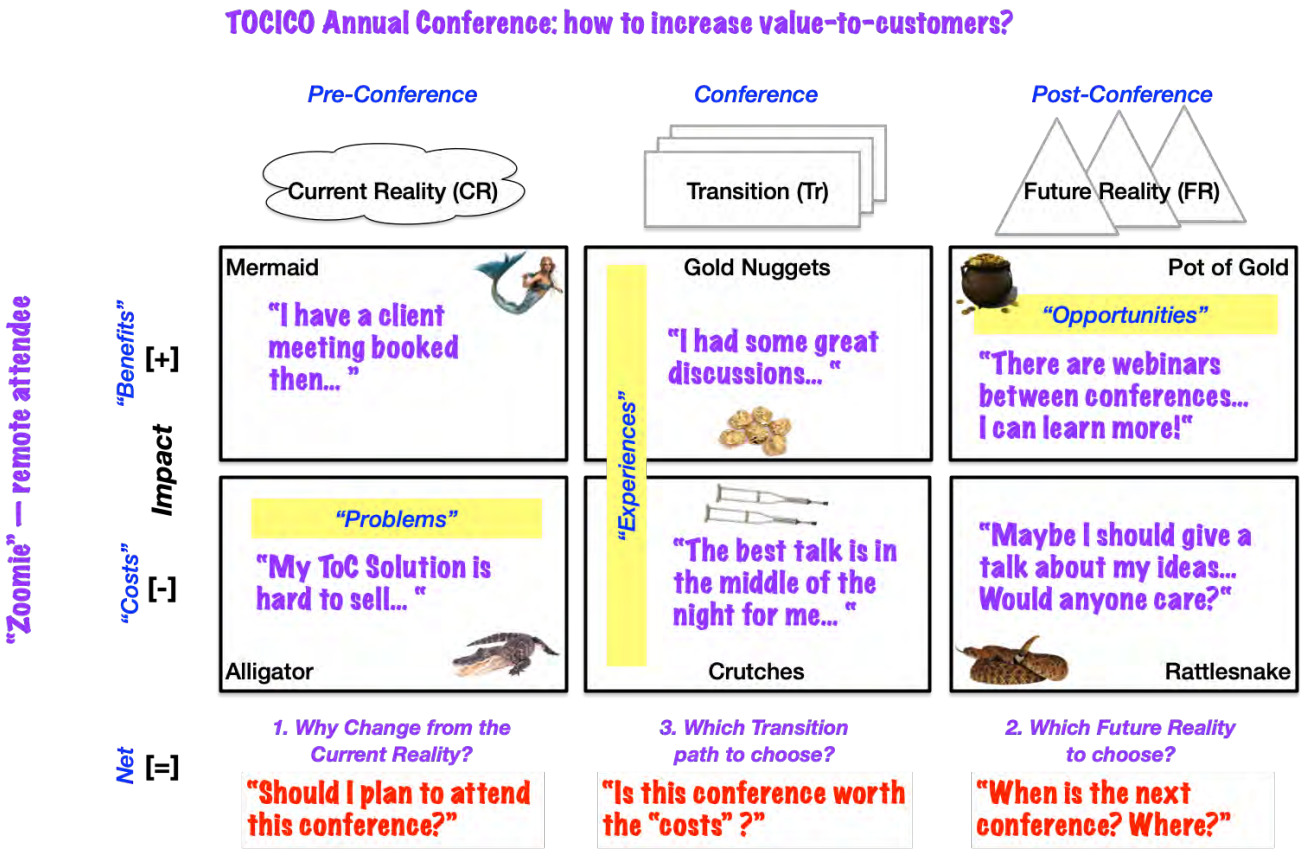
A filled-out Change Matrix+ is a collection of customer needs

Goldratt Insight #2: Fill in the boxes of a Change Matrix with DEs and UDEs (collectively, Customer Needs). Goldratt's 4th Pillar of ToC, Never say "I Know", implies that *we go find out* — so then we *will know*. And the Change Matrix gives us the framework to go find out from our "customer" — whoever we need to say "yes" — what needs we must satisfy, for them to actually say "yes". And capture those answers in the boxes of the matrix, so our proposed solution can then evolve and become a really good change, eagerly embraced. Just like in the change analogy story…

The Change Matrix is a starting point for the initial discovery of what matters most to customers, clients, or colleagues. Customer Needs, collectively DEs and UDEs, are really a fundamental part of the Theory of Constraints. They are essential elements for Current and Future Reality trees, and may appear as entities in many of the other Thinking Process tools. They are also the basis for clients deciding "yes" or "no" to a proposed ToC Solution. And for accepting, or rejecting, any proposed change (or any product, service, solution, etc.). This is the brilliant insight behind Eli Goldratt's original change analogy story, and the Change Matrix itself. We can begin exploring, and discover, what DEs and UDEs matter to customers, by *filling in the boxes* of a Change Matrix.

Copyright © 2022 Richard E. Zultner

Example: Hybrid Conference. There are two distinct customer segments for hybrid conferences, in-person attendees ("roomies"), and remote (online) attendees ('zoomies"). Although they share many customer needs, their primary (#1 priority) needs are distinctly different.



Theory of Constraints Conference example

For remote attendees ("zoomies") the primary need is *education*. There is at least one specific topic they are very interested in learning more about. So how can they find out, if this upcoming hybrid conference, will cover their topic of interest? Sufficiently to make it "worth it" to spend the time and money to attend live online?

During the conference, they may make connections with speakers and other attendees. Will they be able to develop these connections further? When?

And then, following the conference, where are the recordings of sessions they missed, or sessions they want to review again? Watching a recording at 1.5x speed (and pausing, for reflection) may be more valuable to watching in real-time.

Once the specific customer needs of a specific type of customer ("roomies") are understood, it is fairly easy to consider specific actions to meet those needs (and do so better than other competing alternatives). If you don't understand why a particular type of customer decides to attend an event (or not)… it is difficult to efficiently satisfy needs you don't understand. [Zultner 2022]

3.1 Clarifying Customer Needs

Because the terms, "problems, "opportunities", "benefits", and "costs" are often used in non-technical ways, and have multiple meanings… it is simpler and clearer to consider **customer needs** as the implementation-free outcome of what is "better" or "desired" by a customer, or not. Why a change is judged "worth it" — or not.

To clarify, any outcome a customer wants more of — the *increase* of a [+] positive — that desired *change* can be a customer need. The increase may be in size, or quantity (or frequency). Also, if a customer is concerned they will lose a positive, the prevention of that possible loss, is also a customer need.

And any outcome a customer wants less of — the *decrease* of a [-] negative — that desired *change* is also a customer need. The decrease could be in size, or quantity (or frequency). Also, if a customer is concerned there will be an increase of a negative, the prevention of that possible increase, is also a customer need.

Copyright © 2022 Richard E. Zultner

A customer *problem* statement, is often stated as a desired decrease of a current reality [-] negative (an alligator)
A customer *opportunity* statement, is often stated as a desired addition of a future reality [+] positive (a pot of gold).
Both are customer needs. And meeting those needs of is value to the customer.

Customer Need example: "my monthly utility bill for air conditioning is $100". This is a statement of fact about a cost — not a customer need. Is this cost greater than the benefit of a cool and comfortable house? No? Then the air conditioning unit is "worth it". But why did they mention it? Is this cost too high? Would the customer like this cost to decrease? Suppose they are offered a new more efficient AC unit that could provide the same cooling performance, at half the monthly cost? The reduction in monthly cost would be of value, and a customer need. And the customer would compare the ongoing monthly savings (a reduction of an existing cost), to the one-time cost of buying and installing a new unit. If they judge the ongoing monthly savings to be greater than the upfront purchase and installation, then this change is "worth it". And they say "yes".

Of course, **customer needs** should always be stated as *implementation-free customer outcomes* (not assuming or presuming any particular solution, implementation, or technology). The Transition (journey) column is a rich source for underserved customer needs, and an excellent place to add value to an offer.

3.2 The Customer Journey

If customers do not see how to reach their destination, their chosen future reality, why would they say "yes" to a change they cannot get to? The destination is then just a mirage — not a serious possibility. So customers will want to know:

Question: How can I achieve my chosen future reality?
- Have you been there? Can you show me a **map**? Where is the route exactly? Is that the best path?
- Have you guided others along this path? What was their experience? Was it worth it?

First, the [-] negatives: The "crutches" of the Change Matrix
- The **expense** in monetary terms, of making the change.
  - The specific payment terms, and options, may make a significant difference to the customer.
- How much **effort** (intensity and duration) will this journey require?
  - Any concerns about difficulty are considered here.
- What are the **risks**? What is the likelihood I will fail to finish the journey?
  - Any potential "failure modes" that reduce the chance of success, are considered here.
- What are the "**negative branches**" of this journey?
  - Any Negative Branch Reservations caused by making this change, this way.
- What are the **obstacles** on this journey?
  - Anything that may block or starve progress, is considered here.
- What **preparations** are required? What skills, knowledge, or equipment do I need to start, or finish?
  - Any required skills or "capabilities" that may be lacking, are considered here.
- **Anything else**? A customer may raise any concern, including one we have not faced before…
  - Concerns about the necessary permissions or the collaboration of others is a common here.

Someone acting in the role of a **Guide**, or Coach, can be critical in preparing the customer by articulate their concerns, and helping them to overcome them. The recognition of all these "costs" in advance, can actually increase the net value of journey for the customer — if the customer believes they can successful overcome them. A good guide works to assure the customer receives the most value from their journey.

Then, the [+] positives: The "gold nuggets" of the CM2
- What are the **benefits** of the journey itself?
  - This the value of making the change, independent of the post-change gains (the pot of gold).
- What are the "**positive branches**" of this journey?
  - Any Positive Branch Affirmations caused by making this change, this way.
- What are the **enablers** on this journey?
  - Anything that may boost or accelerate progress, is considered here.
- **Anything else**? A customer may raise any hope, including one we have not faced before…
  - Questions about possible positive effects on others is a common here.

Note that the traditional 4-box Change Matrix focuses only on the negatives of the journey, and ignores the positives. Just as customers may raise Negative Branch Reservations, they can also raise (or be informed of) Positive Branch Affirmations — "gold nuggets". Also just as **obstacles** exist, so do **enablers** — "anti-obstacles" — which can boost or accelerate progress toward the gains on their journey. Such "express lanes to the mountaintop" can make one transition plan (and the consultant who offers it) stand out from other plans (and other solution providers).

Copyright © 2022 Richard E. Zultner

In the case of a training course, a course of therapy, a series of life coaching sessions, or even a holiday trip — the journey IS the product — the customer experience — and the source of the actual value-to-customer. Many cruises end up in the same place as they started. What happens in-between, on the trip itself, is the **experience** the customer pays for. The customer walks away from the same physical place they began, hopefully with photos on their phone, and memories… and a judgment the cruise was "worth it".

Example: A **Taylor Swift "The Eras Tour" concert** is a staged experience, that solves no problems, seizes no opportunities, and removes no limitations. The show that last three-and-a-half hours (with no breaks) with 44 songs and 16 costume changes. Tickets are expensive — yet sell out in minutes. And fans say the *experience* is "totally worth it". The experience is the product. The future reality afterwards, is not different from the current reality before the concert.

Enhancement #3 How do customers decide yes or no? Once we have a solid set of DEs and UDEs listed in the appropriate boxes, the next step is to ask the customer how the "benefits" compare to the "costs". For the Current Reality, is the [=] ***net*** evaluation of the DEs and UDEs, compared to the costs, "worth it"?

Adding a [=] **net** row to the model (not more boxes, as this is a summary judgement on the column) captures this judgment. Note that a judgment of "ok" is common, and suggests that the [+] positives are not significantly grater than the [-] negatives.

Compare each column. Every column is a set of customer needs for the same change state.

Compare each row. Every row is a set of customer needs for the same impact, or valence.

The final comparison is to evaluate the entire matrix. An overall "net net" judgment. As an example, if there are some CR [+] "mermaids" that will be "lost" in the FR [+] "pot of gold", then some **loss aversion** studies suggest that the pot of gold must be at least twice the size of the mermaids lost just be to "even".

Also, many people, and organizations, are more sensitive to losses than gains. So a reduction in UDEs (less pain, fewer problems) many be more highly valued that an increase in DEs (greater gains, more opportunities). This is why it is necessary to evaluate each column, and each row, *and* make an overall evaluation.

Given their assessment of their current reality, chosen future reality, and the selected transition plan to the chosen future reality… are they going to go for the offered change? And say, "Yes!"? Why, or why not? This the THE Change Question: "Is this Change definitely good for you" Overall?"

The 6-boxes allow a thorough exploration of what matters most to that decision. If the journey was faster? Less risky? Would that matter? Or perhaps if it was longer, but required less involvement week to week? If in addition to the pot of gold, there was an additional "bonus" [+] available? Or if a pre-transition "boot camp" was added to better prepare for the journey?

This clarity in discovering what matters most to a customer's decision, also allows for better marketing of the change offer…

Goldratt Insight #3: People say "no" to an offer or solution that does not meet their needs, better than any available alternative (including the current reality). In other words, a *bad* change. People say "yes" to the best available solution, that is "worth it". A *good* change. As the change analogy story states, "Show me how the *pot of gold* [FR +] is large enough for me, and the teeth of my *alligator* [CR -] are sharp enough. And my effort and my risk [*crutches*] to change [Tr -] is not as big, and that I don't have to give up on a beautiful *mermaid* [CR +] , then, I assure you, I will climb the mountain." [Say "yes" to the offered solution] To which we must add the *gold nuggets* [Tr +], and *rattlesnake* [FR -], for a full customer needs analysis.

It's not about you, or your solution — it's about your customer, and their needs. And about understanding their needs, from their perspective. If the Change Matrix alone can explain why customers say "no", and provide the guidance to improve your solution so customers say "yes", then it may not be necessary to seek additional factors such as cognitive bias, erroneous assumptions, ineptitude, inertia, unverbalized fear, etc., to explain why customers say "no". We should try the simplest analysis first, and move to more complex analyses only if necessary…

What is Value? The 6-box Change Matrix+ is the simplest framework to accurately define "what is value" (to customers) in a general way. Value-to-Customer (V2C) is determined by what customer needs are met, and how much, over time.

Goldratt's early 2000's 'value' definition, that "value is created by removing a significant limitation for the customer, in a way that was not possible before, and to the extent that no significant competitor can deliver", does apply when a limitation is recognized by a customer as blocking a need. Removing a bad limitation can be "worth it". But adding a good limitation can also be "worth it".

Example: **walls**, **doors** and **locks**. A wall separates the inside from the outside. What is inside cannot go out, and what is outside cannot come in. Where this good limitation is desired, people build walls. A door in a wall, allows you to enter, or

Copyright © 2022 Richard E. Zultner

exit, when you wish, through a temporary removal of the limitation of a wall. Where this removal of the limitation of a wall is desired, people install doors in walls. However, many doors have locks, which prevent a door from being opened by people without the key. A lock re-establishes the limitation of a wall, by those with keys. A lock creates a good limitation, and is "worth it".

Removing a *bad* limitation can create value. But so can adding a *good* limitation. And *neutral* limitations simply don't matter… so removing them, or adding them, has no effect on value to customers. And there are many situations where there are no obvious limitations, and yet value is clearly created. The music industry is a global billion-dollar business… but songs don't remove any limitations, do they?

The 6-box Change Matrix+, with rows for DEs and UDEs, and columns for current, transition, and future realities, is a framework that applies in all cases — a significant renovation.

4. BUILDING ON THE 6-BOX CHANGE MATRIX+

The 6-box Change Matrix+ is a tool for discovery, to understand the needs of customers, clients, and colleagues that we need approval or collaboration from. It is a "step zero" tool — used "before anything else" (BAE). Once we have filled in the boxes of a Change Matrix, there are many ways to build on that foundation.

4.1 Buy-in (sales).

What approach should we use, to get the customer to say "yes" to our offer?

Different buy-in, or sales, experts suggest different starting points, depending on the situation. The Change Matrix can serve as a starting point for choosing an approach. Here are a few approaches mentioned in ToC presentations:

"problem" buy-in. The most common starting point is the alligator [CR **-**]. People are well aware of their significant current **problems**. Their pain is known, and they are motivated to explore solutions to reduce or eliminate their pain.

"opportunity" buy-in. The next most common starting point is the pot of gold [FR +]. Sometimes there aren't any serious problems, so the motivation to change comes from an offered **opportunity**.

"experience" buy-in. The least common starting point is the journey itself [Tr **+ -**] — some changes / products / solutions are simply **experiences**, and the journey itself is the reward. So there may be no significant change to the Current Reality, or transition to a distinctly different Future Reality. A journey can be taken not to solve any problems, or seize any opportunities, but for its own worth.

In some cases the journey may be trivial — simply purchase a new product, open the box, and plug it in. But as products and services become more *experiencified* [Vargo & Lusch 2008], considering the transition of "before' to "after" becomes increasingly important. This is especially the case when the journey is a true transformation (a paradigm shift), as is the case for all ToC Solutions.

Of course, the Change Matrix+ does not dictate what approach you should choose. It is a neutral basis for your decision.

Once a customer says "yes" to our Offer, we then must deliver their desired changes, in our Solution. Different charge models have been developed to help plan this effort.

4.2 Change Models.

What model of change should we use, to plan the Transition?

Every Change Expert has a Change Model that they prefer. A Change Model explains how change occurs, and suggests the best way to make change happen. There has been a great deal of research over the past several decades on "change", "resistance" to change, and "persuasive" marketing of new solutions. So far, I have been able to map all such models I've found, into the 6-boxes of the enhanced CM2 matrix. And doing this shows what a particular model addresses, and what it ignores (that other change models consider).

There are popular Change Models, such as John Kotter's approach [Kotter 2010] that is widely used. In testing the 6-box Matrix of Change, I have not yet found a requirement to increase the number of columns. And interestingly, I've found that some models are "missing" attention to all 6 boxes — but different models miss different boxes…

The renovated 6-box Change Matrix+ has substantial power without additional structure, quantification, or focus. But if necessary, additional power can be added with well-established, proven methods. Three "power" tools are mentioned in the Q&A that follows, and additional harmonious collaborations are possible…
And additional columns, or rows, can be inserted for a "Max" version of the Change Matrix+.

5. THE CHANGE MATRIX AS A TOOL

How have ToC Experts used the traditional 4-box Change Matrix, as a tool? An overview…

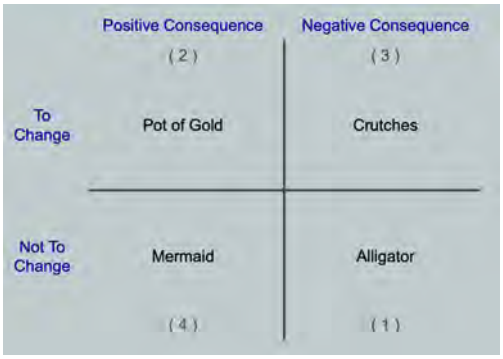
Copyright © 2022 Richard E. Zultner

Alan Barnard, in his TOCICO White Paper on the Change Matrix Cloud Process, describes the traditional 4-box Change Matrix as a tool with "low adoption" [Barnard 2016]. He describes the contents of the Change Matrix as "consequence assumptions" and "competing forces". But the examples provided are clearly positive [+] outcomes ("increase probability of meeting endangered time commitment") and negative [-] outcomes ("being blamed for not taking corrective action when it was still possible to recover time lost on in-process or completed tasks") — or Desirable Effects (DEs) and UnDesirable Effects (UDEs) — and thus collectively, Customer Needs (CNs).

Now when a customer, client, or colleague evaluates how a proposed change meets their needs, they are making this evaluation based of their understanding of that particular change. And that understanding may well involve assumptions about the change, or even their own future. But shouldn't the first step should be to discover, and then understand, what their needs are? A Bad Change — one that doesn't meet their needs — will be rejected. Turning down Bad Changes is just common sense, not "resistance". And the best course of action, following the change analogy story, is to transform the proposed change into a Good Change — a clearly superior offer that meets the customer's needs better than any other available option.

Barnard states the most harmful assumptions include "I am not enough to ... [achieve a desired goal]" or "I/we do not have enough...[of some scarce resource]". These are perfectly valid concerns about a Transition plan to a desirable, but possibly unattainable, Future Reality. If a customer, client, or colleague do not see a viable path to their chosen future reality, one that they have the skill, stamina, and resources to execute… then that Future is a mirage, not a feasible reality. They may need a well-equipped Guide to assure that they are ready to start, and can successful complete, their customer journey.

Kelvyn Youngman used a traditional 4-box Change Matrix, and points out that "if the satisfaction of living with the problem [alligator] is relatively high, then we are less likely to get change". And, "if dissatisfaction with the solution [pot of gold] is relatively high, then once again we are less likely to get change". So, "we want to not *retain* the problem [alligator] and we want to *gain* the solution [pot of gold]. We want to *not gain* the dissatisfaction with the solution [crutches]. We want to *retain* the satisfaction with the problem [mermaid]." [Youngman 2012]

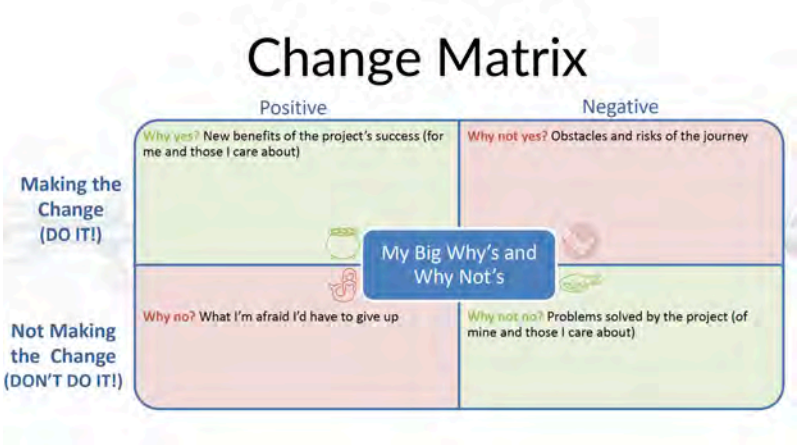


Youngman: Change Matrix

A solution includes (1) a design to make a change, (2) a choice of a destination (future reality) — what to change to, and (3) a selection of a path (transition) — how to make the change. Initially this is described to the customer in an ***offer*** (information about possible solutions), and then the ***solution*** is the decision and execution of one possibility — according to an agreed upon plan. The plan may address problems (CR [-]s), opportunities (FR [+]s), or experiences (Tr [+ -]s) — depending on the customer, and their situation.

The most recent examples of the Change Matrix being used at a ToC Thinking Process tool, are found in the work of Lisa Anne Ferguson [Ferguson 2020], and Lisa Scheinkopf [Scheinkopf 2022].

Lisa Scheinkopf keeps the traditional orientation, and cautions against considering "only one aspect and ignoring the others". So we should consider all the "Big Why's" for making a change, and all the "Big Why Not's for not making the change. With a 6-box Matrix of Change we can (1) evaluate if the Current Reality provides a reason to change (the "alligator") — or not ("the mermaid"), (2) what to change to — which Future Reality (with a "pot of gold" and "rattlesnake") to chose, and (3) how to make the change — which Transition plan (with "gold nuggets" and "crutches") to choose. We can see, and consider, all the relevant and important customer needs, that a proposed change should meet.



Scheinkopf: 4 Big Why's and Why Not's

Lisa Anne Ferguson uses a rotated 4-box Change Matrix, while Scheinkopf keeps the traditional orientation. Ferguson suggests considering the unique viewpoint of "each person from whom you need approval or collaboration" and filling out a separate Change Matrix for each unique viewpoint. This is why the 6-box Matrix of Change has a "Who: " entry for

Copyright © 2022 Richard E. Zultner

the specific viewpoint (the type of "customer", or "customer segment") being documented. So we know whose Change Matrix we are looking at.

All the experts above consider "Not Making the Change" as the Current Reality (status quo), and combine the "Making the Change" Transition (the "crutches" box) with the Future Reality (the "pot of gold" box — the result of "Having Made the Change"). This leaves out the [-] UDEs of the Future Reality (the "rattlesnake" box), and the [+] DEs of the Transition (the "gold nuggets" box). So if a customer, client, or colleague raises "gold nugget" or "rattlesnake" issues… there is no place to capture them. And we are not prompted to even ask about them… Or a anyplace to document the [=] "net" evaluation of the Transition independently from a Future Reality evaluation. Shouldn't the Change Matrix support a full analysis, of *all* the positives and negatives, raised by customers? In all situations?



Ferguson: The 4 Viewpoints

A 6-box Matrix of Change does not interfere with anything that all these ToC Experts are doing with a 4-box matrix, and supports a more accurate understanding of all the customers' DEs, and UDEs, which we need to clearly understand, to get their agreement and collaboration.

6. SUMMARY

All ToC Solutions are fundamentally about improving a system by (1) getting a big gain, (2) fast, with (3) resources you already have (minimal additional investment). These are "Go Big" changes! With gains so big as to be "unbelievable"… and which require a **paradigm shift** (the biggest mental change).

So all ToC Solutions require a decision by the customer to "Go Big" (and shift their paradigm).
Some customers are eager to "Go Big", now, and eagerly seize the opportunity offered to them by a ToC Solution.
Many customers decide NOT to "Go Big", at this time. They may not want to go big (ever), or may believe they can't "Go Big" — right now. But some can be educated… or trained.

Making a change, especially a "Go Big" change, is a always **decision** — not necessarily a ***conflict*** — by the customer. When deciding which change(s) to make, now, customers carefully consider the "benefits" of the change, compared to the "costs", in the contexts of (1) their current reality, (2) their chosen future reality (there are always multiple possibilities — which should they choose?), and (3) the selected transition plan to reach their a chosen future reality — a "customer journey" (there are always are multiple paths — which should they select?).

Any Solution (especially ToC Solutions) is a Change for any customer, client, or colleague — and may be judged a **good change** to be chosen, implemented, and leveraged. Good changes are eagerly embraced, with zero resistance. Or a change may be judged a **bad change** (and are resisted to prevent deterioration from their current reality). Bad changes are considered **threats** to their currently met customer needs… they would end up worse off. They would be ***harmed***. So of course, bad changes are fiercely resisted. That's just common sense…

There may also be neutral (or "meh") changes… that a customer may take, or leave…

Customers want an increase in Value (more Customer Needs met, to a greater extent, without loss), ***after*** they have implemented a Solution — compared to what they had ***before*** they decided to implement that Solution.
Customers consider the journey when deciding if a destination is "worth it". Destinations they cannot reach are only mirages.

The Transition ("customer journey") to make a Change to achieve their chosen future reality, is an ***experience***. With its own [+] positives and [-] negatives (collectively, customer needs). Not all paths to a given future reality are "worth it". Better paths meet more customer needs to a greater extent than worse paths. And very bad paths can eliminate desirable destinations from consideration…

The renovated 6-box Change Matrix+ supports the discovery and analysis of Customer Needs, the basis for Value-to-Customer (V2C). So Customers can be shown the full value of an Offer/Solution, and properly evaluate how well it meets their needs. And Solution Providers can develop higher-value Solutions, for the customers they value most.

Copyright © 2022 Richard E. Zultner

REFERENCES

1. Barnard, Alan. 2016. *The Change Matrix Cloud Process*. TOCICO White Paper.
2. Brassard, Michael. 1989. *Memory Jogger Plus+: Featuring the Seven Management and Planning Tools*. Methuen MA: GOAL/QPC. ISBN 1-879364-02-6
3. Dettmer, H. William. 2007. *The Logical Thinking Process: A Systems Approach to Complex Problem Solving*. Milwaukee, WI: ASQ Quality Press. ISBN 987-0-87389-723-5
4. Ferguson, Lisa Anne. 2020. *The Art and Science of Persuasion*. TOCICO Webinar, 6 May 2020.
5. Goldratt, Eliyahu M. 2010. *Overcoming Resistance to Change - Isn't It Obvious?* YouTube video here. Also Goldratt Research Labs. 2012. *Overcoming resistance to Change with the Goldratt Change Matrix:* here and in Japanese here
6. ISO 16355:2021. *Application of statistical and related methods to new technology and product development process*. International Organization for Standardization. ISO 16355-1:2021(E) Note: Available here from ISO
7. Kano, Noriaki and Nobuhiko Seraku, Fumio Takahashi, Shinichi Tsuji. 1984. "Attractive and Must-Be Quality" (in Japanese). Tokyo: JSQC *Quality* 14 (2 Feb 1984) 39-48.
8. Kawakita, Jiro. 1986. *The KJ Method: Seeking Order out of Chaos* (in Japanese). Tokyo: Chuokoron-sha. ISBN 4-12-001517-3 Note: 1992 *Chōsō no kuni: Hikyō Himaraya tankenki* from Kōdansha ISBN 978-4061590335
9. Kotter, John and Whitehead, Lorne A. 2010. *Buy-In: Saving Your Good Ideas from Being Shot Down*, Harvard Business School Publishing
10. Saaty, Thomas. 1982. *Decision Making for Leaders: The Analytic Hierarchy Process for Decisions in a Complex World.* Wadsworth ISBN 0-534-97959-9 Note: 2013 3rd ed. ISBN 978-0962031786 Available here
11. Scheinkopf, Lisa. 2022. *Assumption Hacking: A ToC Thinking Masterclass*. TOCICO 2022 Conference Workshop, Orlando FL USA. November 2022. Related training course here
12. Scheinkopf, Lisa. 2011. *Never Say I Know: The Tangibility of the Green Curve*. TOCICO Conference Upgrade Workshop, Palisades NY USA. June 2011. Available here
13. Vargo, Steven L., and Robert F. Lusch. 2008. *Service-Dominant Logic: continuing the evolution*. J. of the Acad. Mark. Sci. 36, 1–10 (2008). Available here
14. Youngman, Kelvyn. 2012. "The Systemic Cloud and The Layers of Resistance Hiding in Plain Insight" at *TOCICO 2012 Conference.* Chicago IL: TOCICO.
15. Zultner, Richard E. 1991. "Before the House: The Voices of the Customers in QFD" in *Transactions from the 3rd Symposium on QFD*. Ann Arbor MI: QFD Institute.
16. Zultner, Richard E. 1993. "Priorities: The Analytic Hierarchy Process in QFD" in *Transactions from the 5th Symposium on QFD*. Ann Arbor MI: QFD Institute.
17. Zultner Richard E. 1997. "Project QFD: Managing Software Development Better with Blitz QFD". *Transactions of the 9th Symposium on QFD*. Ann Arbor MI: QFD Institute.
18. Zultner, Richard and Glenn Mazur. 2006. "The Kano Model: Recent Developments" in *Transactions of the 18th Symposium on QFD* Austin TX. Ann Arbor MI: QFD Institute.
19. Zultner, Richard E. 2021. "Essential QFD+: The "Value World" Integrative Framework" in *ISQFD'26 2021 Conference Proceedings*. Frankfurt, Germany: QFD-Institut Deutschland.
20. Zultner, Richard E. 2022. "The New 7 Questions for Technology (7QT) and the Search for Hidden ToC Treasure" at *TOCICO 2022 Conference.* Orlando FL: TOCICO.
21. Zultner, Richard E. 2023. "Prioritizing CC PM Features, Projects, or Portfolios, with AHP: A Critical Chain Project Management Introduction to the Analytic Hierarchy Process" at *TOCICO Critical Chain 2023 Conference*. TOCICO.

Copyright © 2022 Richard E. Zultner

AUTHOR

Richard E. ZULTNER, *Jonah - Mechanic* (Theory of Constraints Master Teacher), from [AGI], and
QFD Red Belt (from Dr. Yoji Akao)
Princeton, NJ USA

1. Certified **Project Management Professional** (PMP) [PMI],

   TOCIC™ Level 3 **Certified Implementer in Critical Chain Project Management** [TOCICO]

   I work with frustrated project managers facing impossible challenges.

   I teach them how to consistently finish their projects early (in 15-25% less time).

   By shifting their project management paradigm… to Critical Chain PM.

2. **Certified Quality Engineer** (CQE) and **Certified Software Quality Engineer** (CSQE) [ASQ],
   Six Sigma Master Black Belt, and **QFD-Architekt** (4. Grad) [QFD-ID]

   I work with entrepreneurs, who are frustrated that their current product or service is just not getting the traction they know it should have.

   I teach them how to create their most critical connection — between their unique gift, and their ideal customer — through an irresistible offer for a perfect-for-you-now product.

   By applying the billion-dollar framework for new product development used by the most valuable companies in the world... distilled into an essential model even a solo entrepreneur can apply.

3. **Adjunct Professor** of Critical Chain Project Management, at Stevens Institute of Technology, in Hoboken NJ. USA (retired)

   I taught Critical Chain project management to graduate students in the Project Management Program, of the School of Technology Management, in online, hybrid, and in-person classes, at Stevens in Hoboken, and at international affiliate programs, for ten years.

Copyright © 2022 Richard E. Zultner

Renovated Change Matrix+:

Eli Goldratt's original 4-box Change Matrix, Renovated to a modern 6-box Thinking Process (TP) tool



Richard E. ZULTNER,
Jonah

Adjunct Professor (retired)
Stevens Institute of Technology

Princeton, NJ. USA
Richard@Zultner.org



Change Matrix (CM+) Questions & Answers

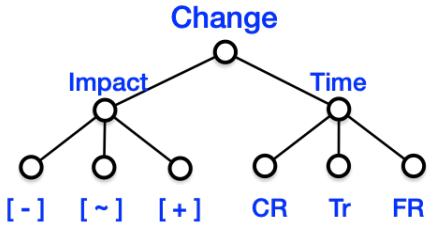
What are the key differences between the original 4-box Change Matrix, and the renovated 6-box Change Matrix (CM+)?

The 6-box Matrix of Change has the same 4-boxes as the traditional 4-box Change Matrix, in. different arrangement — plus two additional boxes. The traditional 4-box Change Matrix is "simpler" — and is well suited to those changes with no significant transition. This traditional model works best when "the change" is fixed, and is offered as a given. A "plug and play" solution. So the only decision is, accept what is offered, or reject it. By combining the Transition and Future Reality of a change into one column, the "new" boxes of rattlesnake [FR -] and gold nuggets [Tr +] are not even considered…

The renovated 6-box Matrix of Change has a dedicated column for the [+]'s and [-]'s of the "making the change" ***Transition***. People often focus on just a few of the boxes, and ignore the others. By intentionally considering all six boxes, we are better able to understand whether a change is truly worth making (choose the best Future Reality), and how best to make it (select the best Transition) — and if it is *possible* for us to make this change. This model is better for *solution providers* and *change creators* — those who want to *craft* the best solution for their customers, and those whose offers involve an *experience* that is a *significant transformation*.

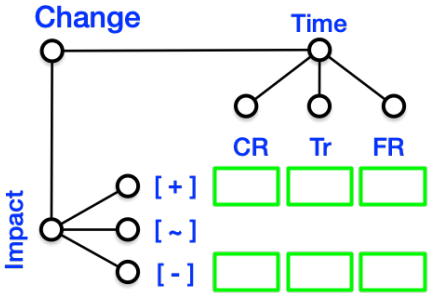
All the Thinking Process (TP) tools are logic trees. Is the Change Matrix really a logic tree?

Yes! The 6-box Change Matrix+ (as well as the original 4-box Change Matrix) is a two-dimensional logic tree — similar to the Evaporating Cloud diagram. That is, the elements are positioned horizontally and vertically, and their position matters.



Logic tree in one dimension

The logic tree of the Change Matrix breaks down into ***Impact***, and ***Time***. And then further into [+] positive, [~] neutral, and [-] negative impacts, and into Current Reality (**CR**), Transition (**Tr**), and Future Reality (**FR**) states (in time). With the interactions among the nodes, we get a two-dimensional logic tree, where the vertical and horizontal position of the boxes (the intersections) are meaningful. Just like in an Evaporating Cloud diagram.



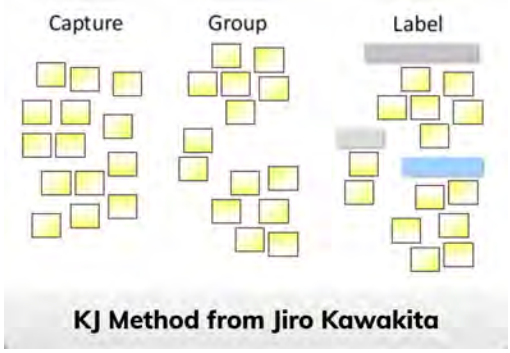
logic tree in two dimensions (2-D)

Can we use the Change Matrix to discover unstated customer needs?

The DEs and UDEs captured by filling in the boxes of a Change Matrix are unlikely to be a complete set of customer needs. But they can be used to uncover the underlying structure of how customers think about their needs (in the context of the change being considered). The qualitative method commonly used to do this by the New Product Development (NPD) community is Jiro Kawakita's **Affinity Diagram** —produced by the **KJ Method**. [Kawakita 1986] The KJ Method provides a simple and easy way for an individual (or group) to surface the underlying hierarchical structure from the heads of those involved, and is typically performed sim-

Copyright © 2022 Richard E. Zultner

ply by "moving yellow stickies around" on a table or whiteboard. [Brassard 1989] The KJ Method has been widely used for this purpose for over thirty years [Zultner 1991], and is a recommended method for structuring customer needs in the global standard for NPD methods. [ISO 16355:2021]



Once the underlying structure has been uncovered, that structure can be used to analytically fill in any missing needs — including needs the customer is not aware of (latent needs). This hierarchical structure can be thought of as a Goal Tree for customer needs (the DEs and UDEs relevant to the change being considered). The KJ Method can also be used to rapidly construct, and complete, a Goal Tree for non-change matrix situations.

Can we quantify the customer needs in the Change Matrix?

As Alan Barnard states: "What if the mermaids, crutches, alligators, and pots of gold all appear to be real and important? In such cases, unless we have a common utility to weigh these against each other, we will be stuck. Unfortunately, in most real life dilemmas where we experience ambivalence, there is no common utility like money to weigh the positives of changing and negatives of not changing (the arguments for making a change) with the positives of not changing and negatives of changing (the arguments against a change)." [Barnard 2016, p.13]

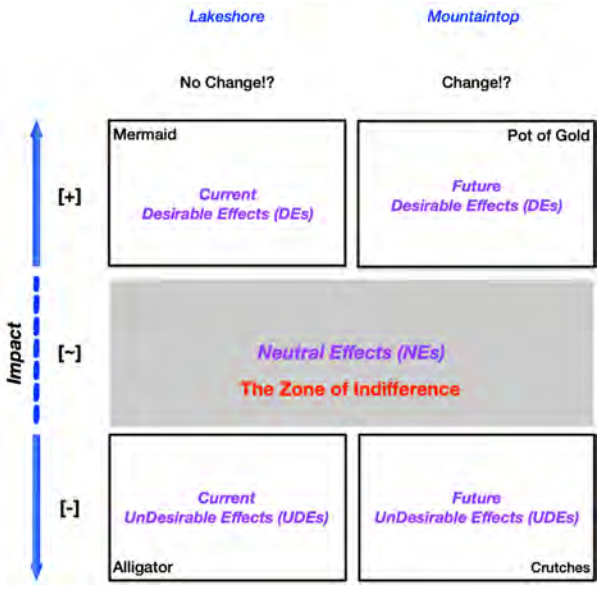
When you need to more carefully assess not just the quantity of DEs and UDEs in a box, or column, but to consider the importance of each, you need a method capable of providing the "common utility" pointed out by Barnard. The quantitative method commonly used to do this by the New Product Development (NPD) community is Thomas Saaty's **Analytic Hierarchy Process** (AHP).[Saaty 1982] The AHP provides a valid and accurate ratio scale measurement of "utility" for individual DEs or UDEs, or between boxes, or between columns. [Zultner 1993] The AHP has been used for this purpose for over thirty years, and is a recommended prioritization tool in the global standard for NPD methods. [ISO 16355-20231]

The AHP can also be used to prioritize just about anything, in any context (including non-change matrix situations). For example, AHP can fill in key gaps in CC PM: how to decide what features to include in a project, how to decide which projects to freeze (or do first) in a multi-project pipeline, how to choose the best portfolio of projects for the pipeline next year, etc. [Zultner 2023]

Does the Change Matrix allow us to focus only on the most important DEs and UDEs?

Yes**.** The vertical impact axis of the Change Matrix only shows significant impacts: *very* Desirable Effects (DEs), and *very* UnDesirable Effects (UDEs). Yet in-between lie the majority of outcomes which neither — they are Neutral Effects (NEs). Such outcomes are "meh", "whatever", or "that's just the way it is" outcomes. They lie in a large "neutral zone" sea of indifference [~] between the extremes of [+]'s and [-]'s. Such outcomes may appear on a CRT or FRT as a logically necessary "statements of fact" or "oxygen" entities.

The existence of a large number of currently neutral, and unimportant, effects was reported by Noriaki Kano [Kano 1984] through empirical studies of customer satisfaction. The **Kano Model** explains why such "indifferent" outcomes cannot satisfy, or dissatisfy, customers. Instead, we should focus on those few effects with the most power to significantly impact our customers [Zultner and Mazur 2006]. The greatest impact comes from providing new Future Reality [+] opportunities, that customers did not know they could have (or did not know were possible), and therefore do not ask for ("exciting quality" in the Kano Model).



Effects: Desirable (DEs), Neutral (NEs), and Undesirable (UDEs)

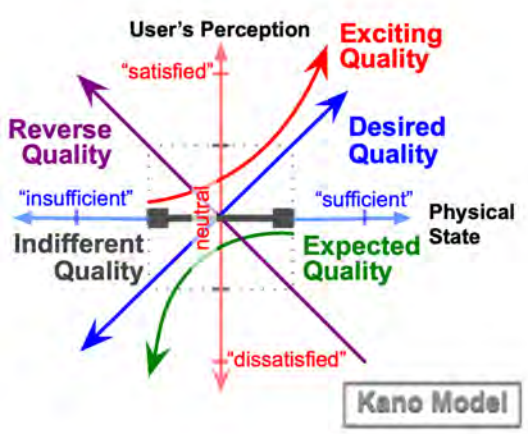
Are there different types of Customer Needs?

Yes**.** Customer Needs (CNs) may be *functional* — external to the customer (pertaining to a customer's situation or "job"). Or *emotional* — pertaining to psychological needs, inside a customer's head. Or *social* — pertaining to the relationship

Copyright © 2022 Richard E. Zultner

between a customer and significant others. And there may be other types of needs, such as *spiritual*, etc.

All three realities ("current", "transition", and "future") of customer needs… may require an exploration of both [+] positive, or [-] negative, Functional, Emotional, and Social Needs. We should understand all the needs a customer is concerned about, on all stages of their journey.



Kano's Model examines the impacts of meeting different kinds of customer needs

What is the 6 Viewpoints Process (6VP)?

This is an extension of the original four-step 4 Viewpoints Process [Scheinkopf 2011], to the 6-box Matrix of Change.
For a specific case where your "good and well intentioned solution was rejected"…

1. Discovery Process: for the customer, client, or colleague you offer the Change to, discover and document their needs, filling in the boxes of a 6-box Matrix of Change:

(**a**) Document the Current Reality. What are their alligators? And their mermaids? Is there agreement on the [=] net evaluation of the Current Reality? Is there a consensus to consider a Change?
(**b**) Has a specific Future Reality been chosen? With what pot of gold? And what rattlesnakes? What is the [=] net evaluation of this Future Reality? Is there a consensus that it would be "worth it"?
(**c**) Has a Transition plan been selected, for the best way to achieve the chosen Future Reality? With what gold nuggets, and crutches? What is the [=] net evaluation of this plan? Is there a consensus that it would be "worth it", and deliver the chosen Future Reality?

2. Why was the proposed Change developed initially? For whom? What needs does it meet? Or not meet?

3. How can the proposed Change be improved to meet more needs? To increase [+] positive DEs ("benefits"), and decrease [-] UDEs ("costs")?

4. How does the proposed Change compare to all other alternatives? And how is that comparison being explained and presented? Are all the needs, being used to evaluate all possible Changes, understood and documented?

The goal in this process is not just to get the other party to "buy in" to your Change. It is to understand what their needs are, and then to see if the Change you initially proposed, can be improved to be the best possible change (superior to all others) for the other party — your customer. A Change they will eagerly embrace — with zero resistance — because it is worth doing, and there is no better solution available (that do a better job of meeting their needs).

How do the 3/5/6 Change Questions fit with the 6-box Matrix of Change?

Eli Goldratt, in his Theory of Constraints approach for system improvement, suggests there are five fundamental questions when considering any change: (note: the first and last questions were added after the original three questions, numbered 1-3)

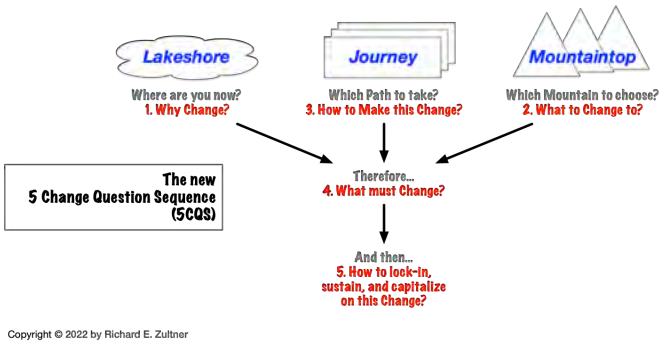
(0) ***Why* Change?** Why consider leaving the current state? How undesirable is it?

(1) ***What* must Change?** The specifics of what would change in the current state.

(2) **What to Change *to?*** What more desirable future state is possible?

(3) ***How* to Make this Change?** What would the transition from current to the chosen future state entail?

(4) **How to *Lock-in, Sustain, and Capitalize* this Change?** The new future state is "better" — how can I stay there? Permanently? And then capitalize on that?



The renovated 5 Change Question model

(5) How to *Leverage* this Change, further?
What is the next jump, from this new base? An additional step, for the ***process of on-going improvement*** (PoOGI). Now that the change has been made permanent, we should consider even further gains. How to improve on an on-going basis, from the now permanent "after change" state? It is especially important to take full advantage of "Go Big" changes, such as from ToC Solutions.

Copyright © 2022 Richard E. Zultner

A challenge in using the first 5 Change Questions, is that they are dependent on the specific context of the customer. A customer with many "mermaids" and few "alligators" may not know, or care, that and even better future is possible — so they don't even consider a significant change (Question 0). And "what to change" (Question 1) may depend on what the customer has decided on — the chosen future state (Question 2). An "alligator" (problem) focused customer wants changes to reduce or eliminate existing serious problems. A "pot of gold" (opportunity) focused customer wants whatever changes will lead to getting the pot of gold (which may not impact their few alligators at all — or their mermaids). A "journey" (experience) focused customer may not require any changes to their current reality — if the journey itself is the reward they want.

The corrected & enhanced 6-box Matrix of Change allows us to examine all customer contexts, and customer needs in those contexts, and help the customer to decide what the best solution is, to best meet their needs. And to choose the best solution, with the best transition plan. Different customers have different contexts, and different needs. So there may not be one sequence of questions, or one Change Model, that will lead to the best solution for all of them, or how to best meet their needs, and provide the best overall value-to-customer.

What other questions do you have?

Copyright © 2022 Richard E. Zultner

The Fundamental Structure of the Theory of Constraints

By Eli Schragenheim and David Updegrove

The Theory of Constraints (TOC) is a pragmatic management theory that leads managers to bring their organizations to significant ongoing improvement without incurring real risk. TOC is based on using the scientific approach (cause-and-effect thinking) to explain the current state and construct robust solutions to improve it. Therefore, every element must be clearly defined, and all ramifications of any action must be evaluated.

This paper's objective is to provide the basic knowledge for novices through experts in specific parts or applications of TOC to understand the wide scope of TOC and its key high-level structure, how its parts interact and how they inspire additional insights that result in this significant improvement for the organization. We think that understanding the way, from very high-level insights that may seem too abstract to be practical, to the much more down-to-earth applications of TOC, will significantly help in expanding the current knowledge to other environments and lead the way for unlimited, yet secure enough achievement of the goal.

We claim that every beneficial insight removes a **limitation**[1] that prevents us from achieving something valuable (more of the goal). Limitations addressed by the Theory of Constraints (TOC) often stem from flawed paradigms or assumptions. Once these limitations, with the untapped value they hinder, and the flaws in the existing paradigm are evident, managers become receptive to exploring fresh opportunities. Successfully challenging common yet flawed paradigms not only overcomes limitations and adds value, but also propels organizations ahead of their competitors still ensnared in the old paradigm. Competition is another limitation we always look to reduce.

Explaining a new insight through the definition of the limitation and its associated flawed paradigms reveals the applicability of the insight, as the scope of the identified flawed paradigm can be wider than the specific limitation we would like to overcome. The potential new value from eliminating current limitations just by realizing the flaw in a common paradigm could be huge.

TOC has challenged several key common paradigms. The main idea behind this paper is to produce an illustrative diagram of TOC's structure, with each concept, tool, belief and insight bringing additional value by itself, and even more by the interaction between them.

[11] Limitation: An act or instance of limiting. Source: Merriam Webster Dictionary www.merriam-webster.com. Many things act as limitations in systems. Although every constraint is a limitation, not every limitation is a constraint. See the definition of constraint in the footnote on page 9

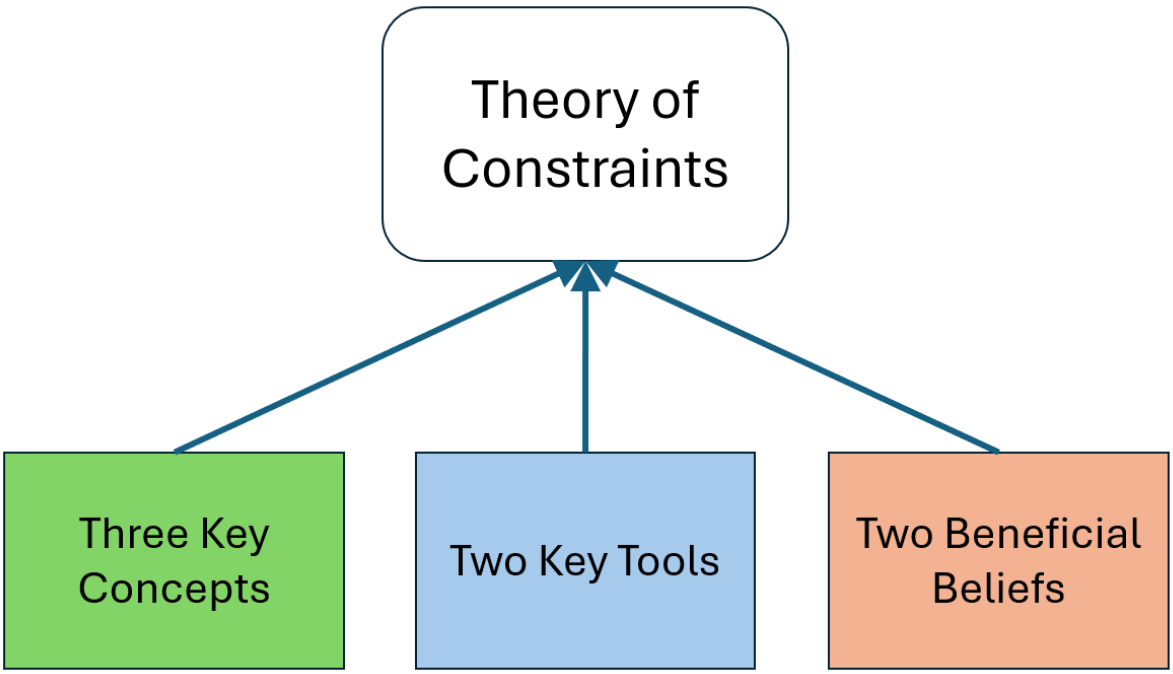
Understanding the seemingly abstract structure of TOC makes it possible for a good practical executive or consultant to quickly reveal new possibilities, practically "translating" the insights that have already proven their value to the reality at hand other types of organizations.

We believe there are seven fundamental qualities inherent to systems that TOC builds upon. These qualities, and how they interact and lead to more detailed lower-level insights and tools are not always obvious and need to be clearly detailed. Standing on the shoulders of giants such as Isaac Newton and leading the way for others, Dr. Eli Goldratt has applied clear thinking and the scientific process to discover them. Following his lead, we have broken down the seven qualities as follows:

1) Three key concepts that address the three fears of every manager: complexity (Inherent Simplicity), uncertainty (Inherent Uncertainty), and conflicts (Inherent Consistency).[2]

2) Two key tools (Inherent Causation and inherent Valuation).

3) Two beneficial beliefs (Inherent Potential and Inherent Goodness).



[2] These three fears are first referenced in Dr. Eli Goldratt's unfinished manuscript, "*The Science of Management*".

Drawn from these seven core qualities, we have further identified three resulting breakthrough insights (Inherent Focus, Inherent Control, and Inherent Value from Innovation). Each of these seven qualities and the three breakthrough insights overcome one or more limitations in our systems. It is anticipated that in the future, many more TOC insights and applications will be analyzed in the same way, and probably lead the way for new insights entering the TOC body of knowledge.

The Theory of Constraints has since its inception been evolving. By the time of his death in 2011, Dr. Eli Goldratt had identified four of the concepts and beliefs noted below as "The Four Pillars" of TOC. These four are Inherent Simplicity, Inherent Consistency (Every conflict can be removed), Inherent Goodness (People are Good) and Inherent Potential (Never Say, 'I Know').

In his 2021 paper "The TOC Pillars", Humberto R. Baptista contributed new terminology to three of the four pillars and added a fifth, "Inherent Tolerance". We have included it here as "Inherent Uncertainty", which we think is a more encompassing and descriptive term.

Although we are not insisting on the entities herein being described as pillars, this paper, remaining consistent with the concepts and tools described, presents an updated view.

The concepts, tools and insights are not presented here in the order they were introduced over the years. However, the thinking processes were already present and in operation at the time each was introduced.

Three key concepts – that address three fears of every manager (complexity, uncertainty, and conflicts)

To create a diagram originating from the most important flawed paradigms (limitations), we've started with the three key concepts, along with the first two breakthrough insights.



Inherent Simplicity[3] addresses the fear of complexity. Consider the following statement:

Human organizations cannot afford to function in too much true complexity because their clients demand a minimum level of reliability from their delivery of value. Organizations that cannot reach this level of reliability will naturally collapse into bankruptcy.

If we accept this statement, it reveals the following limitation:

Being unable to predict the consequences of an action or imposed change well enough.

This failure to predict consequences vastly reduces the quality of decisions.

Flawed assumption: It is a generally accepted assumption that ***Reality is complex***. From the perspective of managing organizations, this means every manager must be truly brilliant to consider all the variables that might impact the system, and even more so to predict their outcomes. Without being able to predict the outcome of every decision, the reputation of the manager is endangered, and possibly his or her future career.

[3] Inherent Simplicity: The concept that nature is simple and harmonious with itself. One of Goldratt's original Four Pillars. Source of the term: *The Choice*, Chapter 4, Eliyahu M. Goldratt, North River Press, 2008. Goldratt believed this concept could be extended to human systems, e.g. organizations.

The second key concept, while different, acts in many ways together with Inherent Simplicity. This is the concept of Inherent Uncertainty.)

The point is that complexity and uncertainty interact together to create a system that must be simple enough to allow for not just being able to predict the total impact of an action on the system, but also to be able to assess the boundaries of the resulting impact due to the uncertainty. We'll discuss the interaction in more detail when we come to Inherent Uncertainty (see page 10). For the time being, let's discuss how what looks like a complex system is actually quite simple.

Whenever we want to remove a limitation, we should first understand how that limitation is handled today. But even before the limitation and the flawed assumption behind it are fully understood, clever people will find a way to deal with it (reduce its complexity; make it more manageable).

Therefore, the seemingly complex system is artificially divided into subsystems, assuming, 1) each subsystem is much less complex, and 2) this can help predict the local impact of any change. Managers hope that optimizing local systems will result in good enough predictions regarding the impact of their decisions on the global system.

This may provide some control, but it has demonstrably limited effectiveness. The quality of decisions is still inconsistent, and serious undesirable effects remain.

For example, Sales decides to announce a 'sale' of a specific product family in the first week of next month. They predict that sales of the chosen products will increase by 100% in the near term and cause future sales of these products to remain up by 5% after the sale is over (and the products return to their current list prices).

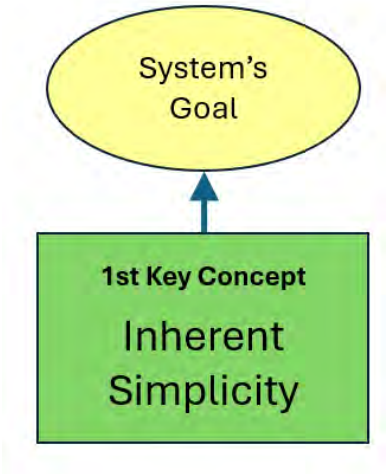
What might happen is that sales for this product family do indeed increase (a victory for the product line's sales team), but sales of other company products decline sharply. The reason is that Production has had to support Sales' emergent planning to create enough inventory for the product line on sale. In this scenario, Production gets this information at the last minute. This could disrupt the manufacturing of other products, making many of them late, and causing stockouts in the stores. Is there any logical connection between the decision of the Sales Department and the difficulties of Production? The answer is, yes, of course.

Requiring a subsystem (say the Engineering Department), to achieve its highest efficiency, without considering other departments, is a huge mistake that blocks innovation. Admitting that we are not certain at that moment of the root cause of our undesirable effects is much better, as it points us toward systemic thinking – to identify the system's *Inherent Simplicity* and lay out a causality map, eventually being able to come up with a working solution.

Treating our current reality as complex hinders us from making the effort to identify the *few variables* that significantly impact the consequences of any action or change, giving us leverage over the system.

Another negative effect

In an environment where every subsystem is expected to achieve maximum performance, the organization acts like it has a hundred (or a thousand) goals. The insight of Inherent Simplicity is profound, leading us to have to clearly verbalize the Goal of the entire System, otherwise, the ability to predict whether a decision would enhance the goal is impossible to make.

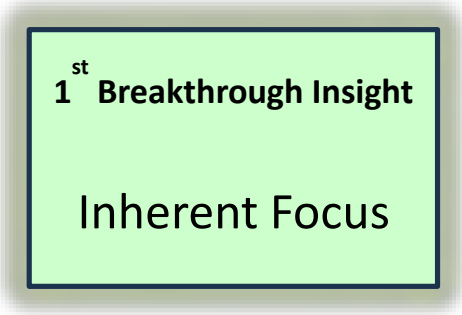


NOTE: Throughout this document, whenever arrows are depicted in drawings, it indicates the progression or flow of knowledge leading to the logical application.

Whether the topic is politics, the world economy, a war in Europe or the Middle East, or a social problem, we all hear too often that the "situation is complex, and there are many causes for it." This is not only wrong, but it is also a damaging statement because it doesn't lead to further efforts to identify the real core cause. We should first seek the Inherent Simplicity in any situation.

Summary

Inherent Simplicity – All systems (for instance, organizations), despite their apparent complexity, are inherently simple.



With Inherent Simplicity pointing us toward a systemic goal and the identification of core cause(s)of problems, it becomes apparent there should be an effort to distill or zoom in on specific areas of the organization. Continuing in this way of thinking leads us to our first breakthrough insight, Inherent Focus[4].

Limitation: **Being unable to focus on what is truly important for maximizing the performance of the organization**, failing to achieve significant and stable improvement toward the system's goal.

Flawed assumption: We are subject to many problems and constraints that shift all the time.

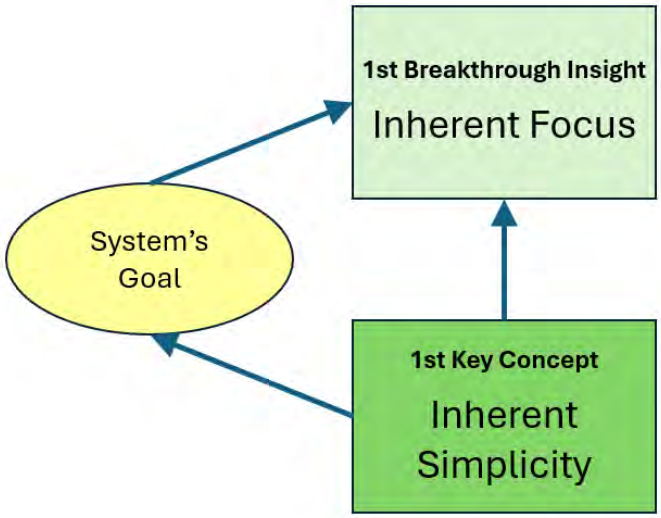
This assumption leads managers to try to make each part of the system more efficient, thinking that if each part of the system is efficient, the entire system will be more efficient. But cause-and-effect analyses prove that this assumption is also incorrect.

Many improvements in various areas have a very minor impact or no impact at all on overall performance. In fact, they may even introduce harm to the system – whereas improvement at the true constraint greatly improves the performance of the entire system.

Example of following the flawed assumption: Implementing policies driving local improvements.

[4] Inherent Focus: All systems have one or a very few constraints that determine their overall performance. Once the system's Inherent Simplicity is identified, we can more easily use cause-and-effect analyses (and other methods) to find them. Source of the term: the authors, 2024.

Inherent Simplicity and the identification of a systemic goal lend themselves to pointing to where the **FOCUS** of managers should be directed. What should we focus on?



Every organization has one, or a very few, constraints that determine its overall performance. Inherent Simplicity leads the way to identifying the few variables that truly impact our ability to achieve the goal. This provides an opportunity to focus management attention on what limits the generation of value.

Many managers believe that they need to focus on every emergent issue (today's fires). However, without understanding Inherent Simplicity, finding the right focus is almost impossible. Thus, too many managers lose their focus as problems and their seemingly small possible improvements consume their attention.

We can maximize the performance of any system by identifying its constraint(s), deciding how we can best exploit them, subordinating everything else to this decision, and getting more constraint capacity when necessary.

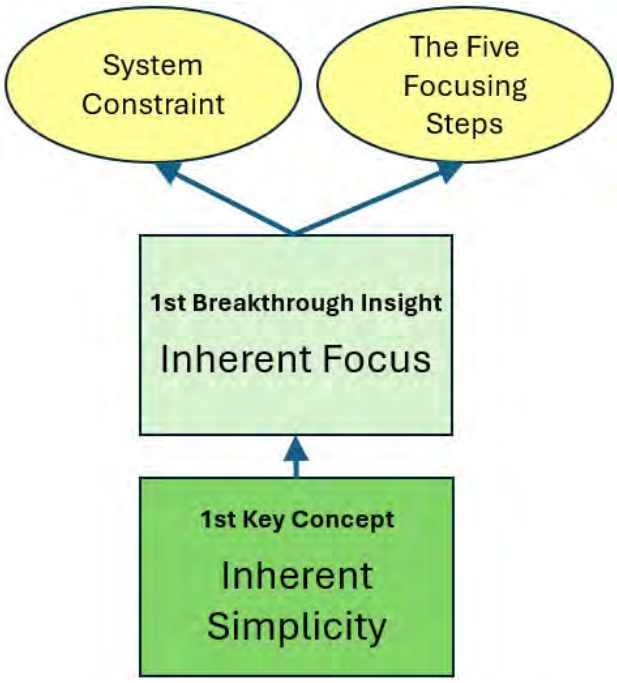
Focusing also means knowing what *not* to focus on at present. We all are constrained by the capacity of our attention. Thus, to focus on what is truly urgent and important, we should learn not to spend our limited capacity of attention on what clearly should not be in focus.

A secondary flawed assumption resulting from the above:

If we can make each part of the system more efficient, the entire system will be more efficient.

The effect of this thinking is that there may be many gains in efficiency in areas that have little or no impact on overall performance. Conversely, improvement at the true constraint greatly improves the entire system's performance. All the other resources should do their best to support the exploitation scheme of the constraint, which should always include meeting all the commitments to the market. Actually, the existing market demand should be always regarded as a constraint that requires subordination to the commitments that have been made. Still, an internal capacity constraint requires an exploitation scheme to determine what can safely be committed to the market.

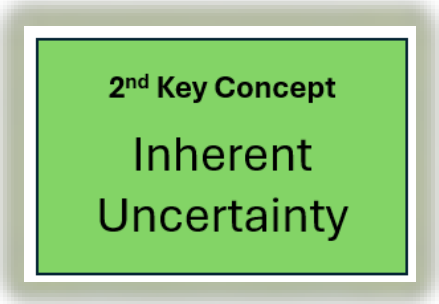
This insight brings light on the creation of two principal revelations of TOC: the necessity of identifying the system's constraint[5] and a set of focusing steps to deal with it.



[5] Constrain*t* – The factor that ultimately limits the performance of a system or organization. The factor that, if the organization were able to more fully exploit it, more effectively subordinate to it, or increase its capacity, would result in achieving more of the goal. Source: TOC Dictionary, Second Edition, 2012.

Summary

Inherent Focus: All systems have one or very few constraints that determine their overall performance. We can maximize the performance of any system by identifying its constraint(s), deciding how we can best exploit it/them, subordinating everything else to this decision, and getting more constraint capacity when necessary.



The Inherent Uncertainty[6] (fluctuations) within our systems interacts with the seeming complexity of our environment. Even when inherent simplicity means focusing on just one internal constraint, yielding an effective exploitation scheme, the reliability of our commitments might still be disrupted. Promising reliably might be compromised because of the possible accumulation of several routine delays. Any plan that seemed good at the time the plan was created might be too unsafe due to the random accumulation of common delays.

Limitation: We cannot systematically meet all our commitments to the market, including deciding when and what we can commit to market demand.

Flawed assumption: Optimal planning should take full advantage of all the available capacity and capability, offering perfect delivery on time and in full.

This assumption regarding the objective of planning comes from a conflict between maintaining full reliability and cutting the cost of capacity, assuming both are equally needed for financial success. The flaw is that in utilizing capacity in full, actual cost is not significantly reduced, because most resources don't need all their available capacity to cover demand. On the other hand, extra (protective) capacity is (absolutely) needed to ensure reliability.

The flawed assumption also explains the desire to measure the performance of every resource, in order to exploit its available capacity.

[6] Inherent Uncertainty: All human-based organizations experience variation and uncertainty. Reacting to incidental occurrences ends up amplifying variability. Planning and execution must explicitly account for common and expected uncertainty with simple mechanisms, and we should react to only extraordinary ones. Don't optimize within the noise. Source of the term: the authors, 2024. Modified from the term "Inherent Tolerance" defined and coined in the TOCICO New Knowledge paper "The TOC Pillars" by Humberto R. Baptista, 2021 https://www.tocico.org/general/custom.asp?page=TOCBodyofKnowledgeTheTOCPillarshttps://www.tocico.org/general/custom.asp?page=TOCBodyofKnowledgeTheTOCPillars

Following the flawed assumption

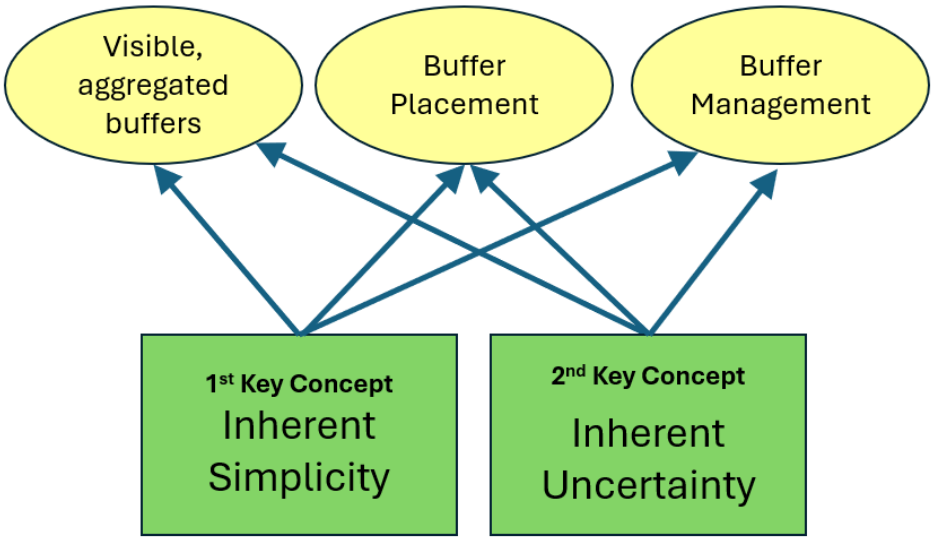
Human beings are aware of the noise in systems and include buffers in their behaviors. For instance, many people take extra time when they go to the airport, considering the possible fluctuations in traffic. However, the culture of organizations values optimization. They ignore uncertainty by relying on one-number forecasts, often turning them into targets that become officially what the organization, and the responsible manager, should achieve. The behavioral reaction is adding hidden buffers to every task, in addition to their forecasts and targets, and to make sure they never miss the target.

The essence of the flawed assumption, that we need to fully utilize all available capacity, has huge practical ramifications, the worst of which is to ignore common and expected uncertainty.

Note that both Inherent Simplicity and Inherent Uncertainty interact with each other because if high utilization of the capacity of every resource can be relaxed then Inherent Simplicity can be achieved, where one resource can be loaded almost to its limit, while the protective capacity of all other resources allow the required flexibility to keep promises intact.

Realizing this flawed assumption, it is now possible to remove the safety embedded everywhere and use **visible, aggregated buffers**, placed at critical points where the protection mechanism must be in place, like at delivery itself.[7]

Another insight is Buffer Management, which creates a priority list for the people in the execution phase.



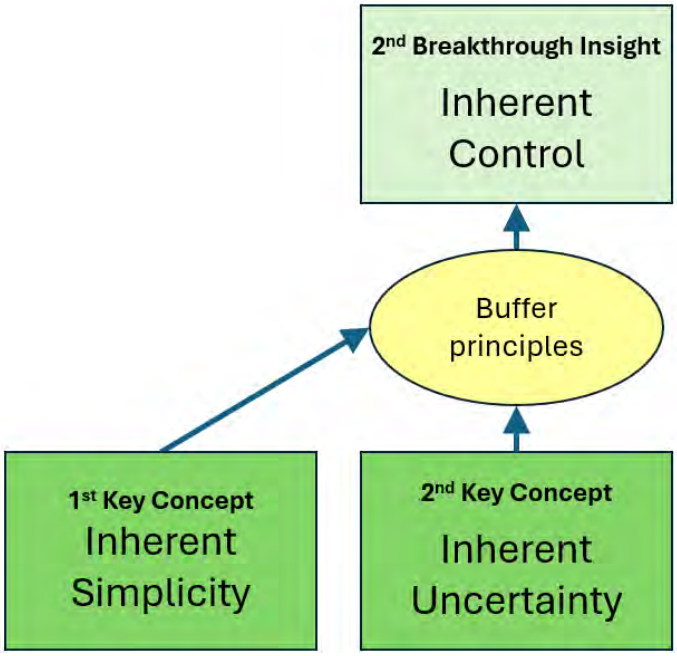
[7] Shipping buffers in production, project buffers in projects, etc.

Summary

Inherent Uncertainty: Our reality is highly impacted by variability and other forms of uncertainty, which makes it tough to guess what we have to do to meet all our commitments to the market. Use buffering to account for common variations. Don’t optimize within the noise.



Realizing the power of these concepts, we now understand we have additional capabilities. Inherent Simplicity and Inherent Uncertainty can be correlated to provide us with a huge benefit beyond simple buffering: Inherent Control[8] is our second breakthrough insight.



Inherent Uncertainty and Inherent Simplicity together reveal the need for protective capacity and lead the way to the use of time and stock buffers at the appropriate locations. But common

[8] Inherent Control: Given that Buffer Principles can handle most but not all uncertainty, Inherent Control means the system can quickly identify signals that point to the possibility of an emerging threat to an important objective and be able to take corrective steps in time. Source of the term: the authors, 2024.

and expected uncertainty still might prevent, from time to time, truly excellent delivery performance.

Limitation: Even with buffers protecting delivery dates, arbitrary accumulation of delays sometimes hurts truly excellent delivery performance.

Arbitrary accumulation of load on the capacity constraint could lead to pressure causing unavoidable delays.

Flawed Paradigms

1. Prioritizing work orders is a complicated mission, considering the size of the order, the importance of the client, and the efficiency considerations of the work centers.
2. Peaks of load on many work centers force frequent re-consideration of what to do next.
3. We do the best we can considering the complexity.

The direction of overcoming the first flawed paradigm is to measure the actual consumption of the time or stock buffers and prioritize accordingly. This is the essence of Buffer Management[9].

Overcoming the second flawed paradigm requires effective control of the load on the constraint. This is called Planned Load, and it is measured by the number of hours of work required to process all the already planned work orders for that work center.

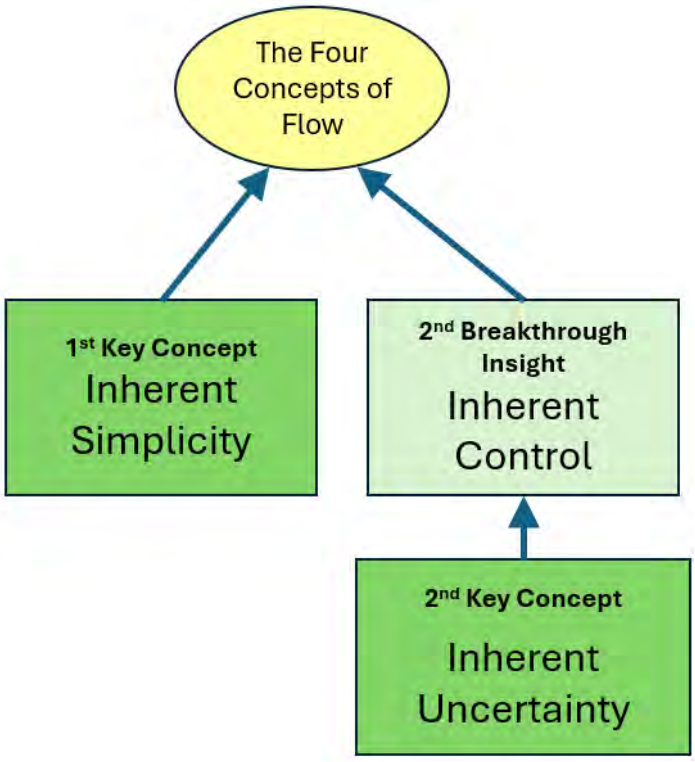
When the planned load grows, it can threaten commitments to the market. Thus, a limit for planned load is required: any real risk of being unable to meet all commitments should be determined a priori. When the limit is approached, Sales should take steps to restrain demand, reduce the level of commitment to the market (e.g. increasing quoted lead times), or Production should find ways to increase the capacity of the constraint.

Eventually, two elements are critical for having full control of the flow to customers.

1. Buffer Management, including a clear single priority scheme to decide what to do next (and to keep the number of red orders under control).
2. Planned Load, which is an effective capacity measurement that points to whether a lack of capacity at the weakest link might create pressure, even chaos, in delivery performance, allowing taking timely steps to face the situation in good control.

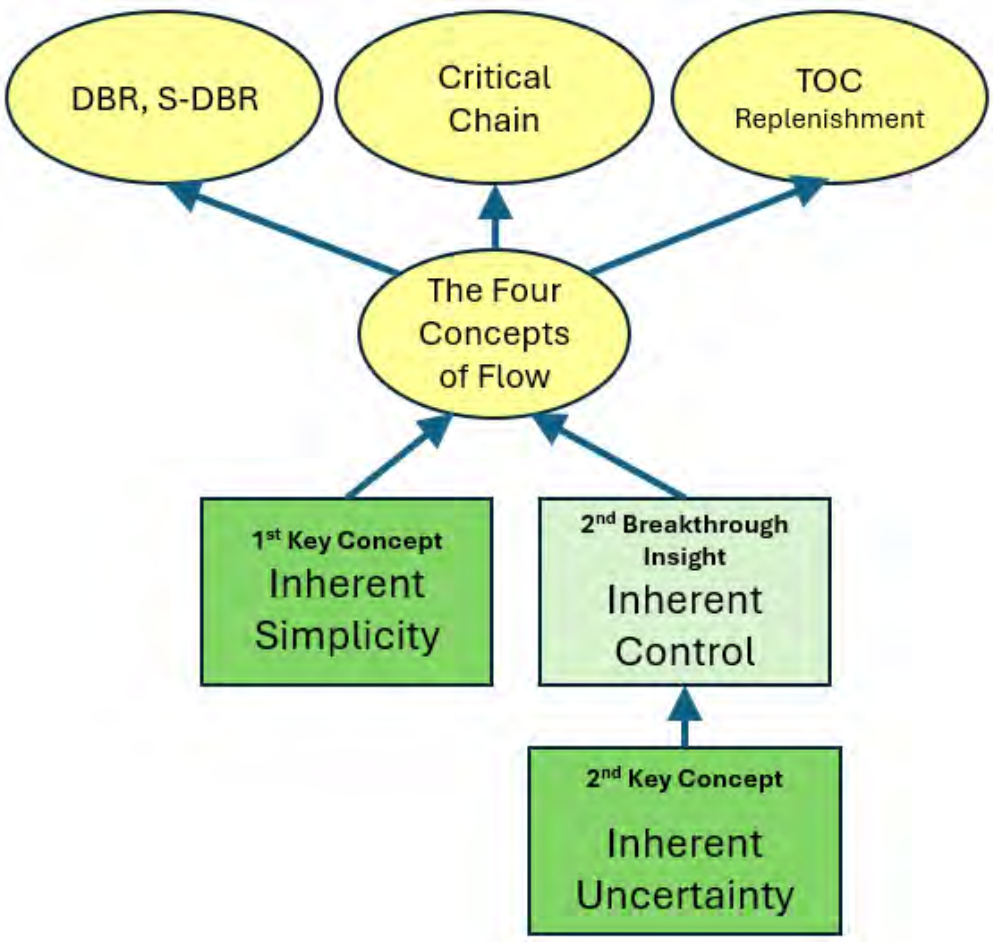
[9] In order not to go into minute detail, the consumption of the buffers is divided into three equal parts: Green, Yellow and Red. Yellow, meaning the buffer has been consumed more than 33% and less than 67%, is more urgent than Green. Red, meaning the consumption is higher than 67% of the buffer can require special treatment, e.g. expediting.

Once we understand the faculty for control in our systems, there is a need to define the various types of controls required for different flow environments. Dr. Eli Goldratt described the guidelines for these controls in The Four Concepts of Flow[10]:

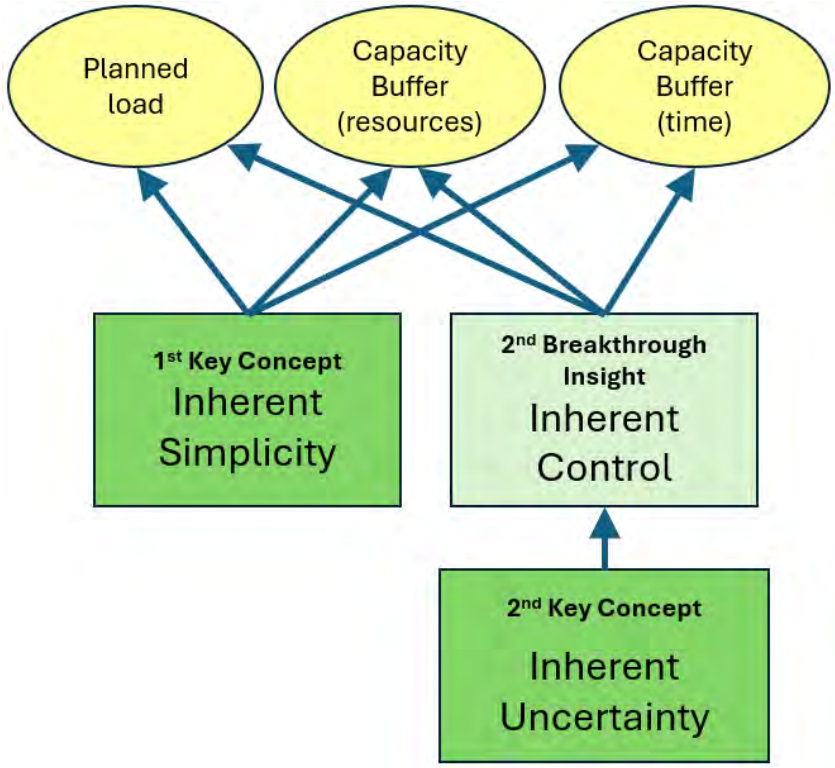


Applying the Four Concepts of Flow, the three main applications of TOC: DBR/S-DBR, Replenishment and CCPM were able to be created, impacted by the need to control statistical fluctuations, which are part of common and expected uncertainty. Within these applications, the use of visible buffers as part of planning is rooted in.

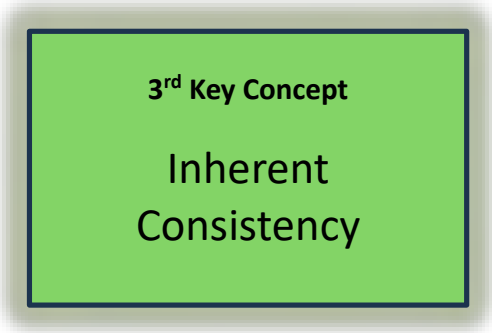
[10] The Four Concepts of Flow: 1) Improving flow (or alternatively lead time) is a primary objective of operations 2) This primary objective should be translated into a practical mechanism that guides the operation when not to produce (prevents overproduction) 3) Local efficiencies must be abolished 4) A focusing process to balance flow must be in place. Standing on the Shoulders of Giants, Eliyahu M. Goldratt, 2008. http://www.tocico.org/page/StandingontheShouldersofGiants?&hhsearchterms=%22standing+and+shoulders%22



The two key concepts and breakthrough insight are also the path to planned load in production, and capacity buffers in production (resources) and project management (time between drum utilization events).



Summary: **Inherent Control –** Effective priorities for meeting all our planning objectives can be generated from building on the foundation of Buffer Management. Closely monitoring the Planned Load of the weakest link provides management with warnings of possible chaos resulting from excessive demand, even before Buffer Management shows too many red orders.



Inherent Consistency[11] addresses the fear of conflicts.

> **Similarly, for mathematics and logic: to the extent that they are used in describing the universe and science, they cannot contain any contradictions. There is, however, a place where contradictions do occur: inside the human mind. We are all fraught with contradictions; we desire contradictory things; we believe contradictory ideas; and we predict contradictory events. –** Noson S. Yanofsky, *The Outer Limits of Reason*

This statement above, drawn from Isaac Newton and others, is based on the Scientific Approach that strives to achieve perfect consistency. (You can substitute the word *conflicts* for Yanofsky's *contradictions* without changing the meaning).

This is a difficult task, even for science, where Quantum Theory includes cases where there are two seemingly conflicting ways to describe reality. The belief remains, however, that this is a misunderstanding, and in the future, all such inconsistencies will be rectified.

The abstract concept should still be used to solve practical conflicts. It can be tough, but these efforts can have a considerable impact, leading the way for challenging our hidden assumptions and coming up with innovative ideas that might generate a decisive competitive edge.

The conflict mentioned above, between improving sales through significantly more reliable delivery performance and reducing costs by achieving high resource utilization is a prime example. To resolve this, we must recognize that due to Inherent Uncertainty, fully utilizing all resources is unrealistic. Instead, focusing on the weakest link—the constraint—proves highly valuable.

Reliability can be achieved by having sufficient protective capacity at all non-constraint resources, planning appropriate visible buffers, and employing buffer management and

[11] Inherent Consistency (Harmony): There are no conflicts (or inconsistencies) in reality. Every conflict can be removed. One of Goldratt's original Four Pillars. Source of the term: TOCICO New Knowledge paper "The TOC Pillars" by Humberto R. Baptista, 2021

Planned Load. Thus, instead of having both minimally effective cost optimization and mediocre delivery performance, we can solve the seeming conflict ('evaporate the cloud' in TOC terminology), securing both reduced costs and much better delivery performance – well above that of the competition. This situation also allows for quoting higher prices and achieving higher net profit (NP).

Limitation: Having to compromise between two conflicting actions, where each action is needed to satisfy a necessary condition for achieving a desired common objective.
By compromising we get significantly less value for the desired objective.

Flawed assumption: *We know and accept our perception of "reality."* Every perception of reality is based on many (often hidden) assumptions. It is possible that challenging just one assumption and calling attention to a situation where that assumption is not valid opens the way to getting much more of the common objective.

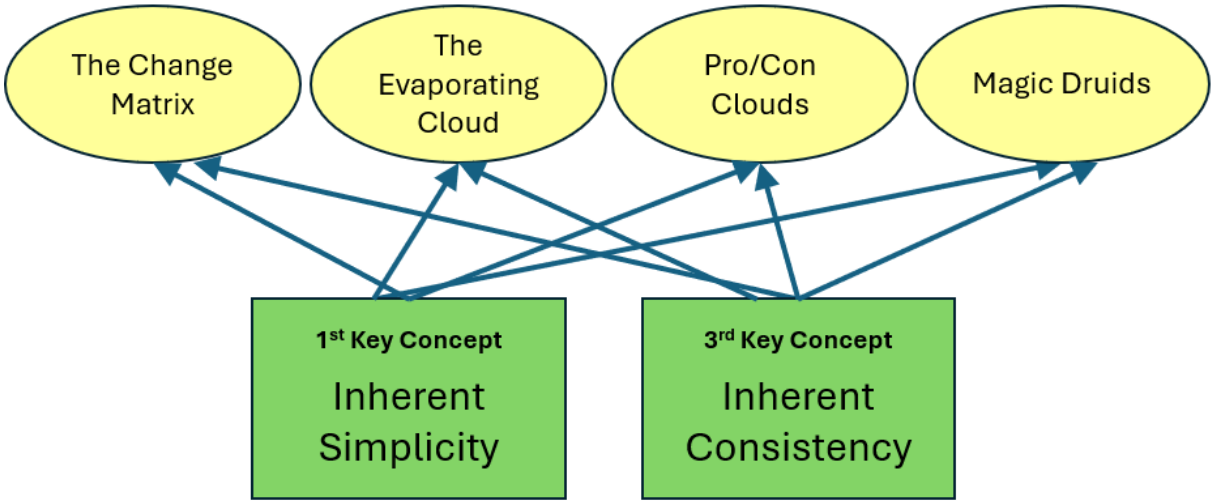
- The perception of a "conflict" should trigger us to reveal our assumptions and then look actively for a valid (realistic) way of challenging them.
- The generic insight of having no conflicts in reality should trigger us to check carefully all our assumptions, to create ways to solve, or 'evaporate' the conflict.

Another example of a conflict due to a flawed assumption

The seesaw conflict of holding less inventory to lower investment and carrying costs, versus holding more inventory to ensure availability to the system, with both being claimed to generate more value.

The flawed assumption ignores Inherent Uncertainty in achieving "optimal stock levels." Once the variability in both demand and supply is fully recognized, a visible stock buffer logically becomes necessary – preventing the oscillating behavior of promoting more inventory and less inventory. It is also clear that it makes no sense to continually adjust the size of the stock buffer, as there is no way to be accurate. Only when there is a clear signal that the buffer is much too high or much too small should a change to the buffer be made.

Inherent Simplicity and Inherent Consistency have been combined to create tools within the TOC community that enable conflict resolution.



Summary

Inherent Consistency (Harmony): There are no conflicts (or inconsistencies) in reality. All conflicts exist only in our minds. One or more invalid assumptions produce any perceived conflict (or inconsistency). *Every conflict can be removed.*

Two key tools



Inherent Causality[12] refers to cause-and-effect relationships within systems. Laying out a way to logically analyze the causes behind usually undesirable effects, as well as to predict future effects from actions, is a basic major tool of TOC. The more sophisticated tools, all based on the system's core capability, include identifying the core problem which is preventing much better success in achieving the Goal.

Limitation: Being unable, by using human intuition alone, to properly diagnose core problems, meaning that solving them would significantly enhance the performance of the entire system, and even when a good diagnosis has been made, finding the right effective solution, and being able to implement the solution.

Flawed assumption: Using logic is too cumbersome, subjective, and difficult to make it effective in finding answers. In fact, a few simple, learnable logical tools can greatly enhance analysis and provide answers to important questions.

Example of following the flawed assumption: Attempting to independently solve undesirable effects (symptoms) in the organization without considering root cause(s)

Keeping the goal of the system continually in mind, these are the key three questions that every manager should constantly ask.

[12] Inherent Causality: All systems, including human systems, are subject to cause-and-effect relationships. From this causality, we can trace back to core issues generating many undesirable effects. Likewise, we can map out an alternative future reality including, in advance, identification and mitigation of new problems generated by otherwise positive changes. Source of the term: the authors, 2024.

1. *What to change?* This means diagnosing what limits current performance. This is more than identifying the physical constraint. It is identifying the key flawed assumption that causes a core problem preventing any effective improvement.
2. *What to change to?* Or, coming up with an effective solution that would clearly improve performance.
3. *How to cause the change?* Creating an implementation plan that overcomes all likely obstacles, including people resisting the change.

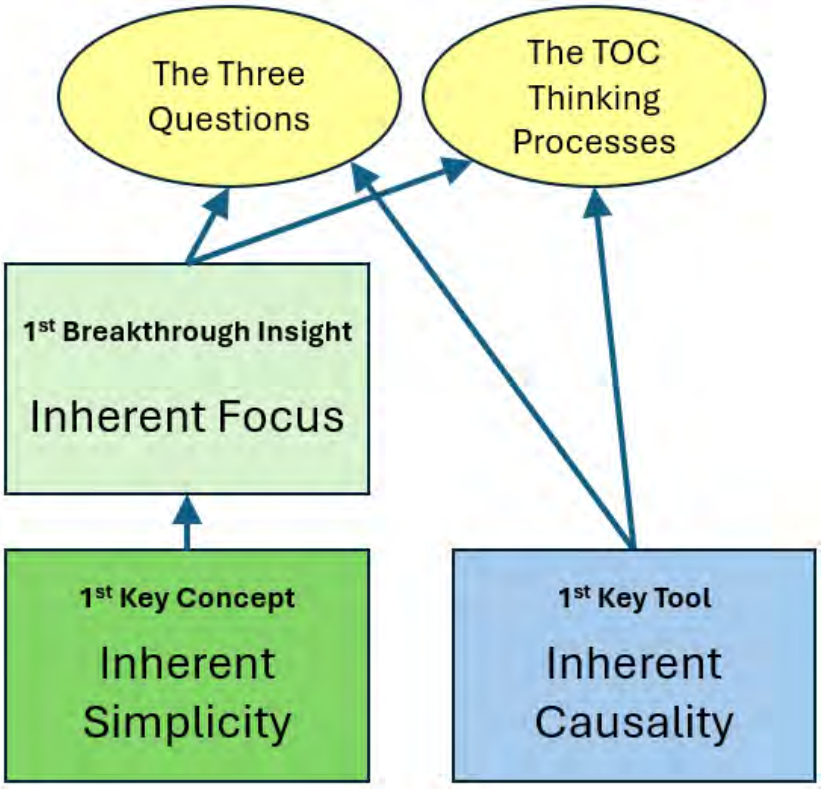
The Three Questions[13] define the ongoing need of every manager to always look for significant improvements and be able to achieve them. Inherent Causality gives the manager a working tool to come up with the right practical answer. Answering these questions requires the use of careful logical analysis, without which might disrupt the good intentions of striving to improve the performance of the system. Without the Inherent Causality tools, answering the three questions based just on intuition could easily lead to a considerable failure.

Goldratt, along with others, made significant contributions to the field of Inherent Causality. One of these contributions is the Current Reality Tree (CRT), which describes a system's current state showing the root cause(s) leading to all the undesirable effects. Following the CRT, we have the Future Reality Tree (FRT), which maps out cause-and-effect relationships to achieve desirable effects in a system (while preventing new negative effects). Another tool is the Prerequisite Tree (PRT), which outlines how to overcome obstacles on the way to achieving an ambitious objective. There is also the Transition Tree (TrT) where the way to lay out detailed steps to an intermediate objective and/or convince somebody else of one's position/proposal is carefully outlined. The Transformational Strategy and Tactics tree is a powerful tool for presenting all the logic answering the three questions, including an effective way to implement the change.

Together with the previously noted Evaporating Cloud, these trees comprise what is now known as the TOC Thinking Processes.

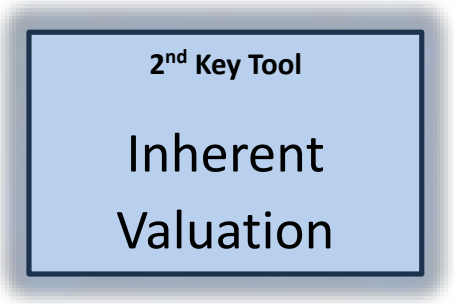
A special important related tool is the Categories of Legitimate Reservation. Eight rules define how to challenge a claimed causality. They are Clarity, Entity existence, Causality existence, Predicted effect existence, Additional cause, Effect Reversal (House on fire), Cause insufficiency, and Tautology. The objective is to focus the discussion on logical analysis: what exactly are we trying to challenge? It forces clarifying the logical arguments and provides a way to verbalize the claims convincingly. When someone is not convinced, he/she should make the effort to point to the relevant category of reservation and then verbalize the challenge.

[13] Later expanded to Five Questions 1) Why Change? 2) What to Change? 3) What to Change to? 4) How to Cause the Change? And 5) How to Measure and Sustain the Change? Source: TOC Dictionary, Second Edition, 2012.



Summary

Inherent Causality: Systems are subject to cause-and-effect dynamics. To understand and manage a system, apply rigorous cause-and-effect logic, governed by the Categories of Legitimate Reservation, which allows effective criticism that is logical rather than emotional.



The second key tool of TOC is Inherent Valuation.[14]

There is a clear need to define the "goal units" of an organization. For a non-profit organization this can be quite a challenge. It can be done, but a lot of thought should be given about how to get a reliable measure. The condition for a 'good enough' answer is checking whether the goal unit can be reliably used to compare this year's performance to the previous.

In what seems to be the simpler case, for commercial organizations, where the goal is making more money now and in the future, there are clear problems in finding the best product mix or deciding on taking or rejecting a market opportunity.

The key performance measurement for commercial organizations is net profit before tax (NP). The question of how to evaluate the impact of taxation rules might get different answers in different countries, so we won't deal with that aspect here. While NP is a good enough measurement, the true challenge is looking for a measurement that can identify the real contribution of a proposed action to NP.

Limitation: It is very complicated to predict the financial impact on net profit for a suggested action. While the principle, *net profit equals revenues minus expenses* still holds, when it comes to evaluating a specific action or transaction there is huge confusion. Without a well-accepted, common-sense rationale (a simple enough procedure), managers might be afraid to rely just on their intuition.

A currently common tool to evaluate the impact of a sale on NP is having the financial department calculate the cost-per-unit of every product to be sold. The problem is that this process, while very simple to use, is *definitely wrong*, leading to a distorted idea of the true impact of a sale on NP.[15]

[14] Inherent Valuation: Understanding the goal of the organization, its goal units, and the non-linearity of the cost of required capacity gives us the ability to measure the generation of value much more accurately. Source of the term: the authors, 2024.
[15] Throughput Economics, p21, by Eli Schragenheim, Henry Camp, and Rocco Surace, Routledge/Productivity Press, 2019

Flawed assumption: Not distinguishing between linear and non-linear behavior.

While revenues behave mostly in a linear way, as do the cost of materials, the cost of the required capacity of various resources usually does not.

Making the distinction between linear and non-linear, while keeping sight of overall financial performance is the essence of Throughput Accounting. The term Throughput (T), defined for commercial organizations is the periodic summation of revenues minus truly variable costs – which includes the cost of materials plus, possibly, commissions and other expenses that vary with every unit sold. Two other financial measurements are Operating Expenses (OE) and Investment (I). Both express the money required to sustain the business. However, the prime measurement for management to focus on is T per period, which expresses the added value generated by the organization for that period.

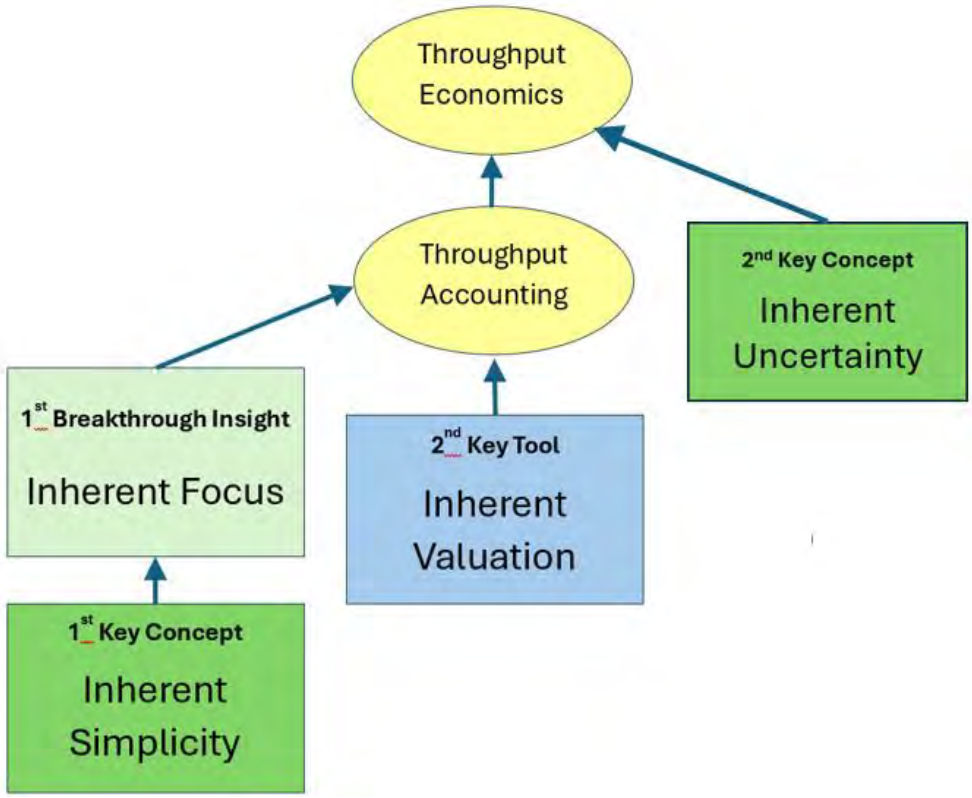
Subtracting truly variable costs from revenues (resulting in Throughput) and considering the non-truly variable expenses as Operating Expenses allows us to make decisions that will increase net profit.

Example: When an airline gives a free ticket to a frequent flyer (after ensuring there are unsold seats on the flight), what is the actual cost to the airline? The simple answer: no extra cost on top of the regular cost of the flight. One could argue that extra passengers would minimally increase fuel consumed and add a small allotment of snacks and beverages. However, this extra cost is so low that for practical purposes it can be considered zero.

Throughput Accounting is a special TOC application that challenges cost accounting practices, including those of Activity-Based-Costing.

Throughput Economics is a new application, stemming from Throughput Accounting to be used for a higher level of decisions, which also considers Inherent Uncertainty.

Operations, Project, and Replenishment Planning have been grossly negatively impacted by cost accounting’s flawed assumptions. All have been now updated according to Throughput Accounting's new understanding.



Summary

Inherent Valuation: *There are two critical questions concerning inherent value:*

1. *How should we evaluate how much the organization has achieved of its Goal? In other words, what are the key performance measurements of generated value for the organization?*
2. *How can the organization significantly increase its perception of value to the market?*

The basic conclusions from Inherent Valuation provide performance measurements. We can apply this understanding to using innovation to significantly increase perceived value. (see Inherent Value from Innovation below).

1st Beneficial Belief

Inherent Potential

Inherent Potential[16], named originally by Eli Goldratt as "Never Say I Know," covers even more than the already huge insight that there is no limit to our potential, as we can always achieve much more. "Never Say I Know" is a great instruction to open our eyes to what *we know we don't know*. Inherent Uncertainty already helps us recognize what we don't know. Let's focus here on extending our efforts beyond our comfort zone, where we (wrongly) feel "We Know," and put efforts forth to see the huge potential ahead.

Limitation: Success leads, many times, to recency bias and inertia that limit searching for more opportunities.

Success is a great example of how good things could become also a limitation, causing negative consequences, which we should be careful of.

Flawed assumption: *"I've made great improvements and am successful enough – there's no need for more, and there is no secure way to achieve more."*

Handled properly, the opportunity is huge and can be achieved safely. There are ways to check the risk, significantly reduce it, and then add buffers to reduce the probable damage even more.

The flawed assumption causes the inertia that is nicely described as "i*f all you have is a hammer, everything looks like a nail."*

While a very big part of TOC deals with improving flow to customers, this belief looks deeply into how to increase value, and the perceived value, to current customers, or to actively look to deliver value to new customers.

[16] Inherent Potential: Every system, no matter how successful, can be significantly improved. Even the sky is not the limit. The higher the base, the higher the jump. Never say, "I know." One of Goldratt's original Four Pillars. Source of the term: TOCICO New Knowledge paper "The TOC Pillars" by Humberto R. Baptista, 2021

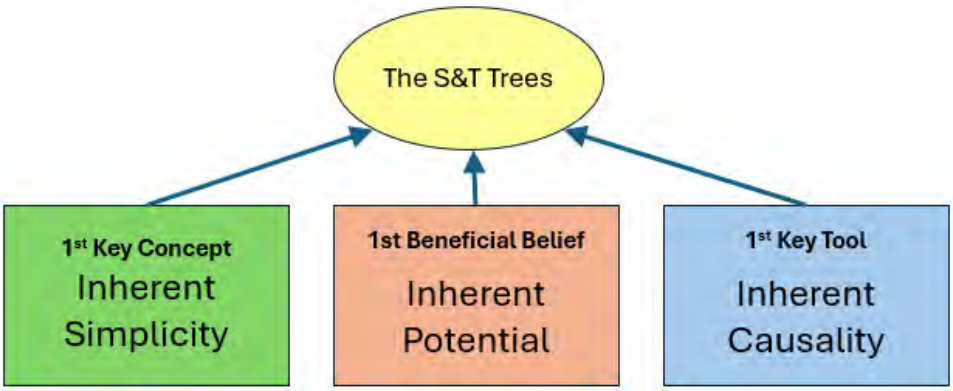
Examples of following the flawed assumptions

1) Thinking that since you are better than you used to be, there is no need to continue improving.

2) Thinking that there are no new, big ways to generate more value without taking a considerable risk that endangers current achievements.

3) Assuming, without careful examination, that a new opportunity will respond to the solution applied to the last opportunity.

Inherent Potential releases us to visualize what may be possible within our system or organizations. When we combine Inherent Potential with Inherent Simplicity and Inherent Causality, we can create tools to construct a detailed roadmap of the best set of strategies and tactics required to realize the potential of the system, considering also the Inherent Uncertainly to overcome the risks.



Success makes us believe we have reached the maximum, and all we need now is to keep what we have achieved so far. This tendency is invoked by the fear of taking big risks, which could wipe out historic achievements.

Risks can be dealt with, there are ways to reduce them. Recognizing that you can never know should make you both challenge your assumption while looking ahead for so much more, with very limited risk.

Summary

Inherent Potential: You can always achieve so much more. “Never Say I Know.”

3rd Breakthrough Insight

Inherent Value from Innovation

Our final breakthrough insight is Inherent Value from Innovation.[17]

To create more value, a necessary condition is to come up with an innovative idea. However, not every innovation generates value. So, we have to clearly identify which innovations have the potential to create value, and also what has to be in place to achieve it.

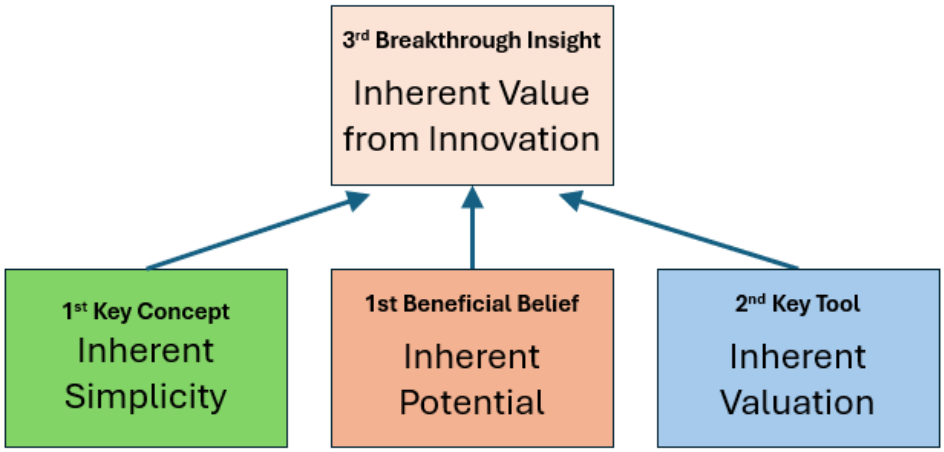
Limitation: Feeling safe within our comfort zone.

Flawed assumptions

1. **The risk of any innovative idea is always very high.**
2. **The only way to reduce the risk of innovation is to invest in many independent innovative ideas e.g. in a Risk Fund, and it'll still be a high-risk endeavor.**

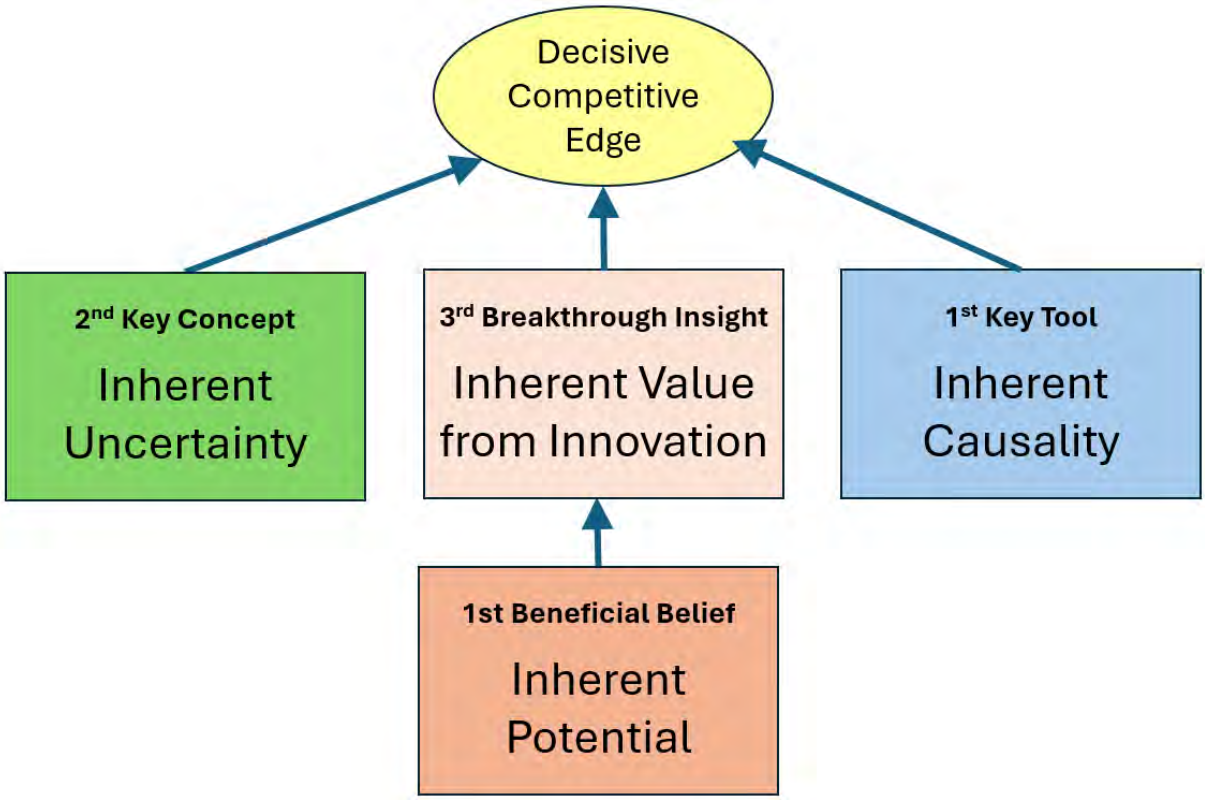
Innovation fits high-risk start-ups and is financed by risk funds which understand how to evaluate innovation and protect their investment by spreading their funds over many such start-ups.

[17] Inherent Value from Innovation: Every innovation means overcoming a limitation. But not every limitation truly blocks achieving something of value. Thus, it is important to examine what is the generated value from any innovation. Source of the term: the authors, 2024.



Market-leading companies can map their forward-looking strategies and tactics by utilizing their current competitive edge. But companies that don't have this advantage need more. They need innovative ideas and the right kind of thinking to move in their markets, and even leapfrog the current market leaders.

To come up with a market-changing action while finding ways to reduce risk in innovation, several TOC insights are used. The combination of Inherent Value from Innovation with Inherent Uncertainty and Inherent Causality is behind the conceptual objective of gaining a Decisive Competitive Edge (DCE), adding it to their detailed effective Strategic plan (e.g. their S&T tree).



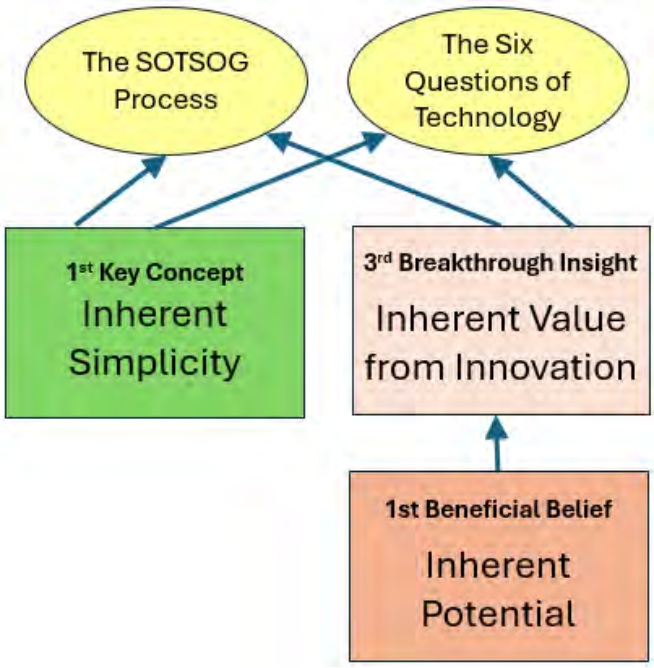
At the heart of reducing the risk of any innovation lie several insights that comprise the Six Questions of Technology to assess the value of a new technology. It is relatively easy to translate "new technology" into *innovation*.

Here are the bare new insights on how to check the true value of a suggested innovation:

a. Gaining an understanding of the current pains, being unable to get the desired value for potential customers within a market segment
b. Identifying the limitation that prevents users from gaining additional significant value
c. Eliminating, or vastly reducing the limitation
d. Being able to lead potential clients to both perceive the new value and know how to fully bring it forth for that market segment
e. Establishing a new decisive competitive edge by creating the required operational and marketing strategy to fully exploit the new generated value

Another tool for reducing the risk of innovation comes from the steps in *Standing on the Shoulders of Giants* (SOSOG), a paper by Eli Goldratt that outlines how to effectively use great

ideas and insights which were developed by giants, meaning they are powerful, and then find how the essence of the Giant's ideas could be used to pave the way to more value.



Summary

Inherent Value from Innovation leads the way to recognize the next step that will dramatically elevate the performance of the system.



Inherent Goodness[18] makes the claim that *People are Good.* This is a somewhat "strange" belief. What does it mean people are good? Were the Nazis in Germany good? It is important to understand that this is not a moral statement, but rather a claim that in organizations, the vast majority of people want to do a good job and be seen as reliable, responsible members of the team.

The key idea is shying away from the easy and distorted habit of blaming. People do not basically wish to do evil and don't enjoy doing bad things to others. People are educated with certain values and beliefs; the circumstances of their life have an impact on their behaviors. And a huge, often overlooked aspect of behavior is the measurement system of the organization. People's behaviors may be directly associated with the measurements that lead to bonuses, promotions, etc., even if those measurements are misguided.

It is absolutely not effective to blame others, certainly before fully understanding their interests and values. Once understanding is achieved, it can be possible to reach win-win agreements.

Limitation: Failing to achieve a desired objective due to the contradictory behavior of other people, which wasn't anticipated and is not understood.

Flawed assumptions:

1. ***When people take actions against our interests, it is usually because they are idiots, have something to gain personally from it, or even enjoy hurting us*.** Thus, we cannot find the right way to convince them to behave in a way that would contribute to what we want to achieve.

[18] People are good. Assigning blame is ineffectual. Similar in application to Stephen Covey's "Seek first to understand, then to be understood." One of Goldratt's original Four Pillars. Source of the term: TOCICO New Knowledge paper "The TOC Pillars" by Humberto R. Baptista, 2021

2. *We cannot really understand what other people truly think*

The third key concept, Inherent Consistency, deals with resolving conflicts, and also highlights the case where other people act to achieve something that clashes with what we are trying to achieve. That key concept, together with this key belief that people are good, and whatever they do it is not just intended to make us miserable, should trigger us to understand others.

From a business perspective, there is special importance to understand our clients, the clients of our clients, our suppliers, and our employees. The Thinking Process tools can be useful to analyze not just our own reality, but also to explain the behavior of other people and organizations.

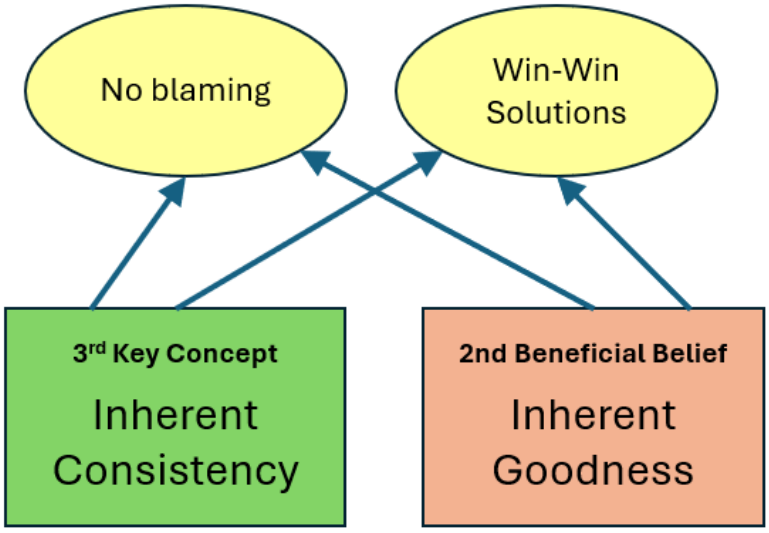
It is difficult to use cause-and-effect logical tools alone to describe the motivation of another person or organization. First, the goal/top objective of the other person or organization has to be clarified. We should also outline our own assumptions, and understand the impact of the emotions of the other party.

Raising assumptions about the effects the other party is facing is critical, but we also need to treat them as hypotheses, looking for evidence that our assumptions are valid.

It should be possible however, based on some known effects and generic assumptions about human behavior, to reduce the overall impression of complexity. In other words, there are a few critical variables that should be considered, including practical gain, ego, and fear.

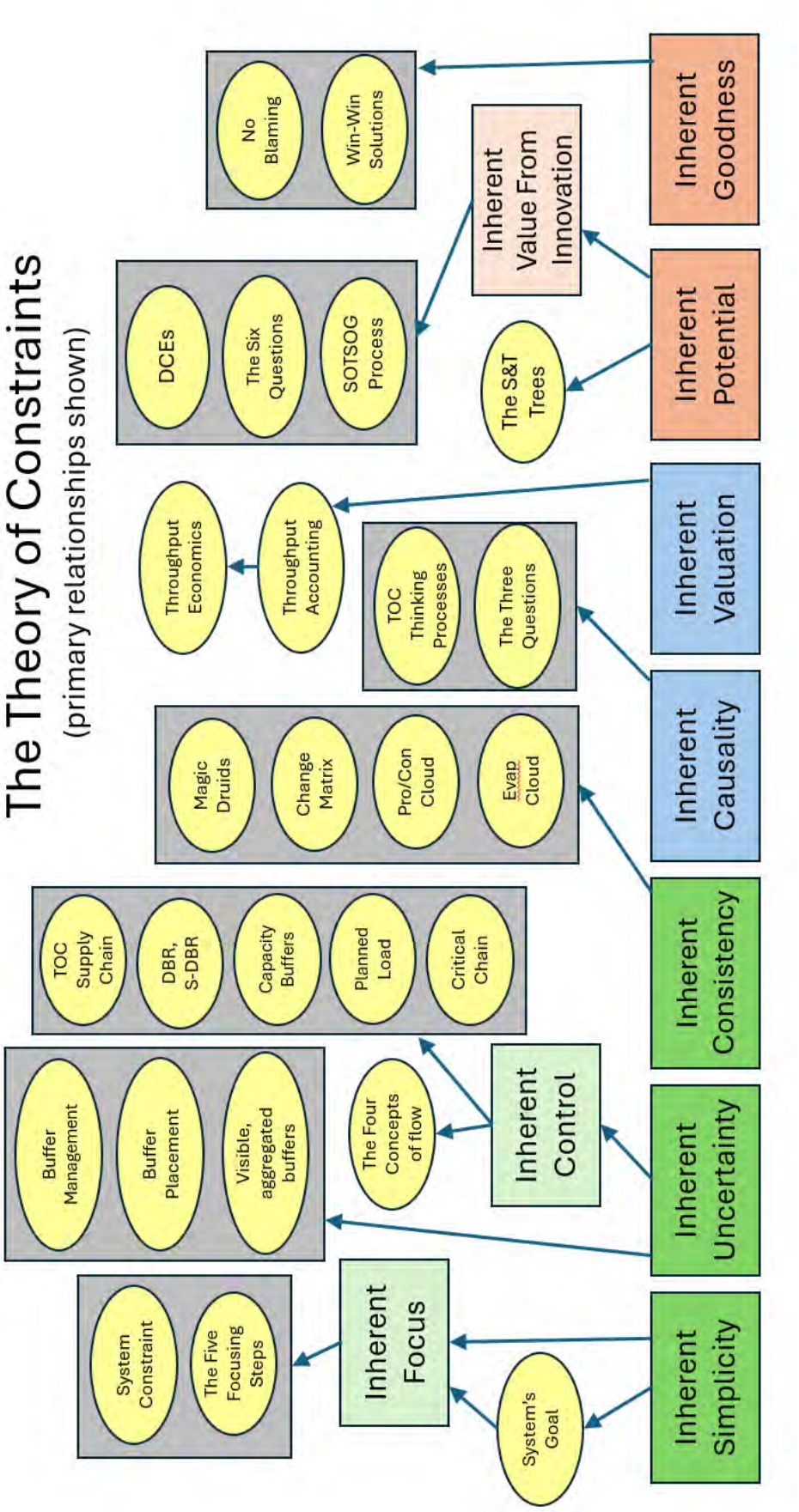
It is easy, and very tempting, to blame others. However, blaming others doesn't help fix a negative situation. Understanding the reasons behind peoples' behavior, and especially the assumptions behind it, as well as the circumstances that generated the reasons, will vastly help us to find our way to create win-win solutions.

People are good is a belief, meaning we are not able to prove it Even if there is doubt about whether the belief is always true, it seems to be very constructive to assume it is true, which pushes us to analyze how it can be explained why *X* took this action that harms us. Identifying the causes would give us a considerable advantage in converting the negative situation into a very positive one.



Summary

Inherent Goodness: People are good. The reasons for negative outcomes of man-made events in our systems do not result from people's nature (good or bad) but from their assumptions, measurements and circumstances.


The Theory of Constraints
(primary relationships shown)
Inherent Goodness
Inherent Value From Innovation
Inherent Potential
Inherent Valuation
Inherent Causality
Inherent Consistency
Inherent Uncertainty
Inherent Simplicity
Inherent Control
Inherent Focus
No Blaming
Win-Win Solutions
DCEs
The Six Questions
SOTSOG Process
The S&T Trees
Throughput Economics
Throughput Accounting
TOC Thinking Processes
The Three Questions
Magic Druids
Change Matrix
Pro/Con Cloud
Evap Cloud
TOC Supply Chain
DBR, S-DBR
Capacity Buffers
Planned Load
Critical Chain
Buffer Management
Buffer Placement
Visible, aggregated buffers
The Four Concepts of flow
System's Goal
System Constraint
The Five Focusing Steps

Selected references on the applications of TOC shown in this document:

System Goal; System Constraint; The Five Focusing Steps *The Goal: A Process of Ongoing Improvement*, 30th Anniversary Edition, by Eliyahu M. Goldratt and Jeff Cox, North River Press

Visible Aggregated Buffers; Buffer Placement; Buffer Management *The Race; Critical Chain; Supply Chain Management at Warp Speed?*

The Four Concepts of Flow Standing on the Shoulders of Giants, video and article, https://www.tocico.org/page/StandingontheShouldersofGiants?&hhsearchterms=%22standing+and+shoulders%22

Drum-Buffer-Rope (DBR) *The Race*, by Eliyahu M. Goldratt and Robert E. Fox, North River Press

Simplified Drum-Buffer-Rope (S-DBR) *Manufacturing at Warp Speed: Optimizing System Financial Performance,* by Eli Schragenheim and H. William Dettmer, CRC Press

Critical Chain Critical Chain, by Eliyahu M. Goldratt, North River Press

TOC Replenishment (Supply Chain) *Supply Chain Management at Warp Speed?*

Capacity buffers (Mulit-Project Management: The Critical Chain Implementation Handbook, by David Updegrove, CreateSpace

The Change Matrix Overcoming Resistance to Change – Isn't It Obvious, YouTube video by Eliyahu M. Goldratt, https://www.youtube.com/watch?v=aEyg73bbVc4

Pro/Con Clouds *ProConCloud* by Alan Barnard, https://www.tocico.org/page/TOCBodyofKnowledgeProConCloud

Magic Druids Magic Druids, by James Powell and Peter Cronin, https://www.tocico.org/page/TOCBodyofKnowledgeMagicDruids

Throughput Accounting, *Throughput Accounting*, by Thomas Corbett, North River Press

Throughput Economics, *Throughput Economics*, by Eli Schragenheim, Henry Camp, and Rocco Surace, Routledge/Productivity Press

Customer Value Framework: Canvas & Chains

The Renovated *6 Questions for new Technology (6QT+)* & Demonstrated: Apple Vision Pro and Taylor Swift



First-generation 2024
Apple Vision Pro [M2]
spatial reality headset

Richard E. ZULTNER

Jonah - Mechanic*

Adjunct Professor (retired)
School of Technology Management
Stevens Institute of Technology

Princeton, NJ USA

Richard@Zultner.org



Taylor Swift
The Eras Tour
(2023-4)

Track: Theory of Constraints (ToC) Academic Stream conference paper

Case Study example: the first-generation 2024 Apple Vision Pro (AVP) [M2] spatial reality headset — a product category-validating innovation, demonstrates the Customer Value Framework (the renovated 6QT+). With some Taylor Swift assistance…

Brief description: Eli Goldratt's **6 Questions for new Technology** (6QT), from *Necessary but not Sufficient* (2000), are renovated (6QT+) for more *focus*, *flexibility*, and *power* — to better meet the Customer Needs (DEs & UDEs) of Innovators, Entrepreneurs, and the next generation of ToC professionals.

Keywords: Apple Vision Pro (AVP) spatial reality headset; Eli Goldratt's "Necessary but not Sufficient" 6 Questions for new Technology (6QT), the renovated 6QT+ Customer Value Framework (CVF) of value chains (value constraints) on a value canvas; diffusion of innovation (Crossing the Chasm); demand constraints

Abstract: Over 25 years ago, Goldratt's *Necessary but Not Sufficient* introduced the 6 Questions for New Technology, but the method has seen limited use outside the Theory of Constraints community. This paper renovates the 6 Questions into a Customer Value Framework (CVF) with six columns that are designed to improve focus, flexibility, and practical usefulness for innovators, entrepreneurs, and product devel-

*Jonah - ***Mechanics*** fix up old, outdated, or unused ToC elements; they ***renovate*** them — in a Process of On-Going Improvement (**PoOGI**). And they "get started now", with minimum viable experiments… and learn as much as they can, from them. Repeatedly.

Copyright © 2024 Richard E. Zultner

opers. The renovated framework shifts the emphasis from limitations alone to customer-valued outcomes, including Desirable and UnDesirable Effects, customer needs, jobs, situations, and customer segments, so that value can be analyzed as a customer-specific value chain rather than as an abstract list of questions. The paper illustrates the framework with the first-generation Apple Vision Pro and with Taylor Swift's Eras Tour as contrasting examples of technology commercialization and experience creation. The central claim is that the renovated 6QT+ provides a more actionable and adaptable way to identify product-market fit, refine offerings, and design an UnRefusable Offer for specific customer segments.

— — — — —

Over 25 years ago, Eli Goldratt's business novel, *Necessary but not Sufficient* (2000), introduced the **6 Questions for new Technology** (6QT). But the promise of this ToC technique for "assessing the value of new technology" has yet to be fully realized — except by a handful of pioneering ToC practitioners.

This paper ***RENOvates*** the original 6 Questions to the 6QT+ to strengthen:

(1) **focus**: update Goldratt's high-level, abstract 6 Questions, to the six most critical success factors for new technology and product development. Result: a ToC framework for value-to-customer, the Customer Value Framework (CVF).

(2) **flexibility:** update the 6 Questions from 2000 to 2010 with Goldratt's Change Matrix+ definition of customer value — to be more flexible. So the framework can be tailored to fit specific circumstances, on a value Canvas.

(3) **power** — "Value is in the details": apply proven, tested, and globally accepted practices for new technology and product development, so the renovated 6QT+ can provide better guidance with specifics. Result: a documented ***value constraint***, with customer segment-specific value Chains.

The paper ***DEMOnstrates*** the renovated 6QT+ Customer Value Framework: Customer Value *chains* (which are *value constraints*), on a Customer Value *canvas*. And uses the case study example of the first-generation 2024 Apple Vision Pro (AVP) [M2] spatial reality headset. With illustrations from Taylor Swift's *The Eras Tour*.

Note: The *6 Questions* are being *renovated* in this paper not because they need repair, but because they can be made stronger. Better. Improved by *renovation* in a Process of OnGoing Improvement (PoOGI). This is one of the most fundamental principles of the Theory of Constraints. And the subtitle of Goldratt's seminal work: *The Goal: A Process of OnGoing Improvement.* [Goldratt 2014] If the original, or revised, 6QT work for you… Then you don't need the renovations in this paper. You do not need to upgrade to the 6QT+. But if you'd like even more focus, flexibility, and power, keep reading….

This paper builds on Goldratt's **Change Matrix+**, a renovated ToC logical Thinking Process (TP) tool that enables a deeper understanding of 'value', from a customer perspective. Value comes from meeting customer needs — collectively, Desirable Ef-

Copyright © 2024 Richard E. Zultner

fects (DEs) & UnDesirable Effects (UDEs). And this foundational insight of ToC, is leveraged in the 6QT+.

Value is "benefits" compared to "costs". [Carlson 2023] And Customer Needs (comprised of DEs & UDEs), taken over time (i.e., the current reality, transition, and future reality), define the six basic types of benefits that customers consider — which are customer segment specific. And actionable. [Zultner 2023a]

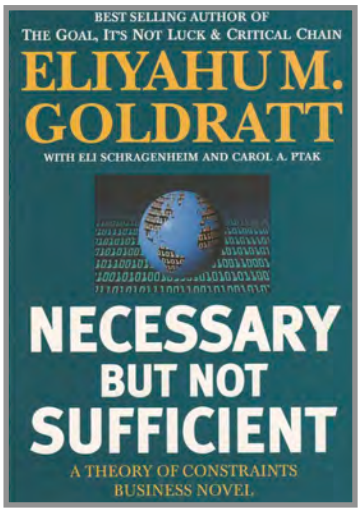
The renovated 6 Questions for new Technology (**6QT+**) provide stronger guidance for any new "technology" solution offered to specific customer segments (for Innovators), and shows how to refine, further develop, and market that technology (for Entrepreneurs). An essential ToC foundation for addressing demand constraints.

The renovated 6QT+ form an innovation "canvas". A *value framework* for analyzing the best way to offer and refine a new (or existing) "technology" for ideal customers. And connects those answers into a *value chain* — a horizontal cross-dimensional logic tree that is a graphical & actionable definition of *value-to-customer* (V2C). And is a *value constraint*, for those customers.

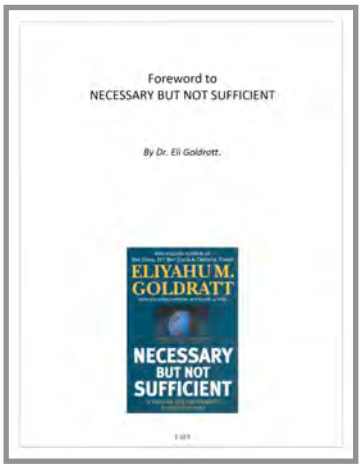
The first-generation 2024 **Apple Vision Pro** (AVP) [M2] spatial reality headset, the result of a development effort of over 10 years, over a billion dollars of R&D, and 5000 patents, demonstrates the renovated 6QT+.

And Taylor Swift's 2023-4 *The Eras Tour* concert series, with unprecedented economic impact ("Swiftonomics"), from 10 million fans, attending 149 sold-out concerts in 51 cities, will demonstrate the limitations of traditional approaches… for staging experiences.

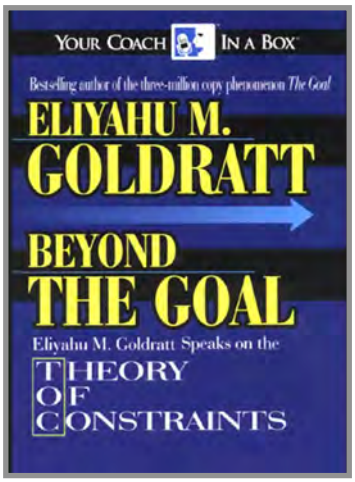
The 6QT+ is for any solution provider, for any "technology" they use — in any "product" — offered to customers.



Published in 2000, *without* all the 6 Questions explicitly stated in the text



Distributed later in 2002, the original 6 Questions for new Technology



Published in 2006, a discussion of the original 6 Questions

Introduction

In 2000 Eli Goldratt's published a business novel, *Necessary But Not Sufficient.* [Goldratt 2000] The **6 Questions for new Technology** (6QT) are often said to have been "introduced" in this book. But this business novel — as published in English — did not list or explicitly state all 6 Questions in the text. Later, in 2002, Goldratt wrote a new *Foreword* that did explicitly list the 6 Questions, with commentary. [Goldratt

Copyright © 2024 Richard E. Zultner

2002] This has not yet been added to any published editions in English.

Here are the original “6 Questions for new Technology”:

Goldratt’s original 6 Questions for new Technology

1. What is the power of the new technology?
2. What limitation does this technology diminish?
3. What rules helped accommodate the limitation?
4. What rules should be used now?
5. Given the change in rules, what changes are required in the new technology?
6. How to cause the change?

There have been multiple revisions made to the original 6QT; some by Eli Goldratt [Goldratt 2006], and others by Eli Schragenheim [Schragenheim 2007, 2011, 2021, 2024], and Alan Barnard. [Barnard 2020, 2024, 2025]

And others have used the 6QT in presentations [Avidan 2015, Baptista 2020, Knight 2015, Thompson 2025, Updegrove 2002].

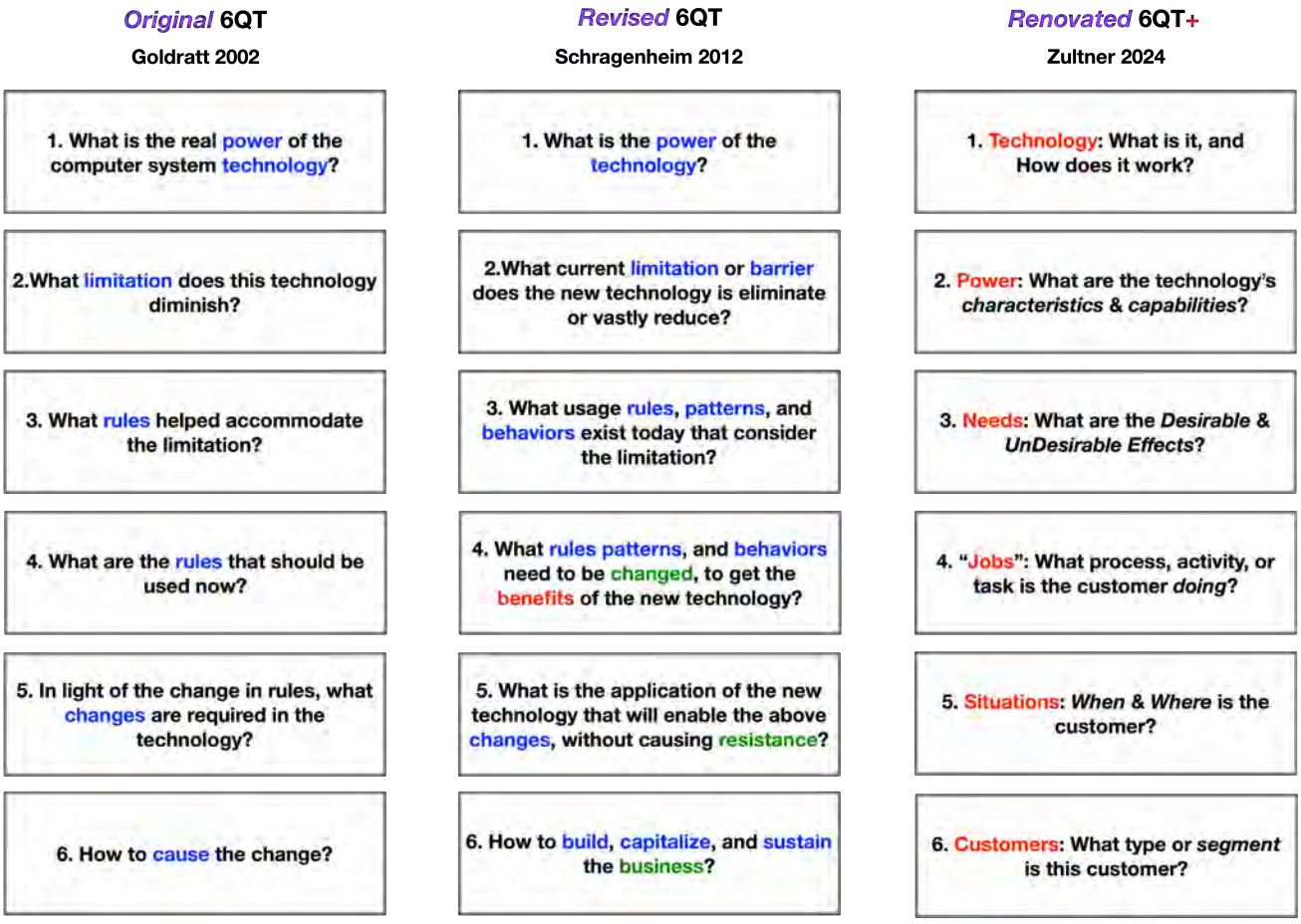


Figure 1. The original, revised, and the renovated 6 Questions.
Limitations, Rules, and Behaviors are NOT the most critical success factors for new technology.
They can now be found inside any of the renovated questions — if they are critical.

Copyright © 2024 Richard E. Zultner

Vision: The documented use of the 6 Questions for new Technology (6QT), over the past 25 years *inside* the ToC Community has been limited. And there are NO signs of their use *outside* the ToC Community… No traction. No "product-market fit" (PMF). [Andressen 2007] So the full potential of the 6QT has not being realized… anywhere.

Problem. How can we improve Eli Goldratt's original 6 Questions to gain traction, with a wider audience?

Importance: The 6QT address an important area — how to ***leverage***, or commercialize, a new technology. Developing new solutions, getting them into the hands of paying customers, and building a business to support those customers, is precisely what innovators and entrepreneurs do. And what ToC professionals do, in spreading the use of Theory of Constraints — their own "technology".

Traditionally, ToC has addressed ways to *increase throughput* in existing businesses, with an already established flow — and therefore focused on constraints that limit that flow — in businesses with established flows, and proven to be viable. Businesses with a history of outputs that have met customer needs. So the primary focus can be on how to offer those customers, more volume, shorter lead times, more reliable delivery, etc. How to improve an *existing* flow.

(a) The Innovation: What ToC has not addressed — until the 6 Questions — is how to *create* a flow initially. How to start up with just an idea, a technology, or a new product — and *create throughput* from scratch. A "zero-to-one" start-up situation. [Thiel 2014] So then Traditional ToC solutions can be applied…

Where there is not yet any *flow*, there cannot be any *constraints* (at least in the traditional ToC "limitation" sense). Could we help those creating new products,

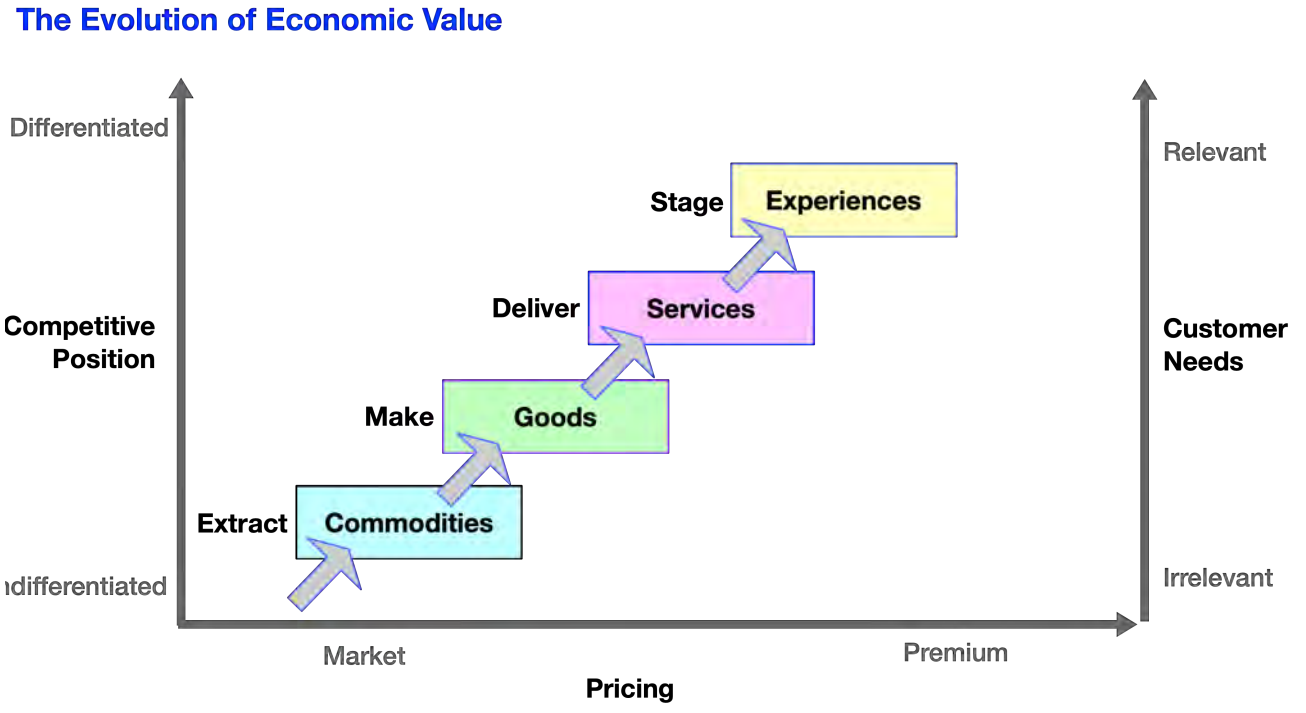


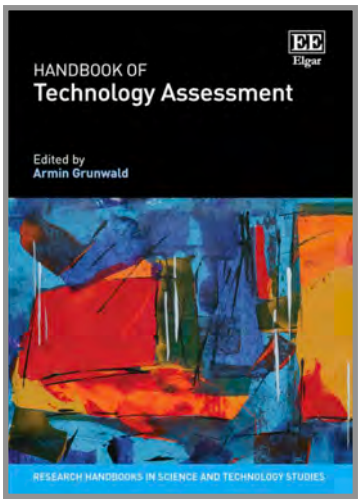
Figure 2. Economic Value: Commodities are fungible, goods tangible, services intangible, and experiences memorable. And experiences are the fastest growing sector. [Pine & Gilmore 1999]

Copyright © 2024 Richard E. Zultner

and new businesses, with "ToC from scratch"? And go from zero throughput, to some steady throughput? A tool for systematic UnRefusable Offer (URO) creation? [Zultner 2017a, 2017b]

(b) The Extension: Over the past decades, ToC has addressed commodities, goods, and services. What ToC has not addressed — until the 6QT+ — is ***experiences***. [Pine & Gilmore 1999, 2020]

Experience-heavy services (travel, entertainment, hospitality, recreation, etc.) now account for the majority of the US GDP. [US BEA 2025] If ToC can help all those who stage experiences — that could seriously lift the spread of ToC…



Technology Assessment isn't new. It's been the focus of serious research for over 50 years…

And the 6 Questions have far more potential, than just the assessment of new technology. [Grunwald 2024] People developing new products, and starting new businesses, with new technology, are looking for help, to succeed in an effort they are committed to. Can we use the 6QT, to improve the 6QT? And expand its potential?

The 6 Questions also have potential for big businesses to add new products, enter new markets, and make even more money. But they'll still survive, if their new technology fails. Start-ups won't. Innovators & Entrepreneurs in start-ups are the ideal customers for the 6 Questions…

Idea. Renovate the 6 Questions. [Gaines 2025] with contemporary knowledge from innovation experts, academic researchers, and communities of practice that actually create new technologies, and successfully develop new products.

PoOGI: Renovation may be the least glamorous aspect of ToC, but it is an essential part of on-going improvement, in a field that has been around for forty years. Renovation should be a routine practice, in ToC. It's the opposite of inertia…

Steps. Renovate each of the original 6 Questions, and place them in a framework.

I have tried, on several occasions, to apply the 6QT — both the original and revised versions. They just weren't very… helpful. But I saw the potential. Before starting this renovation, I did attempt to use both the 6 Questions, on Apple's Vision Pro. I got nowhere. And for Taylor Swift? Limitations, rules, behaviors… are just not helpful. Some ToC experts even told me, "Taylor Swift isn't practical value. So ToC doesn't apply". Even though *The Eras Tour* made her a billionaire… Or "she doesn't do 'technology' so the 6 Questions don't apply". So I ask, "Can we strengthen the 6QT, so they do apply? By renovation?"

Approach: Apply the 6 Questions, to the 6 Questions. Consider the 6 Questions as a new "technology" for ToC practitioners (and others), and use the 6 Questions to improve them. The same way an entrepreneur would use the 6 Questions on a technology solution.

Copyright © 2024 Richard E. Zultner

News. Test the renovated framework with actual details from the first-generation Apple Vision Pro spatial reality headset. A product category-validating innovation that took Apple 10 years, over a billion dollars, and 5000 patents to develop, the renovated 6QT+ framework offers fresh insights into Apple's ongoing global rollout of a new-to-world product platform. And shows how ToC could help others achieve the success of Taylor Swift, in staging memorable and profitable experiences.

Renovation

Eli Goldratt, the charismatic genius founder of Theory of Constraints (ToC), and author of *The Goal* (1984), wrote that making a breakthrough requires only: (a) the courage to face inconsistencies, and (b) the willingness to challenge basic assumptions. [Goldratt 1984]

Diffusion of Innovation. Everett Rogers [1962], Geoffrey Moore [1991], and Clayton Christensen [1997] have a different view… That making a breakthrough — developing a new technology — is just the beginning. That innovation then must *diffuse* into the world. And there is a ***chasm*** between innovators & early adopters, and the mainstream market. Before any technology can be accepted by the majority.

The initial challenge a new technology faces is to gain traction with the early market — innovators & early adopters. And then, to "cross the chasm" to the mainstream market, and continue to spread through the early and late majority.

So Apple, facing severe supply constraints from Sony, whose state-of-the art micro-OLED displays are at the heart of the Apple Vision Pro (AVP) [Bilton 2014]… Chose to

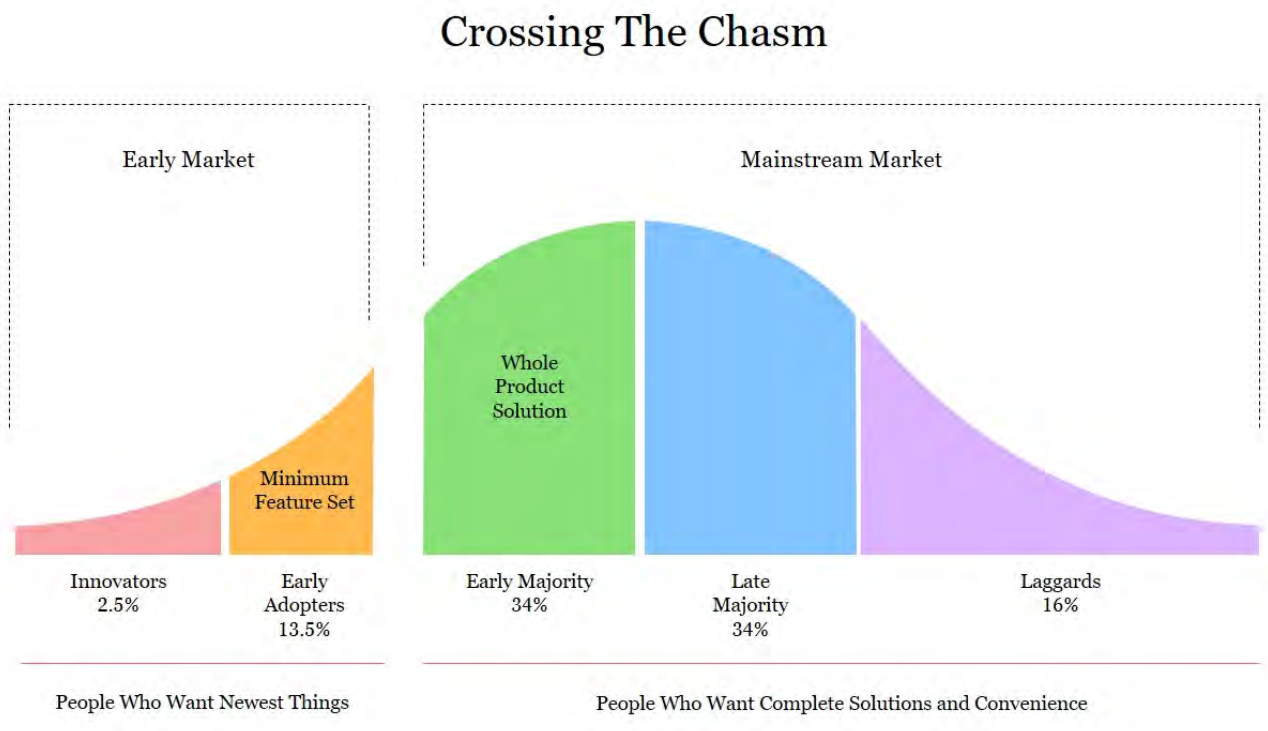


Figure 3. The Diffusion of Innovation model [Rogers, Moore, Christiansen… and others]
The difference between the early and the mainstream markets, is not captured in the original or revised versions of the 6QT. But the 6QT can be upgraded to address this…

Copyright © 2024 Richard E. Zultner

focus initially only on the US market, and only on select early adopters, with their initial launch of their first-generation AVP. This required a tight focus on the customer needs of early adopters, in specific segments. Whose specific needs, could be met at launch, with limited partner support and resources.

So the questions that most need to be asked, for a new technology, are those that would uncover the the high-value needs, of early adopters. For each such customer segment, with a needs-based segmentation. And then "build bridges" to "cross the chasm" to mainstream market customers. [Ulwick 2005]

What are the critical success factors for new technology and product development? For practical guidance, look at what new product practitioners have found to be most important. The "dimensions" of new technology and product development, that are accepted globally, to be most critical for success — conveniently collected in an international standard: *ISO 16355 …for new technology and the product development process*. [ISO 2021] Note that any international standard contains globally *accepted* practices, not the state-of-the-art, or even best *current* practices. So it is a conservative basis for validation of a new framework. And the use of these basic six dimensions, go back to the 1990's in the product development community. So they have solid practitioner confirmation and validation.

For clarity, we need to ask a new question, first:

Question Zero: What is the larger context, for our use of the 6 Questions?

(a) Who are the 6 Questions for? Who are the **customers** that should be using the 6 Questions? In this paper: Innovators & Entrepreneurs — which may

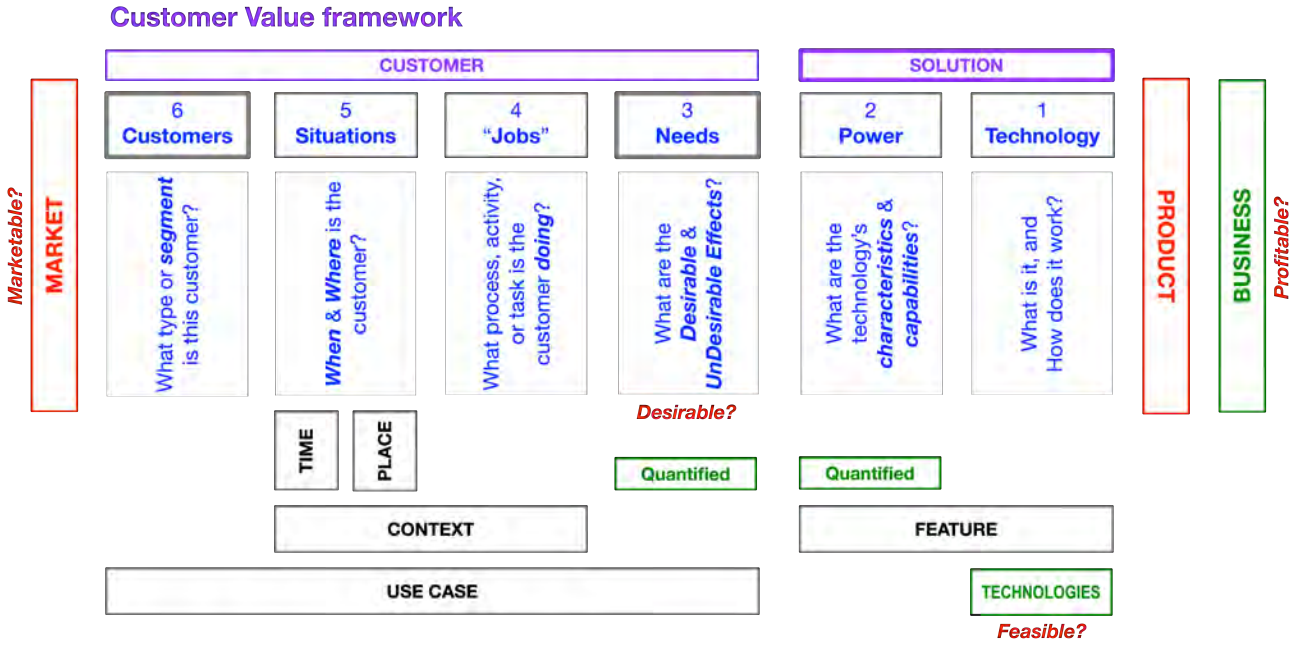


Figure 4. The 6 Questions for new Technology, *renovated* and *rotated* to columns of a Customer Value Framework. These are generic dimensions of critical success factors (CSFs) for new technology and product development. These factors were known in ToC, but were not critical. This framework can be expanded, or collapsed, to fit your particular domain.

Copyright © 2024 Richard E. Zultner

also be found in existing organizations and large companies, commercializing new technologies, developing new products, and entering new markets.

(b) Starting with nothing, *create* a **system** that has flow, where paying customers eagerly buy and use your solution (innovator), and can grow into a viable business (entrepreneur). Initially, this system may have no flow, and thus no constraints (in the traditional ToC sense), and no throughput. Even in an established multi-product (and multi-flow) business, establishing a new technology, a new flow, in a new market, may be completely independent of existing products, flows, and customers.

(c) The **goal** of the above system, is to *leverage* (commercialize) a new technology. To package the technology in a solution that customers will say 'yes' to. So we need to construct (a) a high-value "zero resistance" offer, and (b) deliver a solution with a ***value stack*** that is clearly superior to any alternatives for the customer. In ToC terms, an UnRefusable Offer (URO), that ideally becomes the basis for a Decisive Competitive Edge (DCE), in the eyes of the target customer segment.

(d) The Prime **Measurement** — to tell if we are making progress toward the goal, we'll use the value stack of our ***offer*** (which can only include DEs & UDEs the customer already knows), and our ***solution*** (which may include DEs & UDEs the customer will learn of through use of the solution). So our value stack beats all other alternative value stacks, and our value stack is sufficient to get a 'yes' from the customer we target (in an acceptable percent of the time we make an offer). We are focusing on specific customers, because they are the source of all our throughput.

The 6 Questions below are taken directly from Goldratt's original questions (in bold) [Goldratt *Foreword* 2002], lightly modified for clarity. (Renovations are in blue.)

1. **What is the power of the new technology?** Specifically? How does it work?

   Really two independent questions: what ***is*** the technology, technically; and then, what can the technology *do* (it's capabilities), or *be* (it's characteristics) — it's ***power***. A technology can have multiple characteristics & capabilities. And a capability or characteristic can be delivered or implemented by different technologies. So these are two separate dimensions of product development.
   Note that our focus is on technologies in a product that can be offered to a customer — not just on *features* (which are capabilities implemented using a particular technology) not available separately.

   The <1st> element of the renovated framework: **technology** (the "how" or "means"), described in detail, in technical terms. How does it work, technically? In this paper, the technology is a given — a starting point for our analysis. But if you started with a type of customer (a particular segment), instead, then a technology could be chosen (or created) to best fit that type of customer. A powerful framework should allow us to start anywhere — with any success factor (any column) — and end up with all columns filled in.

Copyright © 2024 Richard E. Zultner

And the <2nd> element: "**power**" — the capabilities (what the technology does) & characteristics (what the technology is). This is now a separate column.

Capabilities can be quantified in terms of performance. For example in the AVP, AI hand tracking to detect poking, tapping, and tugging gestures, with 95% accuracy.
Characteristics can also be quantified. For example in the AVP, latency from headset cameras to displays ("photon to photon") of less than 12ms.
Note that capabilities & characteristics are implementation-free "function" statements. The technology chosen to implement them, the "how", or "means", is a separate decision, and goes in a separate column.

A *technical competitive assessment* at this point can help us to clearly see the strengths & weaknesses of the new technology vs existing technologies from competitors. What specific advantage(s) can the new technology offer? We measure what their performance is, what we can do now (if we have a current product), and determine how much better our performance must be, to be judged clearly superior by the customer. Then we develop a solution that provides that performance.

2. **What limitation does this technology diminish?** And what outcomes (DEs or UDEs) does the customer experience, as a result?

   First, what is a **limitation**? There are two basic types:

   (a) A **presence**, that blocks us. That prevents us from reaching something of value — or experiencing a Desirable Effect. This is a ***barrier*** (or "***boulder"***) type of limitation. We need to ***remove*** the barrier (or find a way around it, making it a non-barrier) so we can experience the DE on the other side of

6 Questions for new Technology+ **Customer Value framework => canvas**

6. **Customers**: What type or **segment** of customer?	5. **Situations**: Where & When is the customer?	4. "**Jobs**": What tasks or processes is the customer trying to do?	3. **Needs**: What are the customer's **DEs** & **UDEs**?	2. **Power**: What are the ***characteristics*** & ***capabilities***, of the technology?	1. **Technology**: How does it work technically?
					Apple M2 chip
Cinephiles (movie lovers)	In bed (not in home theater)	Watch a great movie (as the director intended)	Watch film in original format	70mm IMAX, Panavision, etc.	**Sony micro-OLED Displays**
Travellers (long distance)	On a plane, a train, or a beach in Spain (away from home or office)		No motion artifacts (variable refresh rate)	Frame rates up to 90, 96,100 fps	Audio pods with H2 chip
Complex knowledge worker	Not at desk with multiple screens		No screen door effect	3660x3200 resolution (34 pixels per degree)	
Gamers			Listen in original (surround) sound	Apple Spatial Audio format (Dolby Atmos)	Partner: Disney+ (Most 3-D content)
"Grandparents" (memory lovers)	Not where grandchildren are	Capture lifetime moments when you're with them	"I feel like I'm there"	Apple spatial video format (3-D in MV-HEVC)	iPhone 15 Pro & Max
Serious Sports Fans (sport specific)	Enjoy snacks and drinks, while watching the game	Watch the game, from the best (virtual) seats	Watch in great (virtual) surroundings	Apple **immersive video** 3-D 8K 180° format	Partner: Sports Leagues (Streaming rights)
Remote workers	FaceTime, Zoom, Teams, WebEx, etc.	Attend meetings, webinars, events…	Highly interactive remote collaboration in my space	Personas, Spatial Personas, Share Play (telepresence)	Acquisition: NextVR (immersive video cameras)
					Partner: video conference vendors

7. **Offer**: How are the above entries connected (aligned)?

Figure 5. The Customer Value framework — when filled in — becomes a customer value canvas, This example is for the AVP. (Larger version at end of paper)
The entries In the Customer Needs column, make up the potential Value Stack.

Copyright © 2024 Richard E. Zultner

the barrier. Note that a wall is not a limitation, if there's nothing behind it we want. This type of limitation is a natural extension of the traditional ToC view of *constraints*, *bottlenecks,* and *obstacles*… [Zultner 2023a]

(b) An **absence**, that starves us. Something that we are missing, that we require to enable us to access a Desirable Effect, and experience value. This is a ***canyon*** (or "***chasm"***) type of limitation. We need to ***add*** what is missing, or "build a ***bridge*** over the chasm" that ***enables*** us to reach something of value on the other side. Note that a high shelf, that we cannot reach without a ladder, is not a limitation — if there's nothing on that shelf we want. This type of limitation, a *missing enabler*, is less common in traditional ToC, but is found in the oldest work on constraint thinking, by Justus von Liebig in 1840. Liebig showed that maximum plant yields were constrained by the scarcest required nutrient. What was *missing*, when supplied, *enabled* increased agricultural production. [Liebig 1840] And Liebig worked on a complex organic system, with multiple constraints, that routinely interacted. [Zultner 2026b]

This original Question assumes a specific definition of value: "Value is created by removing a significant limitation for the customer, in a way that was not possible before, and to the extent that no significant competitor can deliver." [Goldratt 2006]

The focus on *limitations*, and the idea that value is "created" by the *removal* of limitations… is partially correct, and partially complete. Consider, **The Taylor Swift Problem** — Taylor doesn't remove any limitations, solve any problems, or resolve any conflicts… but she does generate "big throughput". By staging an experience, of great value to her fans, "Swifties". She generated a $4.6 billion impact on the US economy. [Davis 2023] The serious economic value Taylor Swift

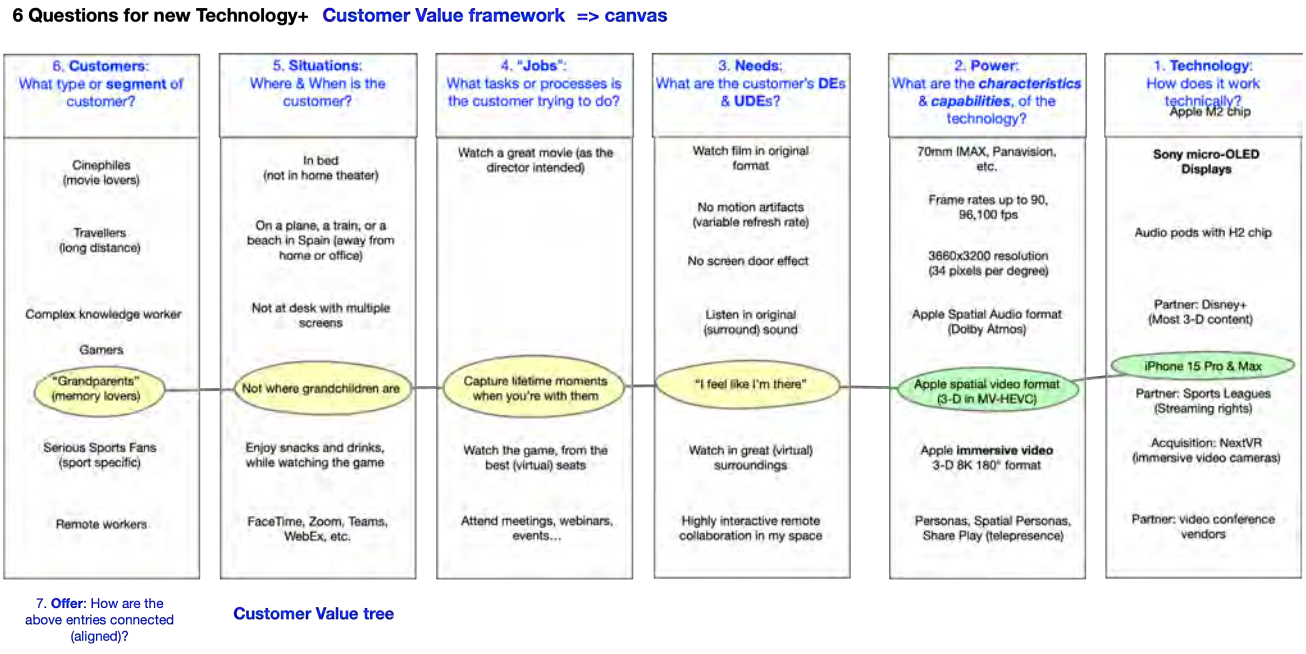


Figure 6. The AVP Customer Value canvas, with the Customer Value chain for the "precious memories" segment. The connected entries aligned in a logic tree, are a value chain for a specific customer segment. The value chain is a "leverage" constraint — it defines what is required to generate throughput.

Copyright © 2024 Richard E. Zultner

created, “Swiftonomics”, has nothing to do with problems, limitations, or conflicts. Just ask a Swiftie, why they attend her concerts, watch her movies, stream her music, or buy her merchandise…

And in still other cases, limitations are irrelevant.

Goldratt’s original definition of *value* did apply to MRP and ERP examples. The 6 Questions mention factors near to the ones in the renovated 6QT+. Close enough to have “potential”, but not clear enough, or powerful enough, for that potential to be widely realized. Goldratt’s later 2010 Change Matrix+ insights provide answers for a more powerful definition of value, and show that’s what is *behind* the limitation / barrier is actually what is valuable. [Goldratt 2010] Limitations may be only value adjacent. [Zultner 2023a]



The Taylor Swift Problem: Taylor doesn’t remove limitations, solve problems, or resolve conflicts… but does generate ”big throughput”

Sometimes, *removing a barrier* does allow us to access a Desired Effect, and experience value. But so can the opposite case — ***installing a barrier*** — if it *prevents* access of an UnDesirable Effect, to us. This is a ***protective*** (or “***safety feature”***) type of limitation. We need to ***install*** a barrier so we are protected from a UDE having access to us. Such protection is of value. Note that a railing is a limitation, because it prevent us from failing off a deck. And we value this protection. It’s “worth it” to customers to be protected from UDEs.

And finally, sometimes neither *removing* nor *installing* a limitation, matters. Because there is no Desired Effect, and no UnDesired Effect, on the other side. Such

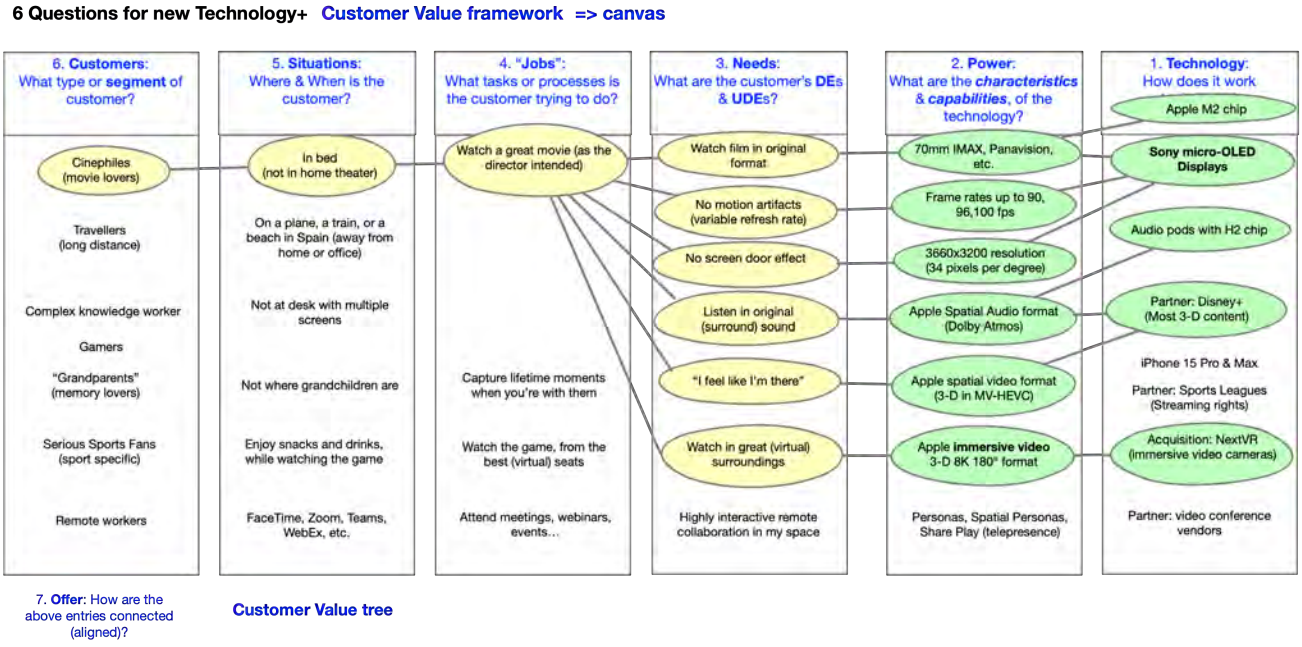


Figure 7. The AVP Customer Value framework, with the Customer Value chain for Cinephile customers. The connected entities in this logic tree, are a value constraint for this specific customer segment. This is a detailed, high-resolution, high-value solution for this segment.

Copyright © 2024 Richard E. Zultner

frequent and trivial limitations are next to Neutral Effects (NEs), and irrelevant. They are ***chupchik limitations*** — not worth paying attention to. Note that the vast majority of limitations fall into this category. So we need practical guidance on how to focus only on limitations that matter. So we don't waste our time and attention thinking about removing (or installing) limitations that don't matter.

A practical solution is to look past "limitations", and focus directly on what matters — the DEs and UDEs. We can use the Change Matrix+ as our tool to discover customers' DEs and UDEs, for their current reality, chosen future reality, and their selected transition between them. [Zultner 2023a]

In many cases, we may skip this step — because customers often know their most important DEs and UDEs. We can simply ask them. And record their answers, in an entry in the appropriate column of the customer value canvas. And because there are usually many, specific answers, we need to turn the list of 6 questions, and into 6 columns that can hold all those answers…

The issue of competitive advantage, is best addressed after establishing what is, and what is not, of value to a targeted customer segment. Certainly competitors must be considered, when setting performance targets for a new technology.

> The <3rd> element: **customer needs** (CNs), what outcomes do customers want?. Ask the customers what specific DEs they want, and what UDEs they don't want, and enter them in the customer needs column. "Fill in the boxes."
>
> Note that true customer needs are ***outcomes***, and thus are NOT statements about anything else (which go into other columns):

(a) any statement about the product (the solution), which would be either a "how" technology statement (how the technology works), or a "function" power statement (about a solution capability or characteristic).

(b) or any customer statement that is not an outcome — such as the "job" (task, process, or activity) they're trying to do, or the situation (when & where) they're in, in doing that "job", or comments about themselves (their customer segment details).

(c) or any statement about the company, producer, or solution provider…

The strengthening of this assumption is a major enhancement of the renovated 6QT+.

A *customer competitive assessment* at this point can help us to clearly see the strengths & weaknesses of the competitors are, in terms of meeting, and not meeting, customer needs. What specific needs(s) can our solution meet? We measure customer's current satisfaction & priorities, for current and known solutions. Saaty's Analytic Hierarchy Process (AHP) can be used to accurately measure qualitative measures, such as customer need satisfaction, and priority. [Saaty 1982] this allows us to *engineer* a decisive competitive edge… even with a new technology.

Copyright © 2024 Richard E. Zultner

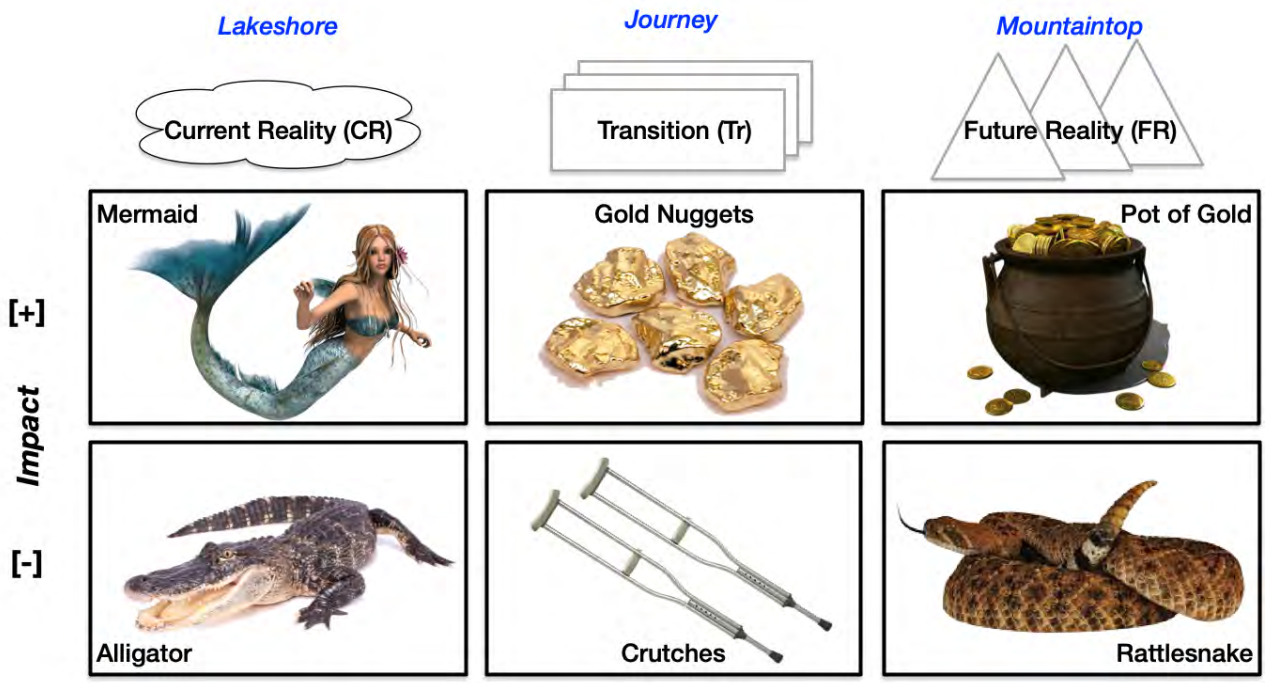


Figure 8. The renovated Change Matrix+: Desirable Effects (top row) & UnDesirable Effects (bottom). Value-to-Customer can be: (1) preserve current DEs, (2) increase current DEs, (3) add new future DEs. And (4) decrease current UDEs, (5) prevent increase of current UDEs, or (6) protect from new future UDEs. [Zultner 2023a]

Customers needs can be "affinitized" (with Affinity diagrams) using the KJ Method [Kawakita 1986], and then structured into a hierarchy, and prioritized. [Zultner 2023b, 2026a] This structure can be used to analytically identify "missing" needs…

3. **What rules helped accommodate the limitation?** For the customer to bypass the limitation? What rules, behaviors, or ways of thinking were required?

   The customer's rules, behaviors, and ways of thinking, apply to specific types of customers, in specific times and places, while performing specific tasks. If they are important, they can be captured in the appropriate column. The renovated framework still accommodates them. And a solution certainly may need to transition the customer from them.

   Note: there are not separate columns for rules, behaviors, or limitations. Because those have not been found to be critical factors, in general, for the success of new technologies. [ISO 16355:2021]

   Limitations removed long ago. Consider a technology that was introduced long ago, that did eliminate a past limitation. And users at that time, received benefits, and value. Today, new users of that technology receive the same benefits, and value — without experiencing any limitations. Take commercial air travel. The historical limitations, removed long ago, are a historical curiosity, as far as the current experience of value is concerned. Customers value crossing an ocean in

Copyright © 2024 Richard E. Zultner

hours instead of days. The limitations of ship travel, removed long ago, are irrelevant to today's travelers, and their current decisions about the value of air travel.

After refocusing this question to ways customers currently meet their needs, and what needs are unmet, we can consider ways a new technology can increase or assure future Desired Effects. And ways future UnDesirable Effects can be decreased or prevented. In ToC terms, the "pot of gold" and "rattlesnakes". [Zultner 2023a] Better would be to ask, what are all the ways the new technology can be "worth it" to the customer? The relevant elements in the framework: <4th> the "**job**" to be done (process or task, what the customer is doing), <5th> the **situation** (where & when the customer does that job), and <6th> the customer **segment** (the type of customer doing that job in this situation). It is fairly easy to spot opportunities to add value… when you are *specific*. These columns are for the most common & generic critical success factors for new technology.

4. **What rules should be used now?** By the customer? To get the most from the new technology? Any new behaviors, or ways of thinking?

   Instead of focusing on rules & resistance, let's focus on value-to-customer connections (which are our "throughput" in this context). Rules & resistance are indirect effects, or side effects, of meeting customer needs — or not. Question 3 & 4 are looking at the same thing, for *today* (current rules) and *tomorrow* (future rules, and the transition to that future). They should be merged into one Question. The Change Matrix+ allows fully exploring answers this question, on one page. And showing *why* the customer will want to change… [Zultner 2023a] If new rules are important, they can be documented in the appropriate column. The renovated framework includes them — if they affect value-to-customer. If they are critical…

And then we can better understand how to help the customer make any required changes in rules, behaviors, or ways of thinking. These are important issues to consider, in the design of a solution, and in planning the implementation of that solution. But they are *not* the most critical success factors, that should be addressed, first.

5. Given **the change in rules, what changes are required in the new technology?** Any changes to the solution — by the solution provider? Or the technology support network? What changes in customer rules, behavior, or ways of thinking, can be softened by refinements in the new technology?

   A "change" will only happen when the customer decides they are better off with the new technology. That is, the "benefits" of the new technology greatly exceed the "costs" (the "price" they pay for the benefits). They ex-



Figure 9. A customized Customer Value "Max" framework. A Markets column is added on the left. And Product columns (Design and Development) on the right. Here, Situation and Jobs are combined into Context. You could also simplify the framework to just customers, needs, and solutions… A "Mini" framework, to fit simpler cases.

Copyright © 2024 Richard E. Zultner

perience higher value-to-customer. Instead of *resistance*, focus on *readiness*. What type of customer eagerly wants the benefits of the new technology, now? Better: What refinements and complements to the new technology will increase acceptance and attract a larger audience, faster (our goal, yes?)? That is, focus on increasing value (increase benefits & decrease costs) in specific ways that customers can relate to, in specific customer jobs, situations, and segments.

If they are important, changes to rules can be captured in the appropriate column. The renovated framework accommodates them, but does not focus on them. Because they're not usually critical…

The final step, is to "connect the dots" of the above answers, into a horizontal cross-column "value tree". Aligned entries that make a customer **value chain**, across all relevant dimensions of the *value canvas*.

6. **How to cause the change?** By the customer?

   Now we turn away from the customer, to a concern about value-to-business. Better: How to best to introduce the new technology? To which customers? In what order? Now we're focusing on marketing strategy, and on the right road map for product evolution. This is an important question — if the new technology can survive past its introduction… which is what the prior Questions address. The 6 elements above can be applied to each generation of technology development, creating a tangible product road map with a strategic orientation.

   The last step, by connected the above answers, is to identify where positive branches can be added, and negative branches trimmed, to increase the customer's value stack, further. Increase "benefits", decrease the "costs".

This completes the *boomerang* approach to constructing a customer value chain:

(a) first "connect the dots" going right-to-left across all the columns, creating the core offer to the targeted customer segment(s)

(b) then go left-to-right and add "twigs" (additional items), "leaves" (quantified levels: minimum, expected, outstanding), and "berries" (quantified importance) to the value chain "vine" across the customer value canvas "trellis". Refine the core offer into one that is UnRefusable, or zero resistance offer

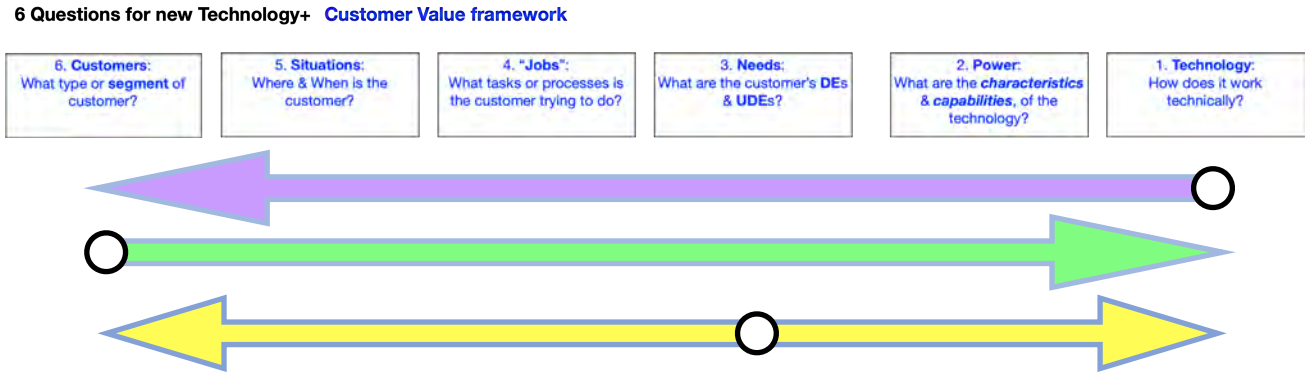


Figure 10. With the renovated 6QT+, you start where you are.
Whether that's technology (right to left), customer (left to right), or needs (middle out).
The order to the 6 questions depends on what you know, and what you want to find out.

Copyright © 2024 Richard E. Zultner

(ZRO), by adding small and specific DEs, and removing "friction" UDEs. Both of these actions increase the value stack, increasing the value-to-customer of the solution.

The result can be refined by quantifying the value of specific levels ("berries") using methods like the Analytic Hierarchy Process (AHP). [Zultner 2026a] AHP can quantify dissimilar quantitative elements, and qualitative elements, into a collective measure of value — a quantified value stack.

The boomerang approach assumes you are starting with a new technology, as a "given". This is also the starting place for the 6QT. And then you work right to left. From Q1 to Q6. To explore the *why* that technology meets some needs, of some customers, but not others. Or choose which customers to target first, with your first generation. But with the 6QT+ you're not limited to that. You can start with a targeted customer segment (Q6), and work left to right, to find the best technical solution (Q1) for that customer. Or you could start with an important customer need (Q4), and work "middle out" from there. To find which customer wants that need the most, and which technology has the most power to meet that need. The 6QT+ framework is flexible, to fit your case. To help you find your product-market fit.

We've seen the original/revised 6QT Questions evolve into the renovated 6QT+ Questions (which could be used, just as questions). And then into a new Thinking Process tool, the Customer Value Framework (with Chains on a Canvas). The "Pro" version has 6 basic columns. But what is your case requires something different? Something tailored? The "Max" version of the CV framework is customized to fit your case. If special dimensions of product development are important, if other factors are critical to your success — add them. If any of the usual columns are not relevant, remove them. Create a "Mini" version. Create your custom value canvas, that fits the entries for your project, your customers, and your technologies. And construct your custom value chains by "connecting the dots", across your customized columns.



Justus von Liebig pioneered "classical" constraint thinking… with leverage

Note: The value chain for a specific customer segment, is a value constraint… but not a traditional Eli Goldratt *limitation* constraint. It is not a resource… [Goldratt 2014] Instead, it is a classical Justus von Liebig *leverage* constraint. [Liebig 1840] It does not limit the value a customer may receive, and thus limit the throughput that a technology could produce. Rather, it is an "Archimedes point" — a foundation to enable value to a customer segment, and generate throughput for the solution provider of the technology. Instead removing what *limits* throughput, we add what *lifts* throughput. Liebig leverage constraints are often what is *required*, but *missing* from a system. Especially useful for new systems, and entrepreneurs. [Zultner 2026b]

For a start-up situation, where individual customers say, "yes, I want that!' The customer *value framework* for innovators & entrepreneurs starts with the six most critical dimensions of new technology success. And the customer *value chain,* a horizontal

Copyright © 2024 Richard E. Zultner

cross-dimension logic tree, "connects the dots" from all the previous steps. [Metaphorically, a "vine of value" grows across the "value trellis" framework.]

This logic tree shows: the logic of a new **technology**, with specific **powers**, meeting specific **customer needs**, for specific **types of customers** doing specific **jobs**, in specific **situations**. And this can then be tested with a minimum viable product… to assess product-market fit (traction). And it works for a trillion-dollar market cap company, like Apple. And new technology like the Apple Vision Pro.

The final stage is to use a series of *value chains* (logic trees of customer value) as linking bridges, to cross the chasm, for specific customer segments. An application of the New Lanchester Strategy (NLS), and beyond the scope of this paper…

Summary:

The renovated 6QT+ is:

Focused: on what matters most, the vital few needs, of the target customer segment(s) you choose. In other words, product-market fit. The only thing that matters, for entrepreneurs. The constraint on your ability to satisfy customers, by meeting their needs. Your demand constraint. It allows you to filter out — and ignore — the trivial many issues that are *chupchiks*. It gives you a place to put everything important, in leveraging a new technology, developing a new product, or entering a new market.

Flexible: 6 columns of the most critical success factors (in general, for product development) [the CV canvas], plus aligned connection(s) [the CV chain]. You can expand, or add columns in the Max version. Or collapse them for a "mini" version. Or even just use the 6QT+ questions, as questions.

Powerful: discover the needs of your targeted customer segment (Ideal Customer) and enter them on the canvas. Construct a core Offer with your initial value chain of aligned entries. And add refinements to increase the Value Stack of your Solution — to a zero-resistance UnRefusable Offer (URO). And perhaps all the way to a Decisive Competitive Edge, if you wish. The framework applies to all technologies, all solutions, and all solution providers — not just "practical" or "traditional" ones…

Contributions

For the ToC Community.

Innovation: A renovated 6 Questions for new Technology (6QT+), a Customer Value framework, that is a ToC Thinking Process logic tool for value-to-customer (V2C) analysis. This can be used to systematically engineer zero-resistance UROs, create a flow (and throughput) from zero, and address demand constraints with new high-value products powered by new technology. And it

Copyright © 2024 Richard E. Zultner

can handle the most technically advanced new products — the Apple Vision Pro.

Extension: ToC can help those who stage experiences, to experience the Promise of ToC: big gains, fast, using available resources. This opens the door to an entirely new ToC for Value solution, for staging Experiences… a large and rapidly growing sector of economic value. And one that is AI resistant…

This renovation honors, and strengthens, the legacy of Eli Goldratt. And offers a powerful new TP tool for the next generation of ToC Practitioners — so they are equipped with clearly superior tools & techniques, than other approaches…

For individual ToC Professionals. The Next Generation — detailed & specific practical guidance how to develop your solutions (professional & personal), to construct high-value offers for ideal customers — for whom your solution is their best answer. And how to refine that Offer, and increase the Value Stack, into a personal Decisive Competitive Edge (DCE).

Next Steps: What else can be fixed, or improved, in this renovation?
How to build, capitalize, and sustain, the *renovated* 6 Questions (6QT+)?

Copyright © 2024 Richard E. Zultner

6 Questions for new Technology+ Customer Value framework => canvas

6. **Customers**: What type or **segment** of customer?	5. **Situations**: Where & When is the customer?	4. "**Jobs**": What tasks or processes is the customer trying to do?	3. **Needs**: What are the customer's **DE**s & **UDE**s?	2. **Power**: What are the ***characteristics*** & ***capabilities***, of the technology?	1. **Technology**: How does it work technically? Apple M2 chip
Cinephiles (movie lovers)	In bed (not in home theater)	Watch a great movie (as the director intended)	Watch film in original format	70mm IMAX, Panavision, etc.	**Sony micro-OLED Displays**
Travellers (long distance)	On a plane, a train, or a beach in Spain (away from home or office)		No motion artifacts (variable refresh rate)	Frame rates up to 90, 96,100 fps	Audio pods with H2 chip
Complex knowledge worker	Not at desk with multiple screens		No screen door effect	3660x3200 resolution (34 pixels per degree)	Partner: Disney+ (Most 3-D content)
Gamers			Listen in original (surround) sound	Apple Spatial Audio format (Dolby Atmos)	iPhone 15 Pro & Max
"Grandparents" (memory lovers)	Not where grandchildren are	Capture lifetime moments when you're with them	"I feel like I'm there"	Apple spatial video format (3-D in MV-HEVC)	Partner: Sports Leagues (Streaming rights)
Serious Sports Fans (sport specific)	Enjoy snacks and drinks, while watching the game	Watch the game, from the best (virtual) seats	Watch in great (virtual) surroundings	Apple **immersive video** 3-D 8K 180° format	Acquisition: NextVR (immersive video cameras)
Remote workers	FaceTime, Zoom, Teams, WebEx, etc.	Attend meetings, webinars, events…	Highly interactive remote collaboration in my space	Personas, Spatial Personas, Share Play (telepresence)	Partner: video conference vendors

7. **Offer**: How are the above entries connected (aligned)?

Copyright © 2024 Richard E. Zultner

REFERENCES

1. Andressen, Marc.2007. "The Only Thing that Matters". Blog post https://pmarchive.com/guide_to_startups_part4.html The seminal definition of product-market fit (PMF)
2. Akao, Yoji. 1990. *Quality Function Deployment: Integrating Customer Requirements into Product Design*. Productivity Press. ISBN: 978-0915299416.
3. Akao, Yoji, and Shigeru Mizuno. 1994. *QFD: The Customer-Driven Approach to Quality Planning & Deployment*. Quality Resources. ISBN: 978-9283311218. Seminal work from the founders of QFD.
4. Apple, 2024a. *Hello Apple Vision Pro*. Apple Vision Pro commercial on YouTube. Available here
5. Apple, 2024b. *Apple Vision Pro User Guide*. Available here
6. Apple. 2024c. *Designing RealityKit content with Reality Composer Pro*. Available here
7. Augustine, George J., Jennifer . Groh, Scott A. Huettel, Anthony-Samuel LaMantia, Leonard E. White (eds.) 2024 7th ed. *Neuroscience*. Oxford University Press. ISBN 9780197616246 Includes the circumplex model of emotions.
8. Avidan, Orion, Christoph Lenhartz, Jeff Schraeder, and David Fradis. 2015. *Answering the Questions of Technology — Take 2: Using the TP to Transform the Way Innovation is Managed*. TOCICO Webinar. Automated refrigerator replenishment case study.
9. Baptista, Humberto. 2020. *Does TOC Need Constraints? Complexity, Constraints, Focusing Steps & Thinking Processes Relationship*. TOCICO 2020 Webinar.
10. Barnard, Alan and Eli Schragenheim. 2018. *Why have so few Organizations adopted the Theory of Constraints?* Goldratt Research Labs White Paper. Applies the 6 Questions to the Theory of Constraints.
11. Barnard, Alan. 2020. "Why Technology is Necessary But often Not Sufficient, to unlock Value". YouTube video. A revised version of the 6QT, with 5 Questions including power, limitation, old rules, new rules, and business model.
12. Barnard, Alan. 2024a. "My Keynote on AI in Dermatology" LinkedIn post. Covers the 6QT as an audit for why AI is necessary but not sufficient, and explicitly frames how to apply the 6QT to AI in dermatology.
13. Barnard, Alan. 2024b. "Why AI is Necessary But often Not Sufficient, to create Value". YouTube video. Covers the 6QT and applies them to AI in dermatology and related value-creation issues.
14. Barnard, Alan. 2025a. "What could limit YOU from unlocking the full power of AI". LinkedIn post. Covers the 6QT as real power, limitations diminished, old rules, new rules, improving the technology, and the business model.
15. Barnard, Alan. 2025b. "Why Technology can be Necessary but not Sufficient to unlock Value". YouTube video. A later video again discusses the logic and the conditions under which technology creates value, using the 6QT.
16. Bilton, Nick. "Why Tim Cook Is Going All In on the Apple Vision Pro" in *Vanity Fair* (1 February 2024). The story of the ten year development of the AVP. Available here and follow up here
17. Carlson, Curtis R., And Alan Barnard. 2023. *Innovation for Impact: A Step-by-Step Process that Creates Value for all Stakeholders*. TOCICO Webinar 12 April 2023. Defines Value as Benefits compared to Costs.
18. Christensen, Clayton M. 1997, revised 2016. *The Innovator's Dilemma: When New Technologies cause Great Firms to Fail*. Harvard Business Review Press. ASIN: B012BLTM6I. ISBN: 978-1633691780. Summary here
19. Christensen, Clayton M. and Michael E. Raynor. 2013. *The Innovator's Solution: Creating and Sustaining Successful growth*. Harvard Business Review Press. ASIN: B00E257S7C.
20. Christensen, Clayton M. 2011, revised 2016. *The Innovator's DNA: Mastering the Skills of Disruptive Innovators*. Harvard Business Review Press. ASIN: B0054KBLRC.
21. Cox, J. F. III, Blackstone, J. H. Jr., & Schleier, J. G., Jr. 2003. *Managing Operations: A Focus on Excellence* (Vols. 1–2). Great Barrington, MA: North River Press. ISBN-13: 9780884271727 "Archimedes lever point" constraints
22. Cox, J. F., III, & Schleier, J. G., Jr. (Eds.). 2010. *Theory of Constraints Handbook*. McGraw-Hill. eBook ISBN-13: 9780071665551 Multiple definitions of 'constraint', including the "Archimedes lever point"
23. Davis, Anthony. 2023. "Look What You Made Me do to the US Economy (Taylor's Version)". HVS website https://www.hvs.com/article/9726-look-what-you-made-me-do-to-the-us-economy-taylors-version Economic impact of "Swiftonomics" in the US at $4.6 billion
24. Furr, Nathan, and Jeff Dyer. 2014. Foreword by Clayton M. Christensen. *The Innovator's Method: Bringing the Lean Start-up into Your Organization*. Harvard Business Review Press. ASIN: B00M6G2WJ8.
25. Gaines, Chip & Joanna. 2025. *Fixer Upper.* Magnolia Network. The defining renovators of this decade, based on TV ratings, cultural impact, franchise size, and media coverage.
26. Goldratt, Eliyahu M. 1984, 2014. 4th rev. ed. T*he Goal: A Process of OnGoing Improvement*. North River Pres. The origin of the Theory of Constraints, in a "last and final" edition.

Copyright © 2024 Richard E. Zultner

27. Goldratt, Eliyahu M., with Eli Schragenheim, and Carol A. Ptak. 2000. *Necessary but not Sufficient: A Theory of Constraints Business Novel*. North River Press. ISBN: 978-0884271703. Paperback 231 pages. Note: the original 6 Questions, are NOT listed and explicitly stated, in this, the current English edition.

28. Goldratt, Eliyahu M. 2002. Foreword to *Necessary but not Sufficient: A Theory of Constraints Business Novel*. Unpublished communication, explicitly stating the 6 Questions for new Technology, distributed by Eli Goldratt in a POOGIforum email to his followers.

29. Goldratt, Eliyahu M. 2006. *Beyond the Goal: Theory of Constraints*. Audiobook. Gildan Media. ASIN: B000ELJ9NO. Extended discussion of the 6 Questions for new Technology.

30. Goldratt, Eliyahu M. 2010. *Overcoming Resistance to Change — Isn't it Obvious?* Animated video. Learning ToC on YouTube. Origin of Change Matrix and how to overcome "resistance" to change. Available here

31. Grunwald, Armin, ed. 2024. *Handbook of Technology Assessment* (Research Handbooks in Science and Technology Studies series). Edward Elgar Publishing. ISBN 978-1035310678. The authority on technology assessment…

32. Hormozi, Alex. 2021. *$100M Offers: How to Make Offers so Good People feel Stupid saying No*. Las Vegas: Acquisition.com. Volume 1. Practical advice on what 'value' is. And yes it has ToC inside…

33. Hormozi, Alex. 2023. *$100M Leads: How to get Strangers to Want to Buy your Stuff*. Las Vegas: Acquisition.com. Volume 2. Practical advise on increasing your value stack. And yes it has ToC inside…

34. Hormozi, Alex. 2025. *$100M Money Models: How to Make Money*. Las Vegas: Acquisition.com. Volume 3. The fastest selling non-fiction book in history. See here And yes, it has ToC inside…

35. ISO 16355:2021. *Application of statistical and related methods to new technology and product development process*. International Organization for Standardization. ISO 16355-1:2021(E). A summary of globally accepted best practices for new Technology and New Product Development. Available from ISO here

36. Kano, Noriaki and Nobuhiko Seraku, Fumio Takahashi, Shinichi Tsuji. 1984. "Attractive and Must-Be Quality" (in Japanese). Tokyo: JSQC *Quality* 14 (2 Feb 1984) 39-48. The origin of the Kano Model.

37. Kawakita, Jiro. 1986. *The KJ Method: Seeking Order out of Chaos* (in Japanese). Tokyo: Chuokoron-sha. ISBN 4-12-001517-3 Note: 1992 *Chōsō no kuni: Hikyō Himaraya tankenki* from Kōdansha ISBN 978-4061590335. The origin of the Affinity diagram, and the "moving Post-Its around" affinity process…

38. Knight, Alex. 2015. *Pride and Joy*. Never Say I Know. ASIN: B00VGSNFV6. ISBN: 978-0955953491. ToC in Health Care. Mentions the 6 Questions…

39. Liebig, Justus von. 1840. *Die organische Chemie in ihrer Anwendung auf Agricultur und Physiologie* (Organic Chemistry in its Application to Agriculture and Physiology). Available here from Project Gutenberg
First explanation of a constraint (scarcest required nutrients) limiting the growth of plants

40. Mann, Darrell, and Simon Dewulf, Boris Zlotin, Alla Zusman. 2003. Matrix 2003: Updating the TRIZ Contraction Matrix. Belgium: CREAX nv. Excellent for injections that dis-solve evaporating (conflict) clouds.

41. Miles, Lawrence D. 1961, 2015 3rd ed. *Techniques of Value Analysis and Engineering*. Lawrence D. Miles Value Foundation. ASIN: B00UIDZRR0. ISBN: B0000CL8CM. The origin of an engineering approach to value. More about the Miles Value Foundation here

42. Moore, Geoffrey A. 1991, 2014 3rd ed. *Crossing the Chasm: Marketing and Selling Disruptive Products to Mainstream Customers*. Harper Business. ASIN: B00DB3D81G. ISBN: 0062292986. Diffusion of innovation applied to marketing. Summary here

43. Pine II, B. Joseph; and James H. Gilmore. 1999 1st ed.; 2020 rev. ed. with a new Preface. *The Experience Economy: Competing for Customer Time, Attention, and Money*. Harvard Business Review Press. eISBN: 978-1-63369-798-0 The progression of economic value, and the rise of Experiences over Services, Goods, and Commodities.

44. Pine II, B. Joseph. 2026. *The Transformation Economy: guiding Customers to Achieve their Aspirations*. Harvard Business Review Press. eISBN: 979-8-89279-138-0 The further progression of economic value, beyond Experiences. To even higher value offers and solutions.

45. Postman, Neil. 1992, 2011 ebook. *Technopoly: The Surrender of Culture to Technology*. Vintage Books. ASIN: B004ZZJBW4. ISBN: 978-0-679-74540-2. Presents Postman's 7 questions for a new technology.
Video of his 1997 "The Surrender of Culture to Technology" lecture at DuPage College available here

46. Rogers, Everett. 1962, 2003 5th ed. *Diffusions of Innovation*. Free Press. ASIN: B00M6G2WJ8. ISBN 978-0743222099. The origin of diffusion of innovation theory. Summary here

47. Saaty, Thomas. 1982. *Decision Making for Leaders: The Analytic Hierarchy Process for Decisions in a Complex World.* Wadsworth ISBN 0-534-97959-9 Note: 2013 3rd ed. ISBN 978-0962031786. An introduction to a very powerful and versatile prioritization approach that works great on hierarchies. Available here

Copyright © 2024 Richard E. Zultner

48. SAVE International. 2020. *VM Guide: A Guide to the Value Methodology Body of Knowledge*. Society of American Value Engineers. ASIN: B08DP4C2QG. ISBN: 1735088013. The professional society for value engineering. More about SAVE here

49. Schragenheim, Eli. 2007. *Goldratt's Six Questions for Assessing the Value of a New Technology*. Las Vegas, NV: TOCICO 2007 International Conference.

50. Schragenheim, Eli. 2011. *Assessing the Future Value of New Products*. TOCICO Webinar. Explains the original and revised 6 Questions.

51. Schragenheim, Eli. 2021. *Goldratt's Six Questions for Assessing the Value of a New Technology*. TOCICO Body of Knowledge Paper.

52. Schragenheim, Eli. 2024. *The Six Questions on Assessing the Value of a New Technology* in *TOCICO Innovation Summit 2024* in Bad Nauheim, Germany. Theory of Constraints International Certification Organization.

53. Sims, Chris, and Alan Barnard. 2013. *SAP and TOC: A Match made in Heaven*. TOCICO International Conference. Bad Nauheim DE on 3-6 June 2013. "ValueSAP", Value Engineering… and value defined in terms of limitations.

54. Thiel, Peter, with Blake Masters. 2014. *Zero to One: Notes on Startups, or How to build the Future*. Crown Currency. ASIN: B00J6YBOFQ. ISBN-13: 978-0804139298.

55. Thompson, John. 2025. *Eli Goldratt: Necessary and Sufficient Conditions (N&S) as a Change Model*. EXEPRON website. The 6QT in a fairly original form. Available here

56. Ulwick, Tony. 2023. *Jobs to be Done: Theory to Practice*. Independently published. ASIN: B0CH1DWMQZ. Summary of Outcome-Driven Innovation here

57. Ulwick, Tony. 2005. *What Customers Want: Using Outcome-Driven Innovation to Create Breakthrough Products and Services*. McGraw-Hill. ASIN: B000RG17R2. ISBN: 0071408673. A popular "Value World" method.

58. Updegrove, David. Foreword by Eli Schragenheim. 2002. *Breakthrough to Clear Thinking and Innovation*. ASIN: B09W8V4P84. ISBN: 979-8437930458. Chapter 12 applies the 6QT..

59. Zultner, Richard E. 2017a. "The Future of Critical Chain Project Management: What to do When the Constraint is in the Market" at *TOCICO 2017 International Conference* in Berlin, Germany. Theory of Constraints International Certification Organization. The Melissa Case Study premiere.

60. Zultner, Richard E. 2017b. "Essential QFD to Make a Solo Entrepreneur Dream Come True" in *Transactions of the 24th International Symposium on Quality Function Deployment (QFD)* in Tokyo, Japan. Japanese Union of Scientists and Engineers (JUSE). 7-8 September 2017. The Melissa Case Study gains traction, internationally.

61. Zultner, Richard E. 2021. "Essential QFD+: The "Value World" Integrative Framework" in *ISQFD'26 2021 Conference Proceedings*. Frankfurt, Germany: QFD-Institut Deutschland. Frameworks in product development.

62. Zultner, Richard E. 2022. "The Renovated 6 Questions for new Technology (6QT+) and the Search for Hidden ToC Treasure" at *TOCICO 2022 Innovation Summit* in Orlando FL. Theory of Constraints International Certification Organization. A first cut at renovating the 6QT.

63. Zultner, Richard E. 2023a. *The Change Matrix: Corrected & Enhanced from 4 to 6 Boxes (CM+)*. TOCICO Body of Knowledge Paper. The Change Analogy Story, and customer needs (DEs & UDEs). The most basic beginning point, for a "full analysis" in ToC.

64. Zultner, Richard E. 2023b. "Prioritizing CC PM Features, Projects, or Portfolios, with AHP: A Critical Chain Project Management Introduction to the Analytic Hierarchy Process" at *TOCICO Critical Chain 2023 Conference*. Theory of Constraints International Certification Organization. Using the AHP with ToC.

65. Zultner, Richard E. 2024a. "The 6 Questions for new Technology, RENOvated (*6QT+*) & DEMOnstrated: Apple Vision Pro… and Taylor Swift" in *TOCICO Innovation Summit 2024* in Bad Nauheim, Germany. Theory of Constraints International Certification Organization. Turning an old technique into a modern TP tool..

66. Zultner, Richard E. 2024b. "Apple Vision Pro: QFD for Innovators & Entrepreneurs" in *28th ISQFD'24 Conference Proceedings*. Aachen, Germany: QFD-Institut Deutschland. Conference for elite product development experts.

67. Zultner, Richard E. 2025. "ToC for Value: Entrepreneurs, Experiences, & YOU — The 3rd Way to Increase Throughput, and the Best Way to Create Throughput (from Zero)" in *TOCICO Innovation Summit 2025* in Las Vegas, USA. Theory of Constraints International Certification Organization. The family of ToC(Value) solutions, including how to handle demand constraints.

68. Zultner, Richard E. 2026a. "Goal(s) in ToC: A Renovated Goal Tree+" in *TOCICO Innovation Summit 2026* in Manchester UK. Theory of Constraints International Certification Organization. A renovated Goal Tree+ based on the Customer Value Framework (CVF).

69. Zultner, Richard E. 2026b. "The Eras Tour of ToC: 'Constraint Thinking' Before, During, and After … Eli Goldratt (1947 - 2011)" a *ToCx Talk* at the *TOCICO Innovation Summit 2026* in Manchester UK. Theory of Constraints International Certification Organization. Modern ToC uses hybrid ToC solutions.

Copyright © 2024 Richard E. Zultner

AUTHOR

Richard E. Zultner,
Jonah - Mechanic *,
is a Level 3 TOCICO Certified Implementer (TOCIC™) in Critical Chain Project Management, and a certified PMI Project Management Professional (PMP).



Richard E. Zultner
*Jonah - Mechanic**
Apple Vision Pro persona

Richard helps those who stage experiences and guide transformations, to add value to their offers and solutions. He teaches them how to explore, analyze, and deliver 'value' — as their customers view it. He does this with proven, tested, and globally accepted "Value World" methods…

Additionally, Richard is a Certified Quality Engineer (CQE), and Certified Software Quality Engineer (CSQE), from the American Society for Quality (ASQ).

He is a Six Sigma Master Black Belt (MBB), and a QFD Red Belt. Richard is an International Akao Prize® recipient for his lifetime contributions to "Value World" communities, awarded by the International Symposium on QFD (ISQFD), and he holds the title of QFD-Architekt from the QFD Institute — Deutschland.

Undergraduate: Philosophy (A.B.), William & Mary in Williamsburg VA
Graduate: Master of Management (M.M.), Kellogg at Northwestern
Faculty: Adjunct Professor in Project Management, at Howe Graduate School of Technology Management, Stevens Institute of Technology in Hoboken, NJ, USA
He is now retired from academia…

Solopreneur. International business consultant for four decades,
and United 2 Million Miler and Lifetime Premier 1K MileagePlus member.

---

*Jonah - ***Mechanics*** fix up old, outdated, or unused ToC elements; they ***renovate*** them — in a Process of On-Going Improvement (**PoOGI**). And they "get started now", with minimum viable experiments… and learn as much as they can, from them. Repeatedly.

Copyright © 2024 Richard E. Zultner

The Theory of Constraints: Core Assertions and Their Scientific Foundations

Guido Bacharach

Abstract

The Theory of Constraints (TOC) proposes that every complex system is limited in achieving its goal by one or very few governing constraints and that effective improvement should focus managerial attention on the dominant constraint. TOC further provides the Five Focusing Steps as a heuristic improvement process, emphasizes explicit goal orientation, and offers a set of logical Thinking Processes for analyzing and resolving complex situations that cannot readily be addressed by its standard application solutions. This paper reviews five principal operational assertions of TOC, examines the extent to which they are scientifically supportable, and clarifies where formal proof is neither possible nor required. Formal support is demonstrated from optimization theory, network flow theory, queueing theory, and formal logic. Particular attention is given to the role of Little's Law within queueing theory, which provides a rigorous mathematical foundation for understanding bottleneck-governed flow, work-in-process, and cycle time, thereby supporting TOC's emphasis on constraint management. The analysis demonstrates that TOC integrates mathematically grounded system laws, empirically supported management heuristics, formal logical reasoning, and foundational definitions into a coherent framework for systems improvement.

Keywords: Theory of Constraints; scientific foundations; operations research; bottleneck; queueing theory; Little's Law; optimization; Thinking Processes; management science

Introduction

Since its introduction by Eliyahu M. Goldratt in the 1980s (Goldratt & Cox, 1992; Goldratt, 1990), the Theory of Constraints (TOC) has become one of the most influential management philosophies for improving the performance of complex systems. Its principles have been successfully applied in manufacturing, supply chain management, project management, healthcare, and public-sector organizations (Rahman, 1998; Watson et al., 2007). Despite its extensive practical adoption, comparatively little work has systematically examined the scientific status of TOC's principal operational propositions. While practitioners generally accept TOC because of its demonstrated effectiveness, the question of which of its propositions correspond to established scientific laws, which constitute management heuristics, and which are definitional in nature has received far less attention.

This paper addresses the following research question: Which of the principal operational assertions of the Theory of Constraints correspond to established scientific laws, which function as management heuristics, which serve as foundational definitions, and how can these different forms of knowledge be systematically characterized within a coherent scientific

framework? It examines that question by identifying five operational assertions[1] that capture essential aspects of TOC and examining their scientific basis. Rather than attempting to "prove TOC" as a whole, the analysis distinguishes between propositions that correspond to established mathematical laws, propositions that function as management heuristics, and propositions that are definitional and therefore require no formal proof. This distinction provides a clearer scientific foundation for TOC while preserving its character as a practical management philosophy.

The value of examining the scientific foundations of TOC lies in strengthening both its academic credibility and its managerial applicability. While TOC has been widely disseminated through practitioner literature and documented in numerous case studies, comparatively fewer studies have examined its scientific foundations in a systematic manner. By connecting TOC's principal operational assertions with established mathematical results in operations research, this paper clarifies which principles are provable laws of system behavior and which are heuristic guidelines. This distinction enhances credibility in academic research, supports integration with related fields such as Lean and Six Sigma, and provides practitioners with a clearer understanding of when TOC insights reflect universal system properties versus context-dependent managerial wisdom.

Although TOC originated in manufacturing, the analytical principles discussed here apply broadly. The mathematical laws of optimization, network flow, and queueing theory describe resource-constrained processes independent of industry. Recent applications in healthcare, logistics, and service operations demonstrate that the same logic of constraint identification and management extends well beyond production systems (Rahman, 1998; Iyanda & Samuel, 2024; Stefano et al., 2024). These examples are not presented as additional empirical validation of TOC, but as illustrations of the domain-independence of the underlying system laws.

The five operational assertions discussed in this paper are not intended to redefine or replace TOC's accepted foundational structures, such as the TOCICO Body of Knowledge Pillars. Rather, they serve as an analytical lens: a small set of operational propositions about flow, constraints, and system improvement that can be examined for alignment with established mathematical laws in operations research. For analytical purposes, the assertions examined in this paper can be related to one or more TOCICO Body of Knowledge pillars (e.g., Reality, Consistency, Causality, Inherent Simplicity, and Respect), but are formulated here in a way that allows explicit mapping to queueing theory, network flow theory, and optimization. In this sense, the paper does not propose new fundamentals for TOC, but provides a complementary analytical framework for examining TOC through established scientific theories.

Accordingly, this paper makes four contributions. It reconstructs TOC's principal operational assertions as explicit propositions, classifies their epistemic status according to their scientific foundations, relates them to established results from mathematics and formal logic, and provides a framework for future empirical and theoretical development.

---

[1] *Terminology Note:* The term **"assertion"** is used here in its scientific sense—a statement that can be tested or proven—without implying a new TOC category. It serves as a neutral analytical label for mapping TOC propositions to their corresponding mathematical or logical foundations.

Conceptual Foundations

Goal.

For the purpose of this paper, a goal denotes the explicit objective against which system performance is evaluated. A constraint can only be identified relative to a specified goal. Different goals may therefore imply different governing constraints.

Constraint.

A constraint is any factor that presently most limits a system's ability to achieve its goal (Goldratt, 1990). Constraints may be physical, market-related, policy-based, or behavioral. While several limiting factors may exist simultaneously, TOC focuses managerial attention on the governing constraint that currently exerts the greatest influence on overall system performance.

Governing Constraint.

The governing constraint is the constraint that currently determines the maximum attainable performance of the system with respect to its goal. It may change over time as improvements are implemented or external conditions evolve.

Bottleneck.

In queueing theory and production systems, a bottleneck is a resource whose demand exceeds or approaches its effective capacity, thereby restricting system flow. In capacity-constrained production systems, the governing constraint typically manifests itself as the bottleneck. In other domains, however, governing constraints may instead be market, policy, or behavioral constraints.

These definitions distinguish between general TOC concepts and their domain-specific manifestations, thereby providing a common terminology for the analyses that follow.

Literature Review

Since its introduction in the 1980s, the Theory of Constraints (TOC) has evolved from a production management approach into a broadly applied management philosophy. Early publications focused primarily on manufacturing and production scheduling (Goldratt & Cox, 1992, original work published 1984; Goldratt, 1990; Cox & Schleier, 2010), while subsequent work extended TOC to project management, supply chains, healthcare, logistics, and public-sector organizations (Rahman, 1998; Watson, Blackstone, & Gardiner, 2007). These studies established TOC as a widely adopted approach for improving system performance and demonstrated its applicability across diverse domains. While numerous studies have examined TOC implementations, applications, and organizational outcomes, comparatively little attention has been paid to the scientific status of TOC's underlying theoretical assertions.

Beyond documenting practical applications, several authors have examined TOC from a theoretical and scientific perspective. Verma (1997) compared TOC/OPT with Management

Science and local optimization, identifying both conceptual similarities with optimization and queueing theory and important differences regarding formal optimality. Naor, Bernardes, and Coman (2013) explicitly investigated whether TOC satisfies accepted criteria for a scientific theory in management research. Kishira (2018) further explored the logical structure of TOC by analyzing its hypothesis framework through the Thinking Processes and proposing a systematic approach to strengthening its scientific foundations. Taken together, these studies suggest that TOC has increasingly become an object of scientific investigation rather than solely a practitioner-oriented methodology.

At the same time, recent empirical research has continued to provide empirical support for the practical effectiveness of TOC-based methods. Stefano et al. (2024) assessed the Theory of Constraints Supply Chain Replenishment System and demonstrated measurable improvements in throughput and delivery reliability. Iyanda and Samuel (2024) found that TOC's Thinking Processes significantly enhance supply-chain decision-making and operational efficiency. Widyarsa and To (2025) integrated Drum–Buffer–Rope scheduling with linear programming, showing that bottleneck-focused improvements increase throughput while complementary improvements at non-bottleneck resources reduce lead time and improve overall system stability. Mabin & Balderstone (2003) analysed a large body of documented TOC implementations. These studies provide important empirical support for TOC's effectiveness but primarily evaluate implementation outcomes rather than the scientific status of the underlying propositions.

A parallel stream of research has positioned TOC within the broader landscape of management methodologies. Rahman (1998) reviewed TOC's conceptual foundations and industrial applications, while Watson et al. (2007) analyzed its evolution as a management philosophy. Sproull (2019) proposed a systematic integration of TOC, Lean, and Six Sigma (TLS), emphasizing both complementarities and differences between these approaches. Collectively, these contributions demonstrate that TOC should be understood as part of a broader family of improvement methodologies rather than as an isolated management technique.

Taken together, the existing literature establishes three important conclusions. First, TOC has demonstrated substantial practical success across multiple application domains. Second, its conceptual and philosophical foundations have attracted increasing academic attention. Third, recent empirical studies continue to provide empirical support for the effectiveness of TOC-based implementations. However, previous research has addressed empirical performance, conceptual structure, philosophical status, or methodological integration rather than systematically examining the scientific foundations of TOC's principal operational assertions. In particular, no previous study has explicitly mapped these assertions onto established mathematical and logical theories while distinguishing between propositions that are formally provable, heuristic in nature, or definitional. Addressing this gap is important because it distinguishes universal system principles from context-dependent management heuristics, thereby strengthening both the scientific foundations of TOC and its practical application. Accordingly, this paper is, to the authors' knowledge, the first to provide a systematic epistemic classification of TOC's principal operational assertions by explicitly

relating each assertion to established mathematical, optimization, queueing, or logical theories.

Methodology

This paper employs an analytical approach, mapping five principal operational assertions of TOC onto established results from optimization theory, network flow theory, queueing theory, and formal logic. The method is conceptual rather than empirical, aiming to clarify which assertions are mathematically provable, which function as management heuristics, and which are definitional.

The five assertions were selected because they represent the principal operational propositions that recur consistently throughout the core TOC literature and are sufficiently precise to permit comparison with established mathematical and logical theories. They do not replace the TOCICO Body of Knowledge pillars or other conceptual structures of TOC but provide an analytical abstraction that facilitates systematic scientific examination.

The analysis proceeds assertion by assertion. For each assertion, the paper first formulates the operational TOC proposition, then examines corresponding results from optimization theory, network flow theory, queueing theory, or formal logic, and finally classifies the proposition according to its scientific basis as mathematically provable, heuristic, or definitional.

For the purposes of this analysis, an assertion is classified as mathematically provable if it corresponds directly to an established theorem or scientific law. It is classified as heuristic if it is supported by established scientific principles but cannot itself be deductively derived from them. An assertion is classified as definitional when it establishes the conceptual framework required for analysis rather than making an empirical claim.

The objective is therefore not to evaluate the practical effectiveness of TOC implementations, but to clarify the scientific status of the propositions on which those implementations are based.

Core Assertions and Their Scientific Basis

In the TOCICO Body of Knowledge, TOC is commonly structured through pillars, core concepts, and application domains. The assertions below are therefore not proposed as an alternative set of fundamentals, but as operational expressions of TOC principles selected for formal mapping to established system laws.

Assertion 1: Every system has at least one constraint

In optimization, the Karush–Kuhn–Tucker (KKT) conditions imply that at an optimum, at least one constraint must be *binding* (Kuhn & Tucker, 1951; Boyd & Vandenberghe, 2004). In network flow theory, the **max-flow min-cut theorem** proves that maximum throughput equals the capacity of the minimum cut (Ford & Fulkerson, 1956). Queueing theory also confirms that throughput is limited by the bottleneck station (Little, 1961; Hopp & Spearman, 2011). The

stronger claim that every system has one and only one constraint is discussed separately in Appendix A.
Conclusion: Existence of constraints is formally provable.

Assertion 2: Improvement must focus on the constraint

Only binding constraints with positive shadow prices affect the objective value (Boyd & Vandenberghe, 2004; Dantzig, 1963). In production systems, adding capacity to non-bottlenecks does not increase throughput (Hopp & Spearman, 2011).

Two Senses of Throughput

It is essential to distinguish between the notion of *throughput* in TOC and the same term as used in queueing or production theory. In TOC, throughput (T) denotes the rate at which the system generates progress toward its goal. In commercial organizations, this is commonly measured as:

T = Sales revenue – truly variable costs (Goldratt, 1990).

It represents *net contribution toward the goal*, typically financial. Little's Law, by contrast, defines throughput (λ) as a *physical flow rate*: the average number of work units completed per unit of time. The two concepts are related but not identical. Physical throughput (λ) determines potential economic throughput (T), while managerial actions such as reducing variable cost or changing product mix can increase T without changing λ. The present paper therefore treats Little's Law as a *physical analogue* supporting TOC's logic of constraint management rather than as a literal equivalence of definitions.

The role of Little's Law

A critical formal connection between TOC and queueing theory is **Little's Law**:

$L = \lambda W$

where L is average work-in-process (WIP), λ is average throughput rate, and W is average cycle time (Little, 1961).

- Under steady-state operating conditions, the bottleneck determines λ, the maximum sustainable throughput.
- Increasing WIP (L) without addressing the constraint cannot increase λ; it only increases W (longer cycle times).
- Thus, managing the constraint is the only direct way to increase capacity-constrained physical throughput (λ), while improvements elsewhere may yield indirect gains through reduced cycle time and market responsiveness.

This relationship underpins Goldratt's Drum–Buffer–Rope scheduling: controlling WIP release ensures system stability and aligns with Little's Law (Hopp & Spearman, 2011).

Under steady-state conditions, Little's Law therefore provides the mathematical explanation for why improvement efforts directed at the governing constraint have system-wide effects on throughput and lead time, whereas comparable improvements at non-constraints often do not.

Buffers as a Necessary Control Mechanism

An important operational implication of Little's Law and variability in flow systems is the necessity of protective buffers. Because processing times and arrivals are stochastic, a constraint resource cannot be fully exploited without some form of time or inventory buffer to prevent starvation. In this sense, the existence of buffers follows directly from queueing-theoretic principles. Buffer Management in TOC operationalizes this insight by using buffer status as a priority mechanism, thereby stabilizing throughput while limiting excessive work-in-process. The need for buffering is therefore formally grounded, whereas buffer sizing and management rules remain context-dependent heuristics.

Conclusion: This principle is not only supported by optimization duality but also by queueing theory, where Little's Law provides a rigorous demonstration that system throughput (λ) is determined by the bottleneck, and that increasing work-in-process (L) without addressing the constraint cannot raise λ; it only increases cycle time (W).

However, this conclusion must be stated with care: improvements at non-constraints do not raise capacity-constrained throughput directly, but they can reduce cycle time and variability. In practice, such reductions in lead time may increase demand, effectively shifting the system constraint to the market. Thus, non-constraint improvements can generate indirect throughput gains when the system constraint resides outside the production process.

Assertion 3: The Five Focusing Steps

The Five Focusing Steps are conventionally stated as: (1) Identify the system's constraint, (2) Decide how to exploit the system's constraint, (3) Subordinate everything else to the above decision, (4) Elevate the system's constraint, and (5) Return to Step 1 if the constraint shifts (Goldratt, 1990; Cox & Schleier, 2010).

- Steps 1–2 (identify, exploit): correspond to locating and fully utilizing binding constraints.
- Step 3 (subordinate) corresponds to system-wide synchronization in queueing theory. Once the governing constraint has been identified and exploited, upstream and downstream resources should be coordinated with its capacity to prevent excessive work-in-process, unnecessary waiting times, and increased variability. Thus, local decisions remain subordinate to the governing constraint in order to optimize overall system performance rather than local resource utilization (Hopp & Spearman, 2011).
- Step 4 (elevate): mirrors sensitivity analysis, where relaxing a binding constraint increases performance.
- Step 5 (repeat): reflects dynamic bottleneck shifts in optimization.

Conclusion: These steps are heuristics informed by optimization and systems principles; a universal convergence proof is not applicable.

Assertion 4: Goal orientation

Decision and optimization theory requires a clear objective function (Keeney & Raiffa, 1976; Churchman, Ackoff, & Arnoff, 1957). Practically, many TOC implementations precede the Five Focusing Steps with "Step 0": explicitly define the system's goal and the measure of contribution toward that goal (e.g., T = Sales – truly variable costs). This ensures that constraint identification and improvement are anchored in the intended objective. Without an explicitly defined objective, neither constraint identification nor system improvement can be meaningfully formulated.
Conclusion: This assertion is definitional and requires no proof beyond the premises of optimization and decision science.

Assertion 5: Thinking Processes

TOC provides logical tools such as the Evaporating Cloud, Current Reality Tree, and Future Reality Tree. These tools map conflicts, causal structures, and potential solutions (Dettmer, 1997, 2007; Scheinkopf, 1999). These Thinking Processes are best understood as an extension within the broader TOC methodology, supporting implementation in managerial and policy environments rather than constituting a separate scientific law.

Logical foundation.

- Each statement in a Thinking Process corresponds to a proposition, and each causal arrow represents an implication (A→B), consistent with **Boolean algebra and propositional logic** (Mendelson, 2015).
- More complex causal statements can be modeled in **predicate logic**, while the overall structure is equivalent to a **directed acyclic graph (DAG)**, consistent with frameworks for causal inference (Pearl, 2000).

Why they are not theorems.

- A theorem is a deductive truth derived within a formal system. The TOC Thinking Processes do not generate new theorems; they are **applications of established logical principles**.
- Their validity rests on (a) **logical consistency** (no contradictions in the causal graph) and (b) **empirical falsifiability** of their underlying assumptions, whose predicted cause-and-effect relationships can be tested against observations in practice (Popper, 1959).
- Rather, they provide a structured framework for applying formal logic to **real-world managerial reasoning**.

Conclusion: The Thinking Processes are grounded in Boolean logic and formal reasoning but are not themselves mathematical theorems. They are best understood as structured applications of logic to organizational problem solving.

Summary Table

Assertion	Scientific Status	Supporting Sources
1. Every system has at least one constraint	**Mathematically provable** (optimization theory, KKT; max-flow min-cut; queueing laws)	Kuhn & Tucker (1951); Ford & Fulkerson (1956); Boyd & Vandenberghe (2004); Little (1961); Hopp & Spearman (2011)
2. Improvement must focus on the constraint	**Heuristic supported by mathematical theory** (shadow prices, bottleneck law, queueing theory, including Little's Law, and systems optimization principles)	Dantzig (1963); Boyd & Vandenberghe (2004); Little (1961); Hopp & Spearman (2011); Stefano et al. (2024); Widyarsa & To (2025)
3. The Five Focusing Steps	**Management heuristics informed by optimization and systems principles**; no universal convergence proof	Goldratt (1990); Ford & Fulkerson (1956); Hopp & Spearman (2011)
4. Goal orientation	**Definitional** in optimization/decision analysis	Churchman et al. (1957); Keeney & Raiffa (1976)
5. Thinking Processes	**Structured logical reasoning grounded in formal logic and empirically testable assumptions**; not theorems	Dettmer (1997, 2007); Scheinkopf (1999); Pearl (2000); Mendelson (2015)

Discussion

Assertions 1 and 2 are directly provable through optimization, network flow theory, and queueing theory, with **Little's Law providing a particularly rigorous bridge** between TOC practice and formal operations science. Assertion 3 reflects an iterative heuristic rather than a theorem. Assertion 4 is definitional within decision theory. Assertion 5 is grounded in Boolean logic and causal reasoning but functions as applied logic rather than as a body of theorems. This analytical foundation is echoed in contemporary empirical work. *Iyanda and Samuel (2024)* show, through a mixed-methods study in U.S. supply chains, that TOC's Thinking Processes are perceived by practitioners as critical tools for improving efficiency and decision-making, thus providing empirical support for their managerial importance beyond their logical consistency. TOC thus integrates mathematical rigor, practical heuristics, and logical reasoning into a coherent framework.

A central outcome of this analysis is that TOC should not be viewed as a homogeneous collection of propositions from a scientific perspective. Instead, its principal operational assertions occupy different epistemic categories. Some correspond directly to established mathematical laws of system behavior (Assertions 1 and 2), others function as management heuristics informed by those laws (Assertion 3), others provide necessary conceptual definitions (Assertion 4), while the Thinking Processes constitute structured applications of

formal logic to managerial reasoning (Assertion 5). Recognizing these distinctions strengthens both the scientific interpretation of TOC and its practical application by clarifying what can reasonably be regarded as formally demonstrable, heuristically justified, or conceptually defined.

Recent TOCICO Body-of-Knowledge panel discussions at the 2025 conference further reflect a growing interest in articulating TOC's conceptual foundations more explicitly. The present paper aims to contribute to this ongoing BoK-level clarification.

By defining constraint, bottleneck, and throughput precisely and aligning these terms with both TOC and formal system theory, the paper responds to the need for conceptual rigor that underpins any claim to TOC's scientific foundations.

Demonstrating the mathematical rigor of TOC has further implications beyond academic credibility. The present analysis suggests that, once its core assertions are formally established, TOC may serve as a bridge between the practitioner-oriented improvement movement and the analytical traditions of operations research and management science. This opens at least three avenues:
First, it enables systematic integration with complementary methodologies such as Lean and Six Sigma, clarifying the distinct contribution of each approach within the TLS framework.
Second, it provides a foundation for extending TOC into new research domains, including stochastic optimization, digital twins of production systems, and algorithmic scheduling.
Third, it strengthens managerial confidence: knowing which TOC principles rest on rigorous system laws versus heuristic reasoning allows leaders to focus their improvement efforts with greater precision.
In this sense, mathematical proof does not reduce TOC to abstraction but rather enhances its role as a robust and adaptable management philosophy.

Although the assertions are examined individually for analytical purposes, they also form a coherent logical sequence in practical application. Explicit goal definition provides the reference frame for identifying the governing constraint. Once the governing constraint has been identified, improvement efforts should focus on it. The Five Focusing Steps translate this principle into an iterative management heuristic, while the Thinking Processes extend TOC by providing structured reasoning for situations in which standard application solutions are insufficient. This distinction between analytical classification and practical application illustrates that the scientific organization of TOC knowledge and its managerial use follow complementary rather than identical structures.

A further nuance arises when comparing TOC with Lean. Lean initiatives often target all processes, reducing setup, processing, and waiting times across the system. While such improvements do not increase the maximum sustainable throughput of a production system constrained by a bottleneck, they substantially reduce lead times. In many cases, this reduction enhances competitiveness and stimulates demand, thereby shifting the system constraint to the market. This explains why Lean case studies frequently show major performance gains even when bottleneck capacity remains unchanged. From a TOC perspective, the distinction is clear: bottleneck improvements are the only direct path to increasing process throughput, while non-bottleneck improvements enhance flow velocity and

market responsiveness. Both perspectives are valid, and their complementarity underpins the development of integrated approaches such as TOC-Lean-Six Sigma (TLS). Empirical evidence further supports this nuance. *Widyarsa and To (2025)* combine the Drum–Buffer–Rope scheduling method with linear programming to optimize a production process. While the primary throughput gains stemmed from addressing bottleneck stations, the study also found that improvements at non-bottleneck processes contributed to smoother flow, reduced lead times, and enhanced overall system stability. This aligns with the view that non-constraint improvements, though not directly raising maximum throughput, provide indirect benefits that complement TOC's bottleneck focus.

Limitations and Future Research

The present analysis is intentionally conceptual rather than empirical. Its objective is not to test the practical effectiveness of TOC implementations, but to clarify the scientific status of its principal operational assertions by relating them to established mathematical, optimization, and logical theories. Accordingly, the proposed classification should be understood as one possible analytical reconstruction rather than the only valid formalization of TOC. Alternative classifications or mappings may also be defensible, provided they remain consistent with TOC's underlying principles.

Furthermore, the analysis focuses on five principal operational assertions and therefore does not encompass every concept contained in the broader TOC literature or the TOCICO Body of Knowledge. Future research may extend this analytical framework to additional TOC concepts, examine alternative formalizations, and investigate empirically how the distinctions between mathematically provable principles, management heuristics, and formal logical reasoning influence implementation success across different application domains.

To our knowledge, this is the first paper that explicitly maps TOC assertions onto formal mathematical and logical foundations while simultaneously providing a systematic scientific classification of their epistemic status and incorporating recent empirical evidence (Stefano et al., 2024; Iyanda & Samuel, 2024; Widyarsa & To, 2025).

Practitioner Implications

This analysis has direct value for TOC practitioners. By clarifying which TOC assertions are grounded in formal system laws and which function as management heuristics, the paper provides guidance on where to focus attention:

- Non-negotiable principles. Assertions such as the existence of a constraint (supported by optimization theory and network flow theorems) and the primacy of the constraint in determining throughput (supported by Little's Law) represent universal properties of systems. Practitioners can rely on these principles as scientific laws that hold regardless of context.
- Heuristic guidance. Assertions such as the Five Focusing Steps and the Thinking Processes remain indispensable for practical problem-solving but should be applied with the understanding that they are context-sensitive heuristics rather than universal theorems.

- Managerial application. Recognizing this distinction enhances decision-making. It allows managers to anchor their improvement strategies in the rigor of proven system laws, while also using TOC's heuristic tools to navigate complexity, variability, and human factors.

Framing TOC in this way strengthens its role as a coherent body of knowledge: it combines immutable system properties with powerful, experience-based heuristics. For practitioners, this provides clarity on what aspects of TOC must always be applied and what aspects can be adapted to local conditions.

Conclusion

The purpose of this paper is not to argue that TOC requires mathematical proof in order to be valuable. TOC has long demonstrated practical effectiveness through widespread implementation experience and published case evidence. Rather, the contribution of the present analysis is to clarify the epistemic status of TOC knowledge: some TOC propositions reflect universal system laws of flow (e.g., constraint-limited throughput and queueing behavior), while others are management heuristics (e.g., the Five Focusing Steps) and structured logical reasoning (e.g., the Thinking Processes). Making this distinction explicit strengthens TOC's scientific communicability, supports its integration with related improvement methodologies such as Lean and Six Sigma, and enhances the conceptual clarity of the TOCICO Body of Knowledge.

The distinction between direct and indirect effects of non-constraint improvements clarifies an apparent paradox: TOC emphasizes that only the constraint governs throughput, while Lean demonstrates that improvements elsewhere can transform system performance. The reconciliation lies in recognizing that Lean improvements reduce cycle time and variability, which may reposition the governing constraint. TOC, Lean, and Six Sigma are therefore not contradictory but complementary perspectives, each addressing different levers of performance.

Goldratt's later reflection, "Standing on the Shoulders of Giants" (1999), identified four flow concepts—Inherent Simplicity, Convergence, Consistency, and Respect—that articulate the philosophical foundations of TOC. These ideas later evolved into the TOCICO Pillars of Knowledge. While the present paper focuses on TOC's operational assertions that can be formally proven or mapped to system laws, the flow concepts provide the epistemological context that justifies TOC's logical structure. Together, they express both the scientific and philosophical coherence of TOC as a theory of flow.

The results presented here reinforce the five **TOCICO Pillars of Knowledge**—Reality, Consistency, Causality, Inherent Simplicity, and Respect. Assertions 1 and 2 embody *Reality* and *Consistency* through formal proof; the analysis of the Thinking Processes expresses *Causality*; the demonstration that system behavior can be explained through a single governing limitation exemplifies *Inherent Simplicity*; and the recognition that certain aspects remain heuristic rather than provable reflects *Respect* for human judgment and contextual variation.

The paper's contribution is twofold: (1) it establishes a rigorous mapping between TOC assertions and scientific foundations, and (2) it clarifies the boundary between provable laws and heuristic practices. These findings resonate with recent empirical studies (e.g., *Stefano et al., 2024; Iyanda & Samuel, 2024; Widyarsa & To, 2025*), which collectively demonstrate that TOC is both theoretically rigorous and practically validated across diverse contexts. This provides a stronger basis for academic research and for practitioners integrating TOC with Lean and Six Sigma approaches.

Taken together, the present analysis demonstrates that TOC spans several complementary domains of knowledge rather than relying on a single form of scientific justification. Its principal assertions range from mathematically provable system laws through management heuristics informed by those laws to formal logical reasoning and foundational definitions. Viewed from a managerial perspective, these assertions also form a coherent progression: explicit goal definition provides the reference frame for identifying the governing constraint; focused improvement follows from that identification; the Five Focusing Steps operationalize continuous improvement; and the Thinking Processes provide structured reasoning when standard TOC applications are insufficient. Thus, the scientific organization of TOC knowledge and its practical application follow complementary rather than identical structures.

From a TOCICO perspective, the value of this work lies not in attempting to prove TOC as a unified management theory, but in clarifying the epistemic status of its principal operational assertions. Rather than requiring a single type of scientific justification, TOC derives its strength from the complementary interaction of mathematically provable system laws, empirically supported management heuristics, formal logical reasoning, and conceptually necessary definitions. By identifying these distinct foundations, the community gains sharper language for academic engagement, methodological comparison, and future theory development. In this sense, formal grounding does not replace practice—it reinforces TOC's position as both an applied management philosophy and a coherent scientific framework.

About the Author

Guido Bacharach, Former Head of Strategy and Digitization Unit at the Stiftung für Hochschulzulassung in Dortmund. After his university studies he has held predominantly management positions, especially in the sales area and in public services. The focus of his work is on strategic digitization, process improvement, and project management. He is co-founder of the TOCICO SIG "TOC in Government.

Appendices

Appendix A: On the Uniqueness of the Constraint

A frequently cited TOC claim is that *"at any given moment in time, there is one and only one constraint that governs the productivity of the system."* This statement requires careful clarification in light of mathematical theory.

Provable weak form

It is mathematically provable that in any system with limited resources, **at least one constraint must be binding** at the optimum. In optimization, this follows from the Karush–Kuhn–Tucker (KKT) conditions: at least one constraint will have a positive shadow price, thereby limiting the objective (Kuhn & Tucker, 1951; Boyd & Vandenberghe, 2004). In network flow theory, the **max-flow min-cut theorem** proves that maximum throughput is determined by the capacity of at least one minimum cut (Ford & Fulkerson, 1956).[2]

Disproof of the strong form

The stronger claim—that there is *exactly one and only one* governing constraint—cannot be universally proven. Counterexamples exist:

- **Degeneracy in optimization**: In linear programming, two or more constraints can be simultaneously binding at the optimal solution, each equally limiting the objective (Dantzig, 1963).
- **Parallel bottlenecks in networks**: In a flow network, if two disjoint cuts each have identical minimal capacity, both cuts jointly determine throughput.
  Thus, mathematics disproves the universality of the "only one constraint" formulation.

Managerial interpretation

TOC resolves this issue pragmatically:

- Often, in real systems, **one constraint dominates**, and focusing managerial attention on it yields substantial improvement.
- When multiple constraints exist, TOC either treats them as a **composite constraint** or redefines the **system boundary** so that each independent flow is analyzed separately.

Conclusion

Therefore, the scientifically rigorous version of the claim is:

At any given time, there exists at least one governing constraint that limits system performance.

The stronger version (*one and only one*) is best understood as a **management heuristic** designed to focus attention, rather than as a universal mathematical theorem.

Appendix B: On Strategic Constraints and Control Points

Several TOC practitioners have extended Goldratt's original concepts by emphasizing the deliberate creation of a *governing constraint*. Woeppel (2001) argues that every system can be positively altered to establish a *strategic constraint* (Cox's term), which dictates the pace of the system and thereby determines long-term throughput. Fox and Fox (2003) refer to a similar mechanism as a *control point*, although Woeppel notes that the control point may be positioned upstream from the strategic constraint. Related terms include *strategic gatekeeping* (Woeppel, 2001) and *controlled materials release* (Schragenheim & Dettmer, 2000).

---

[2] In some models the optimal solution lies strictly inside the feasible region, so no inequality constraint binds; this doesn't negate the existence of system limits—it simply means that, at that operating point, the governing limitation may be external (e.g., market demand) or policyimposed rather than an internal capacity, which is precisely why TOC distinguishes the *existence* of limits from *which* one is currently governing.

Truth value

This claim is **true in a managerial sense**: it is always possible to enforce a governing constraint by regulating material release or pacing at a chosen location in the process. By doing so, the system is synchronized around this point, and throughput becomes directly governed by it.

Scientific status

The principle is **scientifically provable**, not as a law of nature but as a result of controlled intervention:

- In queueing theory, Little's Law ($L = \lambda W$) demonstrates that input control directly influences work-in-process and cycle time (Little, 1961).
- In network flow models, limiting inflow at a chosen node effectively creates a capacity-constraining cut, thereby governing overall throughput (Ford & Fulkerson, 1956).
- In optimization models, adding a release constraint changes the set of binding conditions, such that the designated point becomes the governing limitation (Boyd & Vandenberghe, 2004).

Thus, while a naturally occurring unique governing constraint is not guaranteed, it is **always possible to design and enforce one**. This aligns the managerial language of TOC (strategic constraint, control point, gatekeeping) with well-established results in operations research and queueing theory.

Conclusion

The claim that "every system can be positively altered to create a governing constraint" is **true and scientifically provable** as a managerial intervention. It reflects not a universal natural law, but the deliberate imposition of control to stabilize and synchronize flow.

Appendix C: Managerial Insight vs. Mathematical Abstraction

As emphasized by Schragenheim (personal communication, August 25, 2024; see also Schragenheim & Dettmer, 2000), TOC's practical contribution lies not in asserting that mathematically only one constraint exists, but in showing that organizations should focus on *one, or very few, dominant constraints*. In managerial practice, when leaders are asked what limits performance, the answer is often "many things." TOC reframes the problem: improvement should be concentrated where it has maximum leverage.

This differs from linear programming (LP), where the concept of a "binding constraint" is formally defined. As noted by Ronen (1992), TOC's constraint is analogous to a binding constraint in LP. However, LP is a deterministic optimization method: it assumes certainty and can easily yield solutions where multiple constraints bind simultaneously. In contrast, real-world systems are inherently uncertain. Variability makes it highly unlikely that multiple constraints will operate with precisely equal binding effect in practice. Consequently, from a managerial perspective, one constraint tends to dominate and govern system performance over time.

Thus, while the *mathematical abstraction* allows for multiple simultaneous binding constraints, the *practical insight* of TOC is that focusing on one dominant constraint is both realistic and actionable in environments of uncertainty.

This pragmatic framing reconciles the difference between mathematical abstraction and managerial application, further deepening the TOC Body of Knowledge.

Appendix D: Scholarly Critiques of TOC and Their Relevance to the Present Analysis

Over the last several decades, the Theory of Constraints has attracted a number of scholarly critiques. These discussions are valuable because they highlight conceptual ambiguities, methodological limitations, or evidence gaps that shaped the evolution of TOC from a practitioner-led insight to a more formalized management theory. The critique themes below summarize the most frequently cited concerns together with contemporary responses and clarifications. The purpose of this appendix is not to defend TOC dogmatically, but to contextualize how the present paper addresses many of the issues raised in academic literature.

Overview of Scholarly Critiques and Contemporary Responses

Critique 1: Sub-optimality of Drum–Buffer–Rope (DBR)

Representative sources: Trietsch (2005); Linhares (2009)

DBR has been argued to be inferior to exact optimization or combinatorial methods, especially in product-mix and scheduling contexts. This critique is accurate at the level of mathematical optimality: DBR is not designed to compute global optima for NP-hard problems. Rather, DBR is a practical flow-control mechanism grounded in Little's Law and network-flow logic. The analysis in Assertions 1 and 2 clarifies that DBR operates within the mathematically defined bounds of any flow system and provides a robust heuristic for stabilizing throughput around the constraint.

Critique 2: Limited acknowledgment of intellectual lineage

Representative sources: Duncan as cited in Steyn (2000); Noreen, Smith & Mackey (1995)

Some authors argue that TOC borrows from system dynamics, statistical process control, PERT/CPM, and Just-in-Time (JIT) without sufficiently acknowledging those origins. Goldratt directly addressed this issue in Standing on the Shoulders of Giants (2009), where he explicitly credits earlier work in systems thinking, queueing, and industrial engineering. The present paper reinforces that lineage by mapping TOC assertions to established laws of operations research, making the intellectual continuity transparent.

Critique 3: Proprietary origins and lack of algorithmic transparency

Representative source: Rahman (1998)

The early Optimized Production Technology (OPT) system — an early production-scheduling software developed by Goldratt — was partially proprietary, which raised concerns about scientific transparency. Modern TOC practice, however, is fully documented in open literature, and DBR, the Thinking Processes, and Critical Chain project management are widely available and independently studied. The proprietary nature of OPT is therefore a historical artifact, not a defining characteristic of current TOC methodology.

Critique 4: Insufficient empirical validation of TOC effectiveness

Representative sources: Gupta & Snyder (2009)

Earlier reviews noted a lack of rigorous empirical studies linking TOC implementations to measurable performance improvement. This situation has changed substantially. Recent peer-reviewed studies (e.g., Stefano et al., 2024; Iyanda & Samuel, 2024; Widyarsa & To, 2025) demonstrate improvements in flow, operational stability, and financial outcomes. Academic research has increasingly documented TOC's application base and theoretical development across multiple domains (Mabin & Balderstone, 2003), addressing earlier concerns about limited scholarly

recognition. These results address the evidence gap identified in earlier literature and support the empirical validity of TOC in modern environments.

Critique 5: Under-emphasis on human factors or policy constraints

Representative source: Nave (2002)

TOC was criticized for not sufficiently empowering employees or addressing policy constraints. Such critiques largely reflect early 1990s interpretations. Contemporary TOC practice explicitly incorporates policy constraints, organizational learning, and cross-functional alignment. Moreover, TLS (TOC–Lean–Six Sigma) frameworks directly integrate employee empowerment and structured problem-solving into TOC implementations.

Critique 6: Lack of scientific rigor in Goldratt's early exposition

Representative source: Mukherjee & Chatterjee (2007)

This critique points out that Goldratt often presented insights narratively rather than formally. The main contribution of the present paper is precisely to evaluate the scientific status of TOC's core assertions by mapping them to established mathematical models in optimization, network theory, and queueing. Where TOC principles align with proven system laws, the paper classifies them as "provable"; where they rely on managerial judgment or causal reasoning, they are treated as "heuristic." This distinction directly addresses concerns about rigor.

Synthesis

Taken together, the historical critiques of TOC reflect the natural evolution of a management philosophy developing into a more formal theory of flow. Many early criticisms pointed to the absence of mathematical grounding, unclear terminology, or insufficient empirical research. The analyses in this paper explicitly address these gaps by showing that TOC's core propositions align with fundamental system laws and by clarifying where TOC relies on formal proof versus heuristic guidance. Rather than weakening TOC, these critiques highlight the areas where TOC has continued to mature and where scientific framing can make the theory stronger, more transparent, and more widely adoptable.

References

Boyd, S., & Vandenberghe, L. (2004). *Convex optimization.* Cambridge University Press.

Churchman, C. W., Ackoff, R. L., & Arnoff, E. L. (1957). *Introduction to operations research.* Wiley.

Cox, J. F., & Schleier, J. G. (Eds.). (2010). *Theory of constraints handbook.* McGraw-Hill.

Dantzig, G. B. (1963). *Linear programming and extensions.* Princeton University Press.

Dettmer, H. W. (1997). *Goldratt's theory of constraints: A systems approach to continuous improvement.* ASQ Quality Press.

Dettmer, H. W. (2007). *The logical thinking process: A systems approach to complex problem solving.* ASQ Quality Press.

Ford, L. R., & Fulkerson, D. R. (1956). Maximal flow through a network. *Canadian Journal of Mathematics, 8,* 399–404. https://doi.org/10.4153/CJM-1956-045-5

Fox, B., & Fox, K. (2003). *The constraint management handbook.* St. Lucie Press.

Goldratt, E. M. (1990). *Theory of constraints.* North River Press.

Goldratt, E. M., & Cox, J. (1992). *The goal: A process of ongoing improvement* (2nd ed.). North River Press. (Original work published 1984)

Goldratt, E. M. (2009). Standing on the shoulders of giants: Production concepts versus production applications. Gestão & Produção, 16(3), 333–343. https://doi.org/10.1590/S0104-530X2009000300002

Gupta, M., & Snyder, D. (2009). Comparing TOC with MRP and JIT: A literature review. International Journal of Production Research, 47(13), 3705–3739. https://doi.org/10.1080/00207540802662852

Hopp, W. J., & Spearman, M. L. (2011). Factory physics (3rd ed.). Waveland Press.

Iyanda, I. O., & Samuel, A. T. (2024). Influence of Theory of Constraints on optimizing supply chain management in the USA. *International Journal of Research and Innovation in Social Science, 8*(5), 63–75. https://doi.org/10.47772/IJRISS.2024.8505

Keeney, R. L., & Raiffa, H. (1976). *Decisions with multiple objectives: Preferences and value tradeoffs.* Wiley.

Kishira, Y. (2018). Scientific approach to the Theory of Constraints: Mystery analysis of its hypothesis structure. *Journal of Japan Industrial Management Association, 69*(4), 163–170. https://doi.org/10.11221/jima.69.163

Kuhn, H. W., & Tucker, A. W. (1951). Nonlinear programming. In J. Neyman (Ed.), *Proceedings of the Second Berkeley Symposium on Mathematical Statistics and Probability* (pp. 481–492). University of California Press.

Linhares, A. (2009). Theory of constraints and the combinatorial complexity of the product-mix decision. International Journal of Production Economics, 121(1), 121–129. https://doi.org/10.1016/j.ijpe.2009.04.023

Little, J. D. C. (1961). A proof for the queuing formula: L = λW. *Operations Research, 9*(3), 383–387. https://doi.org/10.1287/opre.9.3.383

Mabin, V. J., & Balderstone, S. J. (2003). The performance of the theory of constraints methodology: Analysis and discussion of successful TOC applications. *International Journal of Operations & Production Management, 23*(6), 568–595.

Mendelson, E. (2015). *Introduction to mathematical logic* (6th ed.). CRC Press.

Mukherjee, S. M., & Chatterjee, A. K. (2007). The concept of bottleneck. Working Paper No. 2006-05-01, Indian Institute of Management Ahmedabad.

Naor, M., Bernardes, E. S., & Coman, A. (2013). Theory of constraints: Is it a theory and a good one? *International Journal of Production Research, 51*(2), 542–554. https://doi.org/10.1080/00207543.2011.654137

Nave, D. (2002). How to compare six sigma, lean and the theory of constraints. Quality Progress, 35(3), 73–80.

Noreen, E., Smith, D., & Mackey, J. (1995). *The theory of constraints and its implications for management accounting.* North River Press.

Pearl, J. (2000). *Causality: Models, reasoning, and inference.* Cambridge University Press.

Popper, K. (1959). *The Logic of Scientific Discovery*. Routledge.

Rahman, S. (1998). Theory of constraints: A review of the philosophy and its applications. *International Journal of Operations & Production Management, 18*(4), 336–355. https://doi.org/10.1108/01443579810206250

Ronen, B. (1992). The complete kit concept. *European Journal of Operational Research, 61*(1–2), 175–182. https://doi.org/10.1016/0377-2217(92)90104-K

Scheinkopf, L. J. (1999). *Thinking for a change: Putting the TOC thinking processes to use.* CRC Press.

Schragenheim, E., & Dettmer, H. W. (2000). *Manufacturing at warp speed: Optimizing supply chain financial performance.* CRC Press.

Sproull, B. (2019). *Theory of Constraints, Lean, and Six Sigma improvement methodology.* Taylor & Francis. https://doi.org/10.4324/9780429284007

Stefano, G., Lacerda, D. P., Morandi, M. I. W., Cassel, R. A., & Denicol, J. (2024). How important is the Theory of Constraints to supply chain management: An assessment of its application and impacts. *Computers & Industrial Engineering, 191,* 109136. https://doi.org/10.1016/j.cie.2024.109136

Steyn, H. (2000). An investigation into the fundamentals of critical chain project scheduling. International Journal of Project Management, 19(6), 363–369.

Trietsch, D. (2005). From management by constraints (MBC) to management by criticalities (MBC II). Human Systems Management, 24(2), 105–115. https://doi.org/10.3233/HSM-2005-24109

Verma, A. K. (1997). Theory of Constraints/Optimized Production Technology and local optimization: A laboratory experiment. *Production and Inventory Management Journal, 38*(2), 77–82.

Watson, K. J., Blackstone, J. H., & Gardiner, S. C. (2007). The evolution of a management philosophy: The theory of constraints. *Journal of Operations Management, 25*(2), 387–402. https://doi.org/10.1016/j.jom.2006.05.002

Widyarsa, D. N., & To, R. R. (2025). Optimization of the production process using the Theory of Constraints (TOC) method based on Drum–Buffer–Rope (DBR) improvements. *SISTEMASI, 14*(4), 1234–1248. https://doi.org/10.5281/zenodo.13894626

Woeppel, M. (2001). *Manufacturing breakthrough: Achieving maximum production from existing assets.* CRC Press.

The Goal of Government: Applying the Theory of Constraints to Government

Alfredo J. Mycue, Micheal S. Giles and Guido Bacharach

14 January 2025

Abstract

This paper is an effort to create a generic goal for all government. It considers the likely candidates for such a general goal and investigates them with a hybrid method that blends the scientific inquiry with historical analysis, political philosophy, and an examination of current governments across the globe. In the tradition and practice of the Theory of Constraints (TOC), this paper uses Eli Goldratt's Standing on the Shoulders of Giants approach to examine the goal of government question. Construction of a government goal tree, which accompanies this analysis, has initiated the process of translating the TOC body of knowledge into the language and context of government. The paper arrives at a suggested generic goal for all government: increase quality of life, now and in the future. Different jurisdictions will arrive at their own definitions of quality of life in diverse ways based on their cultural and historical traditions; but the suggestion here is that governments across the globe can serve their communities by pursuing a common, generic goal that has been tailored to their locality, jurisdiction or region. In the often-polarized practice of governance, this goal offers the promise of complementary, focused governments pursuing an increase in quality of life for people in its jurisdiction. Additionally, in a manner that strives to be apolitical, this paper chronicles the many challenges of creating a generic goal of government to include differing political views, the politics-administration dichotomy, and moral questions such as war and the use of government goals for personal gain. One of the aims of this paper is to attract the interest of public administrators who might be curious about the powerful suite of TOC improvement methods that have the potential to help public managers accomplish their challenging work. The paper wraps up by inviting future efforts that include the next two steps of the TOC approach that follow goal construction: how should progress be measured and what factors constrain that progress.

Introduction

"The legitimate object of government is to do for a community of people whatever they need to have done but cannot do at all or cannot do well for themselves in their separate individual capacities."

– Abraham Lincoln in a letter to Henry L. Pierce on April 6, 1859 (Lincoln 2008, 376)

The Theory of Constraints (TOC) was originally developed in manufacturing and later successfully translated into many other domains. As Eliyahu Goldratt remarked:

"Everything that we are talking about is correct also for the service environment. But you'll have to do the translation—the translation in the language!"

– Eliyahu M. Goldratt in *Beyond the Goal* Audiobook (2006, Ch. 2, 38m26s)

This paper accepts that challenge: to translate the TOC—originally developed for manufacturing—into the language and logic of government. Following Goldratt's own observation that improvement methods must be translated into the language of the environment in which they are applied, this paper extends that principle from manufacturing and services to government. By "translation" we do not mean the application of individual TOC tools within government organizations. Rather, we mean the systematic adaptation of the underlying TOC concepts, terminology, measurements, and logical framework so that they become native to the governmental domain.

Our society and our representatives have many goals for our government. To achieve these goals and aims, government institutions are required to play many roles in our lives, such as the role of unemployment insurer to ameliorate job loss or the provider of law and order to deliver justice and security. Amidst these demands it is easy for citizens, politicians, and public servants to fall into the melee of competing political philosophies, contested mandates, and resource conflicts. The search for government goals often seems to invite conflict and disagreement. By posing the question, what is the goal of government, this inquiry proposes to rise above the fray in a search of a generic answer that is resistant to the differences people hold as to what role they believe government should have in people's lives. Put another way, the objective of this essay is to develop and propose a reasonable and general goal of government that has been generated while considering the philosophies of governance, historical experiences, and individual rights, together with a reasoned conviction that there are certain roles and services that are inherently governmental. This essay proposes to aggregate these elements and obligations of government to create a generic goal. The grand assumption of this investigation is that there is a logical nexus between society, civilization, humanity, and government. The goal of government may very well rest at that junction. A closer and more organized look is in order.

The body of knowledge and investigative framework that constitutes the Theory of Constraints possesses a lineage and track record that makes it an attractive candidate for this inquiry's primary analytical vehicle. In 1984, Eli Goldratt wrote the book, *The Goal*, to examine the often-contradictory behaviors in business and to urge a more aligned and logical path toward a unified, viable vision. Common practices, such as habitual cost-cutting, blind technology purchases, and unfocused management attention caused businesses to squander their efforts and ignore opportunities to grow and profit. Misalignment was the malady; Goldratt offered *The Goal* as the remedy.

The TOC is also composed of a set of tools and methods that aim to reveal and resolve conflicts; this is a good arsenal to have if the objective is a generic goal of government, despite an often-polarized polity. TOC aims to enable ongoing improvement by routinely achieving operational focus with techniques such as the Five Focusing Steps and cause-and-effect diagramming. The TOC body of knowledge (BOK) is composed of a broad suite of problem-solving approaches and instruments, such as "the logical thinking process" that can help one peer into the future, offering viable and goal-achieving changes (Dettmer 2016, p. 22).

As discussed in the Theory of Constraints International Certification Organization (TOCICO) whitepaper "Unique Features of Government and How Governance Could be Assisted by the Theory of Constraints" by

Eli Schragenheim and Alfredo Mycue, TOC offers the potential to address both routine and wicked constraints faced by government (2022). Outfitting public managers with TOC tools and methods can help them to defeat debilitating conflicts and solve problems that historically have frustrated public value production. However, this potential to resolve long standing conflicts can only be reached if the TOC BOK is translated into government language and concepts that resonate with public servants. While the main objective of this paper is to develop a generic goal of government, it also offers an opportunity to introduce and explain the TOC BOK to public servants and those who want to contribute to the public interest.

Intended Audience

We sought to write this paper plainly enough to be appreciated by a general audience, with particular usefulness to three specific audiences: (1) public administrators and elected officials, (2) TOC professionals, and (3) the academic community.

First, we hope that people in administrative and elected offices can use it to improve their operations and workplace relationships at all levels of government. Introducing these government leaders to the powerful problem-solving tools of TOC is a key objective of this effort. Second, we hope that TOC practitioners and consultants can use this paper to attain a better understanding of how the TOC's concepts and tools must be adapted to the unique setting of the government sector. Thirdly, we hope it is of use to the academic community for forging knowledge regarding the constraints of governance and how they affect political systems, public administration, and the management of those constraints.

Structure of the Paper

The methods, examples, and approach used in this paper are presented in a way that translates the TOC BOK into a government lexicon consistent with the reasoning and language often used in public administration. The methodology used to construct this paper draws on TOC problem-solving techniques and tools typically used to analyze an organization for the purpose of enabling a process of ongoing improvement. But this paper does this by using explications and terminology that are designed to resonate with public manager professionals at all levels of government. In order to begin the pursuit of this broad objective, the authors thought it wise to start with the question of "what is the goal of government?" and then to use TOC approaches and tools to fully develop a robust picture of what attributes a goal-achieving government needs to have to effectively serve its citizens. This purpose was accomplished in five parts:

After establishing a few key definitions, the first part of this paper develops a working goal statement for government by following and applying the "on the shoulders of giants" guidelines, which was championed by Goldratt and has been used by other TOC luminaries to investigate improvement opportunities (Ferguson 2012). This method of inquiry facilitated the examination of the relevant works of Plato, Aristotle, Hegel, Kant, Voltaire, Montesquieu, Condorcet, Hobbes, Locke, Jefferson, Madison, Hamilton, Lincoln, Rawls, and other giants who have helped society understand the role that government plays in our lives. This process is

based on the fundamental belief that knowledge, posited and demonstrated by giants in their fields, can function as a solid base on which others can build upon further understanding.

The SOTSOG approach enabled development of a generic goal of government of any country that is of the people and for the people, which the authors recognize as the majority of the countries on the globe. On this basis, this paper postulates that the goal of government is to increase the quality of life of its community members now and in the future.

In the second part, the authors strove to identify and then justify why we chose ten key assumptions that underlay the goal of government. The draft goal statement and the key assumptions laid the foundation for the third part of this inquiry: an interference diagramming exercise among the authors where the generic goal of government was placed in the center of a whiteboard and all manner of obstacles, interferences, and challenges to goal achievement were identified (Sproul & Nelson 2012, 65). Continuing the brainstorming session, the authors identified possible injections, solutions, and creative ideas as to how to overcome or mitigate the challenges. Persistent conflicts, often political or polemical in nature, were initially identified here in Part 1 and investigated in Part 4.

The second part this paper also focuses on a generic goal for governments: "Increase quality of life, now and in the future." While recognizing that this objective may give rise to fundamental conflicts—such as the inherent tension between the societal goal of government and the personal goals of governors—such core conflicts are out of scope for this work.

We explicitly limit our conflict analysis to issues pertinent to goal selection within the broader framework of increasing quality of life. These specific challenges are addressed in the context of the "sticky wickets" topics discussed in detail throughout the paper. This analysis does not venture into other core conflicts that may affect the quality of life. However, it is the authors' hope that other persistent conflicts in government, especially those in the realms of politics, policy and implementation, will be investigated by other authors in other analytical papers.

The third part of the paper used the results of the interference diagramming to identify the critical success factors and necessary conditions that the authors used to populate the government goal tree in Figure 2 below. Treating the enterprise of government as a macro system, we developed a goal tree for government to represent the system's goal in a logical, visual flow denoted by arrows between the entities. Goal tree development allowed the authors to identify the critical success factors which indicate the key capabilities necessary for goal achievement. This assessment process also enabled the authors to distinguish those critical success factors from supporting necessary conditions in the tree. H. William Dettmer, author of *The Logical Thinking Process: A Systems Approach to Complex Problem Solving*, observed that critical success factors can "be considered major milestones, or terminal outcomes, on the journey to the goal" (Dettmer 2016, 68). Critical success factors are crucial necessary conditions that, if omitted, would jeopardize, if not prevent, goal achievement. Thus, in the third part, the goal tree is represented and discussed broadly, setting the stage for the fourth part of the paper.

The fourth part of the paper conducted a critical analysis of the goal tree. Questions such as "why were these critical success factors chosen, while others were excluded?" are addressed in this part. Deliberative focus on the goal tree and its components provided an opportunity to exchange ideas, clarify concepts, and debate difficult or contradictory aspects of the emerging tree. This paper summarizes and reports on those challenging deliberations. Agreement and consensus were often a satisfying product of this process, but not always. Take for example the lack of consensus surrounding the suggested critical success factor, the "ability to problem solve" and "ability to address market failures." The authors disagreed as to whether that function was a necessary condition of government, as envisioned by the goal. Such key questions, labeled as sticky wickets, are investigated in the paper, but not at the cost of losing focus on the goal of government and its critical and necessary elements.

The fifth part of the paper is a more reflective section. It considers the relative successes and limitations of this inquiry, and invites further critique and contribution from citizens, public managers, politicians, and members of the TOC community. The goal tree proposed here is in need of their feedback and improvement suggestions. This part of the paper also considers the relative utility of a generic goal of government and speculates on the potential of a common goal to engender consensus and social focus. This final part also considers and reaffirms the subjacent objective of making the TOC BOK accessible to public administrators around the globe. Part five concludes by proposing that the next step in this pursuit is the development of ways to measure progress toward the goal. An ambitious path forward is laid out for the confluence of TOC, governance and administration.

An Apolitical Perspective

This paper holds a risk that readers may suspect that a political agenda of some sort is being surreptitiously honed by the authors. As noted in the politics-administration dichotomy discussion, it is nearly impossible to discuss the goal of government without inviting political views into the conversation. The authors realize that politics imbue all the activities of government to some extent; nonetheless, they sought to analyze the topics and questions of this paper in an apolitical way. If the paper is successful in this endeavor, then this paper has the potential of rising above political struggles even as it draws generic conclusions.

Take for example, the critical success factors, especially those that discuss public value and governance markets. The paper endeavors to design and describe them in apolitical terms. This is because the suggestion of this paper is for political decisions to be decided by the owners of each government. Put another way, each critical success factor, as it is defined by the people in a specific jurisdiction, will be shaped and tailored to reflect localized politics and values. For example, public value in one country may include public education and universal healthcare. In another country, public value may be more narrowly focused on guaranteeing natural individual rights. The governance markets at work in each jurisdiction determine which political views and values are dominant in that region.

Such politically defined public values are not grafted onto this paper. Rather, this paper provides a generic and theoretical structure that, when utilized by a particular society, can migrate from the general to the specific via the jurisdictions' political processes. Locally or regionally defined public value will take shape in

provided services that are determined and funded by the political process. The idea is for political questions to be debated and decided in specific jurisdictions. It is for them to decide what public value is, which, in turn, shapes the definition of quality of life for the jurisdiction. On this basis, each community determines the priority needs to be provisioned by their government.

Hybrid Goal Development: Scientific and Philosophical

The approach used by the authors to develop and select a succinct, generic goal of government was a hybrid method that combined several goal derivation approaches. In The Goal, Goldratt used Socratic questioning to lead Alex Rogo to conclude that the goal of a profit-oriented manufacturing company is to "make money now and in the future." In later work, Goldratt and subsequent TOC developments expanded the discussion of organizational goals and their necessary conditions. The present paper is not concerned with refining the goal of business organizations, but with applying the same logical process to governments. To further guide this inquiry, we used the SOTSOG approach to assess what has been accomplished by giants in the domain of government purpose, what areas remain untouched, and thus need to be examined.

Ever vigilant for chupchiks and political quagmires, we shared our government experiences, observations, and studies. We collected various “goal of government” hypotheses put forward by political philosophers and politicians to include Plato, Aristotle, and other giants listed above who have helped us understand the role that government can or should have in the lives of the people in the jurisdiction or polity. In their search for government’s purpose, these giants considered and debated many of the necessary conditions that are now reflected in the government goal tree (will be discussed in Part 3 of this paper). Nonetheless, among the examined writings six distinct themes vied for the apex position of general goal:

Hypothesis 1: The goal of government is to provide security. Example proponent: Hobbes

Hypothesis 2: The goal of government is to enable trade through the provision of stability. Example proponent: Adam Smith. This is the closest to “making money” via prosperity as urged in *The Goal*.

Hypothesis 3: The goal of government is to advance the interests of the nation. Example proponent: Alexander Hamilton

Hypothesis 4: The goal of government is to safeguard individual rights. Example proponents: George Mason and many contemporary libertarians.

Hypothesis 5: The goal of government is determined by the leader. Example proponents: Louis XIV and de facto theory of monarchies and some republics.

Hypothesis 6: The goal of government is to increase quality of life. Example proponent: Aristotle.

The inquiry follows a hypothesis-driven process consistent with scientific reasoning in the sense that we tested the hypothesis we chose (increase of quality of life) against the philosophical writings, academic literature, and nations’ foundational documents in a succinct, manageable way. Additionally, we researched the facts shared in our paper, shared our experiences in government, discussed scholars who have deeply considered the purpose of government, and debated the hypotheses among ourselves. Some of these internal debates raised topics that became sticky wickets that are discussed later in the paper. The TOC Thinking Processes (TP) ultimately provided the best recourse and way forward. TP facilitated the best

discussions and precipitated insight. Deductive reasoning, in addition to considering evidence resulting from inductive reasoning, substantiated an increase in the quality of life as the ethical, moral, humanistic, history-tried, non-western centric, and logical goal of government in the shortest way that still seemed persuasive and rational.

Throughout this paper, public administration scholarship provided depth and evidentiary research supporting Hypothesis 6, and general importance of a generic goal for all government. For example, there is considerable research that associates goal setting and goal clarity in government with higher levels of performance. The 2010 Government Performance Project was a 14-year national effort to evaluate and compare performance among the US states. It identified goal clarity as one of the elements common to states that were frontrunners in the large-scale study on state performance. In its findings, the Performance Project identified that "a set of lessons clearly demonstrates that for public organizations clarity of purpose and the ability to limit priorities, and to measure progress are strongly associated with management capacity and quality" (Ingraham et al. 2003, p. 118). Furthermore, in both observational studies and experimental studies, goal clarity has been consistently identified as a driver of performance data use (Kroll 2015, p. 481; James et al. 2017, p. 259; Anderson & Stritch 2016, p. 211). This is an indication that goal clarity interacts with other factors to create a positive multiplicative effect on performance, which demonstrates the importance of goals in all levels of government and for all governments.

The authors of this paper acknowledge that this effort has major limitations: we were not exhaustive in our research and analysis. The arguments and examples presented are purposive in nature. Our research discussions with others were not random and were a result of our geographic locations and western cultures. We acknowledge the vastness of the topic, but we still took a step toward what many might consider impossible: a lucid statement of a general and generic goal of government at any jurisdictional level. And this effort, pregnant with flaws, insufficient time, and limited research is offered with a supporting goal tree from the TP. We could have shied away from including particular conditions necessary for a government pursuing the generic goal; but we did not. Yet, we did not purport to decide for jurisdictions how they should define public value, nor did we decide for them how their local governments should produce the public value their constituents desire (Moore 2013, 43, 56). Invariably, discussions of this nature become contentious because people have their own predispositions and convictions of what they believe their government should be. Our paper is nothing more than an invitation for other similar efforts to test our preliminary conclusion that a viable generic goal of government is to increase the quality of life of those in its jurisdiction. Nonetheless, our determined and adamant conviction is that such limitations and political disagreement should not cause us and others to evade addressing the central, but largely unaddressed question: What is the goal of government?

Definitions

Several terms in this paper are critical to understanding the message we attempt to convey. These terms and their definitions strive to be intelligible and meaningful to public servants who are largely unfamiliar with TOC, and to TOC practitioners who are unfamiliar with political and public administration language.

Goal

The “goal” of a system, as defined in the TOCICO Dictionary, is “the purpose for which the system was created, as determined by the owners of the system” (Coxet al., 2012, 58).

Quality of Life

For the purposes of this paper, we have amalgamated several sources to define quality of life as *the general condition of individuals and societies*. This blended definition comes primarily from several United Nations sources, including the *World Health Organization Quality of Life User Manual* (World Health Organization, 1998), *How’s Life? 2020: Measuring Well-being* (OECD, 2020), and UN-Habitat’s Quality of Life Initiative (UN-Habitat, n.d.). This general condition is a multi-faceted concept, made up by the interrelationships between physical health and longevity, psychological state, level of independence, personal beliefs, social relationships, and the interrelationships of these elements with the surrounding environment. In general, the term “quality of life” is often used interchangeably with “well-being”. As we shall see and assess, Aristotle equated quality of life with “the good life”, and his description of this objective state was formative in the development of the goal of government proposed here.

Government

This inquiry defines government as the groups of people that exercise authority over an organized community or society, through legislative, administrative, and judicial functions. Government is often a common term for different societal structures, to include nation, republic, kingdom, state, province, territory, region, county, city, town, or municipality. The Oxford Learner’s Dictionaries defines government as “the group of people who are responsible for controlling a country or a state,” although this paper would replace controlling with the “exercise of authority” (Oxford Learner’s Dictionaries 2024)

“People” or “Citizens”

In this paper we differentiate between the terms “people” and “citizens”. In this differentiation we will follow the definition used in most political systems.

Definition of People

The term "people" refers to all individuals within a state or society, regardless of their legal status. It includes everyone residing within the country's borders, such as residents, immigrants, and sometimes even temporary visitors. The concept of "people" is broader and more inclusive, covering anyone subject to the nation's general social, economic, and legal environment.

Definition of Citizens

"Citizens," on the other hand, are members who hold a specific legal relationship with the state. Citizenship comes with specific rights (like voting and holding public office) and obligations (such as paying taxes and, in some countries, compulsory military service). Citizenship generally requires meeting legal criteria, such as birthright, naturalization, or descent, and grants individuals a formal membership in the nation-state.

Why the Distinction Matters

This distinction allows a state to define who has full participation in political life. Citizens have exclusive rights that shape the nation's future, such as voting and political representation. By distinguishing citizens from the general population, states can manage legal, social, and economic benefits and responsibilities, often reserving the most significant rights and duties to citizens.

Justice

This paper defines justice as the principle of fairness and moral rightness, ensuring that individuals receive what they are due in terms of rights, opportunities, and resources, based on equity and impartiality.[1] Note that the clause "ensuring that individuals receive what they are due" conveys a social dimension of justice, enabling it to be applied conceptually to governments. John Rawls in *A Theory of Justice* maintains that, while individuals may differ in terms of their individual definition of justice, it is possible to develop, or aggregate, "a characteristic set of principles for assigning basic rights and duties and for determining what they take to be the proper distribution of the benefits and burdens of social cooperation" (Rawls, 1971, p. 5). In reconciling individual concepts of justice with social ones, Rawls points out that "Those who hold different concepts of justice can, then, still agree that institutions are just when no arbitrary distinctions are made between persons in the assigning of basic rights and duties and when the rules determine a proper balance between competing claims to the advantages of social life" (Rawls, 1971, p. 5). This argument supports the proposition that governments can work to define, pursue, and ensure justice for the society it serves, thus contributing to the quality of life in the community.

Part 1 - What is the Goal of Government?

Approach

This paper marks the start of the journey toward comprehensively translating TOC into the language and systems of government. To navigate this journey, we take the Standing on the Shoulders of Giants (SOTSOG) approach, documented by Dr. Lisa Ferguson in the TOC Body of Knowledge (Ferguson, 2012). The name of the approach stems from a comment in Sir Isaac Newton's 1675 letter to Robert Hooke, a rival scientist: "If I have seen farther, it is by standing on the shoulders of giants" (Koyré, 1952, p. 315). Drs. Goldratt and Ferguson used the metaphor to convey the process of building upon established knowledge by challenging that learning, and, in doing so, creating even more knowledge to "see farther." This approach is defined as:

[1] Note that the authors received some assistance from Chat GPT in the construction of this one sentence definition. It is a paraphrase of a distilled definition suggested by Chat GPT who helped to synthesize definitions of justice from the *Stanford Encyclopedia of Philosophy* (Nodelman, Allen & Perry, 1995), *A Theory of Justice* (Rawls, 1971), and *Nicomachean Ethics* by Aristotle.

1. Identify a giant, not a chupchik.[2]
2. Identify the enormity of the area not addressed by the giant.
3. Get on the giant's shoulders.
4. Identify the conceptual difference between the reality that was improved so dramatically by the giant and the area untouched.
5. Identify the wrong assumption.
6. Conduct the full analysis to determine the core problem, solution, etc. (using the TP)

Thus, the ambition of this paper is to utilize this analytical framework to investigate the goal of government and to start the process of translating TOC into the language and terminology of government.

Identify A Giant

For the purpose of this inquiry, the giant is Dr. Eli Goldratt, whose development of the Theory of Constraints (TOC) established one of the most comprehensive frameworks for ongoing organizational improvement. TOC has become one of the world's most influential management methodologies. *The Goal*, originally published in 1984, continues to be one of the bestselling management books of the last 40 years, while the writings of Goldratt continue to have a positive impact on the business world (Goldratt, 2014; The Best Business Books Ever, 2003, p. 63; Mabin & Balderstone, 1999). The impact of TOC on the business world is well documented. *The Goal* continues to be widely-read and influential, predominantly because it remains mandatory reading in many university business programs.

Identify the Enormity of the Area Not Addressed by the Giant

Although TOC has been successfully applied in several governmental organizations—through successful applications in government agencies by TOC practitioners, including the widely recognized work led by Kristen Cox in the State of Utah—a comprehensive translation of the TOC body of knowledge into the language, concepts and operating logic of government has not yet been undertaken. This gap represents the area that remains largely unexplored within the TOC body of knowledge and therefore forms the focus of the present inquiry. This is not to say that there have been no successes in implementing TOC in government agencies. There have been successful TOC implementations in government and we recognize and thank the TOC luminaries who have contributed in this realm. These successes are what fuel the authors' aspiration for a full-scale translation of TOC for government.

A principle embedded in SOTSOG is that successful utilization of improvement approaches depend on tailoring those methods to the specific environment in which they will be implemented (Goldratt, 2009). Or, as Goldratt stated in *Beyond the Goal* (2006), "Everything that we are talking about is correct also for the service environment. But you'll have to do the translation—the translation in the language!"

Is the government sector large enough to justify such a translation effort? Mycue and Schragenheim (2022) note that over 37% of global gross domestic product (GDP) is spent by governments. If this sector is not large

[2] A chupchik is the feature on a steam kettle that creates a whistle when the water boils, calling our attention and appearing urgent, although the call of the chupchik is often not of relative importance (Bogner, 2007).

enough to convince the reader of its worth, we believe the fact that virtually no one lives without feeling the impact of governments on their lives should tip the balance for any reader.

Get on the Giant's Shoulders

We recognize *The Haystack Syndrome* (Goldratt 1990a) as one of the most comprehensive justifications for the value of implementing the TOC operations solution (known as DBR, later improved to become S-DBR) to a production facility, and how to program it in an information system. *The Haystack Syndrome* also provided the ladder that the authors needed for this paper to get on Dr. Goldratt's shoulders, and peer into the government landscape. In the opening chapters of *The Haystack Syndrome*, Dr. Goldratt maps out the justification for his improvement solution by answering the most fundamental questions about an organization:

What is the goal?
How should it be measured?
What procedures will accomplish this for the topic at hand?

This paper also takes this approach, although future efforts will need to ascertain how the goal of government should be measured and investigate ways to robustly accomplish that goal.

Identify the Conceptual Difference Between Realities

There are conceptual differences between competing convictions and those that hold those convictions often maintain their perceptions are realities. Goldratt in this step encourages a juxtaposition of those competing "realities" to ascertain their differences. The conceptual differences relevant to this paper revolve around questions that ask on what basis goals of organizations should be established. For example, Goldratt urged for-profit companies to adopt "making money, now and in the future" as their goal and he specifically applied the logic of *The Haystack Syndrome* to companies whose goal is to make money, but he acknowledged that a monetary goal does not fit all organizations. He stated in the opening of Chapter 3, "Thus, for other types of companies, the following analysis does not apply, even though I believe the logical process is probably the same" (Goldratt, 1990a).

Where does this leave us? Goldratt never articulated what he considered the goal of government to be. But there certainly is no shortage of giants in political literature to suggest what the goal should be; many have provided thoughts on the goal of government. Agreement among them, however, may be hard to find. In fact, there are nearly as many perspectives on what the goal of government should be as there are people. Everyone has their own opinion of what their government's role and purpose should be. This can lead to assumptions that can inhibit or even prevent the attainment of the goal.

Identify the Wrong Assumption

The *SOTSOG* approach urges identification of persistent and pejorative assumptions which may be impeding insight and innovation. In the TOC atheneum, any assumption that hampers the goal is potentially a "wrong assumption." In the spirit and language of SOTSOG, by wrong assumption in the fifth step, this paper is referring to a supposition with little or no supporting evidence that serves as a mental obstacle to those who

unwittingly or knowingly embrace it. When those who do the work of government, or lead the work of government, embrace impeding or unsupported assumptions without rigorous inquiry, the ongoing improvement of government can be stymied.

Dr. Eli Goldratt asserted that the root cause that prevents improvement of any organization is the core conflict. Conflicts are based on assumptions about reality, and finding the invalid assumptions in conflicts can open the door to developing effective solutions. Dr. Lisa Ferguson, in her collaboration with him, provided two examples of wrong assumptions in her 2012 TOCICO webinar entitled "Understanding More About the Standing on the Shoulders of Giants Process". The first was the assumption that *any improvement was a zero-sum game in which there was an inevitable tradeoff between cost and quality*. The second example was that *viable solutions that offer a win for both sides in a conflict are improbable, if not impossible, and that win-lose solutions are inevitable* (Ferguson 2012; Goldratt & Goldratt-Ashlag 2009, 82-84; Fisher & Ury 1981).

While analyzing the conflicts and disagreement surrounding the question of what the goal of government is, the authors encountered two candidates for wrong assumptions: The first, that a clear goal in government is impossible, is one that the authors have frequently encountered in their own lives. The second potentially wrong assumption, that government is a money-making operation, concerns the nature and purpose of government. Both possibly wrong assumptions can have negative consequences in government and society, and therefore require elaboration and assessment.

The first assumption that we propose as invalid is that *there is no clear goal for government because the goal is dependent on the people in power at the time*. The authors do not agree with this assumption and this paper argues against it through the logical progression of our assumptions, the articulation of a proposed goal for any government, and in the paper's analysis of the constitutions and founding articles of non-democratic countries.

A second potential wrong assumption arises when the goal formulated for profit-oriented organizations is transferred directly to government. In TOC literature, financial performance is essential to the viability of profit-oriented organizations. However, governments exist for a fundamentally different purpose. Their financial resources are means that enable the pursuit of their purpose rather than the purpose itself. Goldratt pointed out that making more money now and in the future cannot be substituted as the goal for not-for-profit organizations, such as armies. "Army? Try to imagine that the goal of the army would have been to make more money… that's Atilla the Hun, maybe. Okay? Our armies are in order to make more defense." (Goldratt 1999, *GSP Session 2: Finance and Measurements*). The academic community predominately concurs with Goldratt, in that the goals of private business and government are vastly different (Allison 1980; Bozeman 2007; Mintzberg 1996). Government is purpose-based and not profit oriented.

Utilizing the need to make more money as the goal of government would also create conflict between the necessary conditions of government. One conflict, for example, is with the fact that governments are normally prohibited from making a profit in their establishing legislation. In almost all cases, governments are legally allowed only to generate revenues that do not exceed their approved budgeted expenses. In order to generate more revenues than this, we would inherently be forcing governments to garner and spend more

on expenses than what they are authorized to spend. Whenever this happens inadvertently, such as in the case of program income, it causes significant programmatic and appropriation problems.

Every organization requires enabling conditions in order to achieve its goal. For governments, fiscal sustainability is indispensable. A government that cannot responsibly manage its financial resources will ultimately be unable to pursue its goal of increasing quality of life. Nevertheless, prudent financial management is an enabling condition, not the goal itself.

When it comes to bettering government, an assumed prerequisite to improving government services that the authors have witnessed in their professional lives is that, *if we want to make an improvement, then we have to spend more money*. This would be an incomplete application of TOC's five focusing step process of ongoing improvement (POOGI) outlined here:

Step 1 - Identify the system's constraint(s).

Step 2 - Decide how best to exploit the system's constraint(s).

Step 3 - Subordinate everything else to the above decision.

Step 4 - Elevate the system's constraint(s). Only if exploitation and subordination prove insufficient should the constraint be elevated. In government, there is often a tendency to move prematurely to Step 4 by requesting additional budgets, personnel, or legislative authority before fully exploiting existing constraints and subordinating surrounding activities.

Step 5 - If in the previous steps a constraint has been broken, go back to Step 1. WARNING!!!! If in the previous steps, a constraint has been broken, go back to Step 1, but do not allow INERTIA to cause a system's constraint..

Spending more money (i.e. elevating the constraint) is the fourth step of the process. Before elevating the constraint, we must exploit or optimize the identified constraint, and subordinate everything else, such as other resources (machines) to our decisions for how to exploit our constraint, before elevating the constraint. Unfortunately, in government we often make the assumption that we are already operating at maximum efficiency and any improvement will require additional people and additional funds (Cox, 2018, 63).

To challenge both invalid assumptions, we claim that there *is* a universal goal that can be articulated for governments of many shapes, jurisdictions, and sizes; and we maintain that goal is *not* to make more money now as well as in the future.

<u>Conduct the Full Analysis</u>

This paper uses the analytical approach presented in chapters two through four in the *Haystack Syndrome* (Goldratt, 1990). The approach is outlined by these questions: "What is the goal? How should it be measured? And what procedures will accomplish this?". In the present paper, we apply the Standing on the Shoulders of Giants (SOTSOG) approach specifically to the development of a generic goal for government. Future work may apply the same approach to additional elements of the TOC Body of Knowledge as they are translated into the governmental domain. The generic goal developed here provides one foundation for future work on translating additional TOC concepts—such as measurements, Throughput Accounting, operational concepts, and other elements of the TOC Body of Knowledge—into the governmental domain.

Further studies can help to determine how the goal is measured, a method for applying throughput accounting in government, the nature of operations in government, and the nature and impact of inventory in government, to name a few. We hope to collaborate with the TOC and government sector communities in the future to continue on this journey.

What Is a Goal?

Similar to words like "strategy" and "improvement," "goal" can be defined differently, depending on context and whom you ask. *The Random House Dictionary* defines goal as "the result or achievement toward which effort is directed; aim; end" (Stein, 1966, p. 605). To further clarify what is meant by "goal" as it is used in this paper, among the various formulations of the concept of a goal found in TOC literature, this paper adopts the definition contained in The TOCICO Dictionary. There a goal is defined as: "The purpose for which the system was created as determined by the owners of the system" (Cox, et al., 2012, p. 58). Put another way, the goal is the *reason* for system creation that the owners had in mind when they created the system. This definition, in turn, invited the authors to investigate three questions in this first part of this paper: What is the system? Who are its owners? And what is its purpose?

What Is the System?

The TOCICO Dictionary (2010) entry for "throughput-world paradigm" identifies that a system is "a series of dependent [components] that must work together to achieve [a common] goal." Many times in TOC, a system is defined as an entire organization. For the purposes of this paper, we define the system we are discussing as "a government". This is where setting the boundaries of our system can get tricky. Many of the sub-systems of government can be (and have been) large enough to be defined as entire systems on their own. Although such entities can legitimately be analyzed as systems in their own right, they remain interconnected subsystems of the broader governmental system. Consequently, improvements at the subsystem level should ultimately be evaluated in terms of their contribution to the overall goal of government. Take for example the previous TOC work already completed in the military, health care, and education sectors; the improved organizations or networks have each been designated as "government systems." To confuse matters more, sometimes what constitutes a government sector in one jurisdiction may not be within the sphere of government activities in another jurisdiction.

With the utmost respect to this previous work, we are not discussing a specific sector of government. The systems relevant to this paper are governments as a whole: whether they are national (i.e. countries), territorial (i.e. provincial, state, or territory), regional (counties and regional authorities), or local (city or municipal).

Why did governments come to be? We do not have a specific record of why governments came to be, as the development of government predates recorded history. Nonetheless, our train of logic goes like this: People exist. Individual people have needs and aspirations. And somewhere in history, people learned that forming

larger groups of people (families, tribes and communities) helped in attaining individual needs more than a solitary existence could. But what are those needs?

We draw on Abraham Maslow's hierarchy of needs (1943) to examine this question. The needs are:

Level 5 - Self-actualization need - the need to achieve one's full potential in their life.

Level 4 - Esteem needs - the need to have self-respect and to be respected by others.

Level 3 - Belonging and a need for love - the need to give and receive love, and to be a part of a group.

Level 2 - Safety needs - the need for physical safety and personal security.

Level 1 - Physiological needs - the basics to sustain life: food, water, air, warmth and sleep.

People form communities to better meet these needs. People establish governments to provide structure and order to the community; and with such structure in place, people are then better able to pursue their needs. Abraham Lincoln similarly claimed in 1859 that "The legitimate object of government is to do for a community of people whatever they need to have done but cannot do at all or cannot do well for themselves in their separate individual capacities" (Lincoln 2008, p. 376).

The governments which exercise authority over territories, communities and societies come in many forms, to include federal, state, province, county, tribal, municipality, or other local jurisdictions. This patchwork quilt is the system that has evolved from the original requirement to meet individual and community needs. These government systems often overlap and, despite their founding mandate to better meet the people's needs, they occasionally conflict with one another.

Who Are the System's Owners?

The owners of government are those community members who have established a government in authority over a population and region. The owners are the people subject to the established government; the governed are the owners. In support of this proposition, John Locke observed that every individual had natural and innate liberties and that the aggregation of these liberties formed "in the People a Supreme Power" (Locke 1690, 367, Chap. XIII §149). To Locke, this supreme power derived from natural law which recognized the inherent freedom and natural rights of every individual. However, in order to realize the benefits of community and increased quality of life, Locke observed that it often made sense to give up some of these liberties through the establishment of a social contract which defined the relationship between the governed and the governors (Tulley 1991, 634-637). This mutual agreement was a recognition that the people were ultimately sovereign and the true owners of government. This conviction is evident in Locke's assertion "that the Legislative being only a Fiduciary Power to act for certain ends, there remains in the People a Supreme Power to remove or *alter the legislature*, when they find the Legislative act contrary to the trust reposed in them" (Locke 1690, p. 367, Chap. XIII §149). Thus, the people are the sources of this supreme power and the people are the owners of any government formed under the people's auspices.

This ownership of the government by the people is stated in many different forms of governments' founding articles and constitutions. This paper's limited sampling of national founding documents, for example,

revealed instances where the government rules by divine right. An example of this was Louis XIV's now legendary sentiment, "*L'État, c'est moi"* (or "The State is me"). But, such antiquated notions are no longer an accepted way to legitimize the rule of a government, regardless of type. Even in the cases of monarchies, dictatorships and communist regimes, the governments overwhelmingly profess to be operating in the public interest.

Such declarations are usually manifest in their founding documents or in public addresses of their leaders. For example, in the founding or confederating documents of Russia, China, Myanmar, and Venezuela, we witness language that justifies the government because its objective is to look after the well-being of their citizens. The establishing constitutional documents are fairly clear on the matter. Consider these quotations from the founding articles and constitutions of these four autocracies:

The *Constitution of the People's Republic of China* (1982): "All power in the People's Republic of China belongs to the people." (Chapter 1, article 2).

The Constitution of the Russian Federation (1993): "The bearer of sovereignty and the only source of power in the Russian Federation shall be its multinational people." (Chapter 1, article 3.1).

The *Constitution of the Republic of the Union of Myanmar* (2008): "The Sovereign power of the Union is derived from the citizens and is in force in the entire country." (Chapter 1, article 4).

The *Constitution of the Bolivarian Republic of Venezuela* (rev. 2009): "Sovereignty resides untransferable in the people…" (Title I, article 5).

One might argue there are governments that exist for their own aggrandizement or to perpetuate the form of government that preserves the privileges of a certain leader, caste or class. This accusation may be true in some of the 195 countries on earth, but the point made here is that the founding documents of the vast majority of those countries profess that their government is "of the people" and "for the people." And even when that is demonstrably not true in practice, the leaders, ruling juntas, and parties continue to sponsor this claim because it provides the governments they lead with legitimacy. At the time of this topic's research and deliberations, the authors considered whether the offered generic goal of government applied to all governments or just democracies. For the purposes of this paper, we broadly and generously included all governments that maintain they are "of the people" and "for the people," which we interpret as a government that operates to secure and maintain the well-being of the governed population and an acknowledgement that the people of these countries are, or should be, the owners of their governments.

What Is the Purpose of Government?

Based on the logic discussed thus far, we have partially introduced the purpose of government which is to enable people to meet their intrinsic needs and generally improve their quality of life more than they could in a solitary existence. On this basis, the following government objective was formulated as a working hypothesis: In short, the goal can be phrased as:

To increase quality of life, now and in the future.

This proposition, that government should enable increased quality of life, now and in the future, stems from principles of community, public service, and ongoing improvement. The conviction underlying this hypothesis is that at the end of the day, after all the government decisions, transactions and actions take place, the general public, or "average citizen" is better off, indicating that government has moved the needle toward an increased quality of life for the community it serves.

The scientific method requires that a theory or proposition be framed as a hypothesis and tested with empirical evidence. Interestingly, this hypothesis testing was applied to some non-democratic states that were examined and are discussed in Part 4 of this paper. While the authors did not conduct a comprehensive assessment of the constitutions of authoritarian governments, we did examine the constitution of China, Russia, Myanmar, and Venezuela. This assessment determined that the articles of unification referred to a degree of quality of life affirmation in regard to the governments' mission. Words such as well-being, worthy life, and development of man illustrate a widespread aspiration that government facilitate an increasing quality of life.

The authors leave the question of whether non-democratic countries successfully and reliably increase the quality of life for their people to political scientists. But we do document that the lion's share of those countries *say they pursue an increase in quality of life* and may also aspire to do so. Taking the same approach as we did with the question of who owns the government (in cases where there may be widespread disagreement), we looked to the constitutional language of some recognized authoritarian states and discerned similar statements which avow to improve the quality of life of its people. Here are a few examples:

The *Constitution of the People's Republic of China* (1982): "The state shall… gradually improve the material and cultural wellbeing of the people" (Chapter 1, Article 14).

The Constitution of the Russian Federation (1993): "Man, his rights and freedoms are the supreme value. The recognition, observance and protection of the rights and freedoms of man and citizen shall be the obligation of the State" (Chapter 1, Article 2).

"The Russian Federation is a social State whose policy is aimed at creating conditions for a worthy life and a free development of man" (Chapter 1, Article 7).

The *Constitution of the Republic of the Union of Myanmar* (2008): "We, the National people, firmly resolve that we shall… stalwartly strive for further burgeoning the eternal principles namely justice, liberty, equality and perpetuation of peace and prosperity of the National people" (Preamble).

The *Constitution of the Bolivarian Republic of Venezuela* (rev. 2009): "The essential purposes of the State are the protection and development of the individual and respect for the dignity of the individual, the democratic exercise of the will of the people, the building of a just and peace loving society, the furtherance

of the prosperity and welfare of the people and the guaranteeing of the Fulfillment of the principles, rights and duties established in this Constitution" (Title I, Article 3).

Despite not being a representative sampling, these four non-democratic countries demonstrate that a significant amount of legitimacy is garnered by governments who avow to serve their people and, at least ostensibly, work to improve their lot in life. It is apparent that even non-democratic countries want to be, or at least profess to be, "of the people and for the people" (Lincoln 1863/2008). For the purposes of the generic aspirational goal of government advocated by this paper, it is apparent this goal applied to a base of nations that is broader than the 48% that are democratic nations Bastian et al., 2024).

A person well-versed in the TOC body of knowledge might critique the goal of "increase quality of life" because they agree with Eli Goldratt's generic goal of business, "become an ever-flourishing company" (Cox & Schleier, eds., 2010, 8). They might ask if we should apply this "ever-flourishing" goal to government. But this logical critique may be inconsistent with the responsibilities and objectives of public sector organizations. In TOC, the meaning of an "ever-flourishing organization" depends on the nature and purpose of the organization under consideration. For profit-oriented organizations, flourishing has been associated with sustained growth and the long-term ability to fulfill their purpose. The question addressed in this paper is therefore not how businesses flourish, but what flourishing means for governments and how that purpose can be articulated as a generic goal. . Continual growth of government, however, may be inconsistent with the values and objectives of the citizens. As we will see in our goal tree in Section 4, for a government to aim at continual growth would risk violating the necessary conditions of defining and upholding people's rights and of controlling the costs of government, which must be met to achieve the ultimate goal. A growing government is not a necessary condition of a government pursuing increasing quality of life. And, as discussed below in the assumptions, the owners of government determine the limits of their government, which includes its development and size. A community might choose to craft a specific goal for their government that uses ever-flourishing language, but generally a government that exists to perpetuate itself and be ever-flourishing would be inconsistent with the general necessary conditions outlined in the government goal tree presented in this paper.

Alternatively, in the "ever-flourishing" sense, the goal of increasing quality of life could be rephrased by a community "to develop an ever-flourishing society, now and in the future." Such a goal, which captures the intent of "increasing quality of life," rephrases the goal to be more aligned with TOC language and practice. This may have merit because societies, like living things, desire to develop and thrive. On the other hand, this continual flourishing may eventually challenge the critical success factor of sustainability, which is discussed below. Resources on Earth are limited. For the purposes of this paper, we will remain with the "increase quality of life" as the generic goal definition for the remainder of this paper.

Part 2 – Key Assumptions

The following assumptions are not presented as empirically established facts of life, but as explicit working assumptions that define the scope of the conceptual model developed in this paper. These are the assumptions on which we have based the formulation of the goal of government. In some ways these assumptions operate as propositions or asserted axioms. Conceptually, in a way similar to how axioms are used in mathematics, the objective is to use these assumptions as building blocks throughout the rest of the paper to logically support the goal or factors critical to the achievement of that goal. If a person significantly disagrees with these assumptions, it is an indication that their definition of a good or necessary government may be at odds with the goal of government proposed here. Conversely, if these assumptions largely hold true for a person or a government then this is a logical indication that the proposed goal of increasingquality of life may apply to their vision of good or necessary government:

Assumption 1: Individual people have needs and aspirations, and they look to ways to achieve them.

Assumption 2: People can pursue their needs and aspirations better in groups and organizations than alone.

Assumption 3: The owners of an organization set the goal for the organization.

Assumption 4: The owners of a government are its citizens.

Assumption 5: Government, as envisioned here, is a government of the people it governs and it exists for the people it governs.

Assumption 6: Governments, as envisioned here, pursue the public interest for the nation and draw legitimacy from that pursuit.

Assumption 7: Government has an intrinsic obligation to meet the needs of its people or it is at risk of replacement.

Assumption 8: The specific goal of each government is stated in its establishing legislation, which includes constitutions, charters and other foundational laws.

Assumption 9: There is, or can be, a generic statement that can capture the generic goal of all governments.

Assumption 10: The generic goal of government is “to increase quality of life, now and in the future”.

Each assumption can benefit from a brief discussion as to why it is important for the objectives of this paper, and how they work to justify the development of a generic goal for government. In assumption 1, “individual people have needs and aspirations and look to ways to achieve them,” we recognize the inherent vulnerability of a single person. As described by Maslow, a person has basic needs (such as food, shelter, and physical security). But they also have more evolved needs, such as emotional sustenance, recognition, and a driving need to contribute and self-actualize (Maslow 1943). As noted in Assumption 2, when human beings come together to form groups, they are able to satisfy those needs more easily and more robustly than if they attempted to do so alone. And, when certain needs such as security are satisfied, individuals can attend to other necessities, such as markets and commerce, more effectively.

For the purposes of this paper, the following foundational assumptions define the scope and analytical perspective of the inquiry.

Assumptions 1 and 2

Assumption 1: Individual people have needs and aspirations and look to ways to achieve them.

Assumption 2: People can pursue their needs and aspirations better in groups and organizations than alone.

These assumptions offer reasons why people form communities. As they grow and thrive, communities develop governing bodies to help meet individual and community needs. These associations and relationships result in benefits that are significantly greater than the sum of the parts, which are individual people. When people form governments, they secure for the community members something more than the aggregate of their individual strengths and talents. In other words, people form government for two primary reasons. First, to facilitate or ensure that the bottom rungs of Maslow's hierarchy are met, but also to make attainment of the top rungs possible, such as friendship, self-esteem and self-actualization.

This synergy produced by government was what Aristotle was trying to convey in *Politics* when he said, "It is clear then that a state is not a mere society, having a common place, established for the prevention of crime and for the sake of exchange." Aristotle was arguing that individuals came together and formed states to facilitate bonds of friendship and community. "The end" he asserted "is the good life, and these are the means towards it. And the state is the union of families and villages having for an end a perfect self-sufficing life, by which we mean a happy and honorable life." He concluded that a state was a political society that existed "for the sake of noble actions, and not of mere companionship." ("The Politics" Book III page 84 in *The Politics of Aristotle* by B. Jowett published in 1885.)

These needs encompass the fact that people must first and foremost survive, before being able to thrive, feel good and be satisfied. Tis implicit assumption revolves around the innate human striving for a better quality of life, individually. To support this assumption, we draw on various psychological theories and empirical studies (such as Maslow's pyramid of needs, Freud's Hedonism and Pleasure Principle, Seligman's Positive Psychology, and the philosophy of epicureanism).

Thus, the first two assumptions lay out the fundamental reasons a state exists and explain why people throughout history have sought to establish governments. As Aristotle noted, government makes "the good life" possible for individuals.

Assumption 3

Assumption 3: The owners of an organization set the goal for the organization.

In order to determine a possible generic goal statement for government, we can articulate the characteristics of a goal from a TOC perspective. The TOCICO Dictionary defines a goal as:

*The **purpose** for which the **system** was created as determined by the **owners** of the system.*

This assumption is used by the TOC community to craft goals and objectives for various organizations. In this case, Assumption 3 works to establish legitimacy of governmental authority because the purpose of government is determined by its owners, i.e. the people in the jurisdiction that the government governs.

Assumption 4

Assumption 4: The owners of a government are its citizens.

For our government organizations, the owners of the government are the society that it serves. This definition is not bound by any specific form of government. Rather, it includes all systems that have been authoritatively defined as being owned by the people it serves. Government does not exist to serve itself; this is assured by both Assumption 3 and 4, which together establish that the owners of the system of government are citizens who determine the purpose of their government system.

Assumption 5

Assumption 5: Government, as envisioned here, is a government of the people it governs and it exists for the people it governs.

A government, by definition, curbs freedoms of individuals by governing behavior. Is government justified in usurping some rights, taxes, property, and sometimes even life so that it can accomplish a public good that serves society? This proposition assumes so. The good that government accomplishes for society justifies the abridgement of some individual liberties.

Consider what Thomas Hobbes in the Leviathan in 1651 said would happen if people do not accept the governance of a monarch, which he refers to as the leviathan. Hobbes' argument describes a dearth of civilization because of an absence of government. "Whatsoever therefore is consequent to a time of war, where every man is enemy to every man, the same consequent to the time wherein men live without other security than what their own strength and their own invention shall furnish them withal. In such condition there is … no knowledge of the face of the earth; no account of time; no arts; no letters; no society; and which is worst of all, continual fear, and danger of violent death; and the life of man, solitary, poor, nasty, brutish, and short." (Hobbes 2008, chap. 8). Hobbes goes on to define a kingdom as "an estate ordained by men for their perpetual security against enemies and want" (Hobbes 2008, chap. 38). He maintained that in order to preserve life and security, individuals and society must accept government over themselves.

According to Hobbes, the provision of security is the first order of business of government. He pointed out that this obligation binds the people to the government and binds the government to the people. This agreement is an essential aspect to what Rousseau and Locke later called a social contract. While the goal of government, as envisioned here, is much broader than simply security, Assumption 5 is primarily based on the concept of this contract. The arrangement also provides government legitimacy. This legitimacy is derived from the people who voluntarily, in the grand sense, relinquish some of their freedom in the

expectation that their lives will be better while they are governed by the government. Thus, government, as envisioned here, is a government of the people it governs and it exists for the people it governs.

Assumption 6

Assumption 6: Governments, as envisioned here, pursue the public interest of their constituent society, and draw legitimacy from that pursuit.

This assumption broadens the role of government as a security-providing leviathan into an institution that operates with the public interest in mind, well beyond the obligation to deal with the threat of warfare and mayhem (Hobbes 2008, chap. 38). Clearly, the public interest is a vague term, but it is one that many governments pledge themselves to in their documents of formation.

The aggregate public good accomplished for citizens has the potential of providing the current government legitimacy. To appreciate this, take for example its polar opposite: a dictatorship that is devoted to the glorification of the dictator and aggrandizement of the nation. In this case, the people are *means* used by the dictator to obtain *ends* quite different from improved lives and greater opportunity among citizens.

Assumption 7

Assumption 7: Government has an intrinsic obligation to meet the needs of its people, or it is at risk of replacement.

The goal that government should increase the quality of life of its people is often associated with social contract theory, which suggests that governments exist to serve the interests and well-being of their citizens (e.g. https://ethicsunwrapped.utexas.edu/glossary/social-contract-theory). This is dependent upon the preferences of the citizens of the state. An example of this are citizens' expectations that, year to year, there is at least a perceptible improvement in their quality of life (Gallup 2020). This expectation may also be relative to the quality of life citizens perceive in other nations. If these expectations are disappointed by a government in the long run, citizens will seek a change to a government that they trust to fulfill these requirements more.

Governments will therefore be well advised to meet the expectations of a steady improvement in the quality of life of its citizens. However, it is also historically known that governments that cannot or do not want to do this will resort to a different strategy. In this case, an internal or external enemy is often sought and, if necessary, invented to maintain power. This enemy, who then really (or fictitiously) endangers the national community, activates the primal need of the survival of the threatened group in the sense of Maslow's Hierarchy of Needs. This real or perceived threat leads to the likelihood that such governments can survive for a certain time without increasing the quality of life of the population.

Assumption 7 is supported by various theories, historical examples, and social concepts. Social contract theory posits that individuals establish governments to safeguard their natural rights, with governments reciprocating by ensuring citizen well-being. Democratic accountability emphasizes that governments derive

authority from citizen consent, with regular elections serving as a mechanism for holding leaders accountable. International human rights frameworks, such as the Universal Declaration of Human Rights, assert governments' duty to protect citizen rights; failure may lead to international pressure (United Nations General Assembly, 1948). Historical precedents of political unrest and upheaval illustrate that governments facing prolonged neglect of citizen needs often encounter unrest and potential replacement.

It's important to note that the specific obligations and expectations of a government may vary depending on the political system, cultural context, and the values of the society it serves. Nevertheless, the general principle that governments should meet the needs of their people to maintain stability and legitimacy is widely recognized and supported.

Assumptions 8 and 9

Assumption 8: The specific goal of each government is stated in its establishing legislation, which includes constitutions, charters and other foundational laws.

Assumption 9: There is, or can be, a generic statement that can capture the generic goal of all governments.

Assumption 8 recognizes that there will be specific differences between countries whenever their government goals are considered or compared. These differences will reflect the varied cultures, values and historical experiences of each country. Commonalities and differences between specific country goals will often be manifest in the founding documents of the nation, such as a declarations of independence, articles of unification, or constitutions. As suggested by Assumption 9, these differences do not undermine the validity or utility of a common, generic goal for government.

A common goal for government holds the promise of helping to find common objectives and has the potential of aiding in the identification of common values, but it does not prevent countries from elaborating, adapting, or modifying their goals to meet the needs and culture of their society.

This does not mean that all governments, regardless of their primary goal, will fit under the comprehensive and collective goal this paper seeks to define. For example, a government would be excluded from subscribing to the general goal outlined here if they were not a government of the people and for the people, as observed by Assumption 5. Likewise, bonafide adoption of the common goal would be precluded if the government did not recognize their citizens as the owners of the government, as noted in Assumption 4. The umbrella of the goal of government has coverage limits and those limits are observed here through the stated nine assumptions.

Assumption 10

Assumption 10: The goal of government is to increase quality of life, now and in the future.

Assumption 10 results from the fact that the papers' hypothesis or proposition, which represents our proposed generic government goal, is based on Assumptions 1 through 9. Assumption 10 is summative and

deductive in nature; it is not intended for the tautological purpose of proving the goal of government. Rather, it is included as the capstone of the other nine assumptions, each of which lend support to the claim that the goal of government is to increase quality of life. The authors offer this proposition based on the presented evidence, arguments, and cumulative strength of the nine prior assumptions.

Part 3. Goal Tree Development

What Is a Goal Tree?

William Dettmer, the author of *The Logical Thinking Process: A Systems Approach to Complex Problem Solving*, stressed that organizations must have a way to robustly communicate the goal of the outfit and to outline the necessary conditions for organizational success (Dettmer 2016, 6). If an organization is successful in this, it establishes a form of organizational context or running-logic that justifies and aligns the efforts of the organization. Debates and deliberations concerning the goal of the organization are crucial during an organization's inception or transformation, but ongoing and divisive dissent concerning purpose can be detrimental to an organization as it coalesces around its goal and concentrates effort on surmounting undesired effects that interfere with the goal. Thus, a goal-oriented climate, as urged by Goldratt, Dettmer and Scheinkopf, helps to preclude pejorative debates on established organizational goals and encourages focus on achieving those goals. This also provides the organization to more easily identify and surmount the undesirable effects that threaten the organization's goal. A goal tree is one way to create focus and consensus around organizational objectives.

Dettmer maintains that "A Goal Tree is a graphical representation of a system's goal, critical success factors and the necessary conditions for achieving them.… Each of these entities in the goal tree exists in a necessity-based relationship with the entities below it" (Dettmer 2016, 68). According to Dettmer's thinking process logic, the goal tree is intended to establish a firm baseline or standard for what should be happening if a system is to succeed. It is a picture of *what good looks like* for the organization as it is successfully accomplishing its goal. Dettmer links the goal tree to the other Thinking Processes by pointing out that the creation of a tree establishes logical connections to relevant evaporating conflict clouds and the future reality tree in the overall logical thinking process utilized during TOC applications. In Dettmer's view, the goal tree is foundational not just because it represents where the organization wants to be, but also because it lays out the necessity-based groundwork for how the organization intends to get there. Put another way, the elements on a goal tree represent the capabilities one must have and conditions that must exist to create the wherewithal that, in turn, enables goal achievement.

For these reasons, this paper utilizes a goal tree as the primary tool to help proceed toward our objective of creating a generic goal of government. However, someone familiar with the TOC suite of thinking tools might wonder, "Why a goal tree, and not a strategy & tactic tree at this point?" The main difference between a goal tree and a strategy & tactic tree is that the latter focuses on the specific ways that a strategy will be achieved. A goal tree thus focuses on what needs to be achieved and the significant activities and conditions

required to bring about the goal. A goal tree does not specify how those conditions will be created, but a strategy & tactics tree does exactly that.

"Strategy," Eli Goldratt pointed out, is "the answer to 'what for?'" and "tactic--the answer to "how?" (Cox & Schleier 2010, 8). Strategy & tactics trees developed by Goldratt specify the detail and direction needed to accomplish large scale improvement. In Lisa Scheinkopf's assessment, "as more TOC implications focused on holistic organizational transformation rather than single-function improvement programs, it became clear that the standard collection of excellent TOC tools were insufficient to obtain the synchronization and communication required for a major, holistic organizational transformation initiative to achieve and sustain the intended improvements" (Cox & Schleier, 2010, p. 769). A tool was needed, suggests Dr. Ferguson, that "provides an explanation of the specific actions to be implemented over the next several years to achieve the high-level strategy or goal of the organization" (Cox & Schleier, 2010, 1015). Thus, strategy and tactics lay down specific details and requirements needed to accomplish changes in a specific organization, while a goal tree visualizes what this change might look like conceptually as necessary conditions stack up to achieve critical success factors.

Since this paper concludes with a generic goal, and not a specific government goal for jurisdiction, a strategy & tactics tree is not yet needed for this initial inquiry. However, once the authors or other TOC-in-government trailblazers get to the point of implementing a particular strategy, a strategy & tactics tree can be developed based on the groundwork covered in this inquiry. The present paper does not address the development of Strategy & Tactics Trees or other implementation tools. Its purpose is more limited: to establish a logically derived generic goal that may serve as a foundation for future work on adapting additional TOC concepts to the governmental domain. This paper and its authors are not yet at the point of developing the strategies and tactics of how to achieve it, that is, how to implement our changes that will get us closer to the desired goal. Instead, we are at the point of developing the necessary conditions that enable a government organization to fruitfully pursue the generic goal.

What Does the Literature Suggest Might Be the Critical Success Factors and Necessary Conditions for Our Goal Tree?

Goal trees are composed of necessary conditions and critical success factors. Dettmer, in a conversation with Eli Goldratt in 1995, derived a succinct definition for the ubiquitous TOC term, necessary conditions. They determined that "A necessary condition is a circumstance indispensable to some result, or that upon which everything is contingent" (Dettmer, 2016, p. 6). Lisa Scheinkopf puts it another way by stating that in order for some outcome, B, to occur, a necessary condition, A, must first exist (Scheinkopf 1999). And, she points out as a logical double-check, "the absence of A is sufficient to cause the absence of B." (Cox & Schleier, 2010, p. 744).

In *Thinking for a Change*, Scheinkopf makes a few observations about necessary conditions that are important to this paper because they describe several relationships that necessary conditions can have with the goal of government. "Necessary conditions," she maintains, "are rules, policies, or laws that provide the limitations or boundaries within which we believe we are allowed to pursue goals and objectives." But she

caveats, "conformance with a necessary condition does not guarantee that a goal will be achieved, but we usually believe that if we don't have the perceived necessary condition in place, we will certainly be unable to attain that goal" (Scheinkopf, 1999, 69).

Clearly, necessary conditions are stepping stones that enable the organization to earnestly and progressively pursue its goal. But what is the difference between a necessary condition and a critical success factor? Dettmer maintains that this line is drawn largely on the basis of the judgment of the goal tree creator. Critical success factors are necessary conditions that, because of their importance, operate as milestones or "showstoppers" that should be prioritized and pursued with an abundance of vigor during implementation. Dettmer helps to distinguish between necessary conditions and critical success factors by observing that the latter "are the 3-5 high-level terminal conditions that must be satisfied for the goal to be achieved" (Dettmer, 68, 86). He asserts that distinguishing between necessary conditions and critical success factors enables future implementers of the tree to achieve focus.

These definitions helped to guide the authors as to which conditions were "important and necessary" enough to justify placement on the goal tree, and what other conditions merited consideration, but relative to the other conditions competing for space on the tree, were not as "important and necessary." Keeping in mind the need to keep the tree generic and widely applicable to nearly all governments, the authors used the definitions to determine which necessary success factors should be elevated to become critical success factors. These critical factors represented more crucial and more encompassing elements, and thus provided the tree a relative hierarchy of conditions.

Governments' responsibilities across the globe have considerable breadth and ideological differences. These responsibilities can vary considerably from country to country based on available resources and politics. As discussed at the end of Part 1 of this review, the authors tried to focus on responsibilities that the vast majority of governments have in common regardless of where they are on ideological spectrums. This is the logic of the goal tree creation: the struggle to restrict the condition to what was essential, and to distinguish between critical and necessary conditions. As you will see, we were not always successful, but we documented where we differed and recounted the decisive discussions in the "sticky wickets" section of this paper.

In TOC literature, the origins of the main necessary conditions of any organizational strategy appear to start formulating in the pages of *It's Not Luck* (Goldratt 1994, 82, 270-274). In the book, the protagonist, Alex Rogo, is desperately trying to find a way to not have companies in his division sold while he is on a trip with two board members who are on a mission to do just that. In trying to convince these board members to keep the companies, he provides an evaporating conflict cloud, which notes that successful companies must serve the stakeholders. In order to achieve the objective, organizations must meet two necessary conditions: they must protect the interests of the shareholders, as well as the interests of employees (Goldratt 1994, Chap. 10). Other necessary conditions, "provide satisfaction to the market now as well as in the future" and "make money now as well as in the future," are outlined later in the book (Goldratt 1994, 273).

These necessary conditions were further refined by Dr. Goldratt after the publication of *It's Not Luck*, and were presented in the Goldratt Satellite Program on Strategy (Goldratt, 1999, GSP Session 8). Although a

goal tree was not presented in the novel, Alex's conversations from chapters 10 and 30 can be positioned in a goal tree format to create the below tree (80, 273). Here, the necessary conditions for any strategy to succeed are stated as:

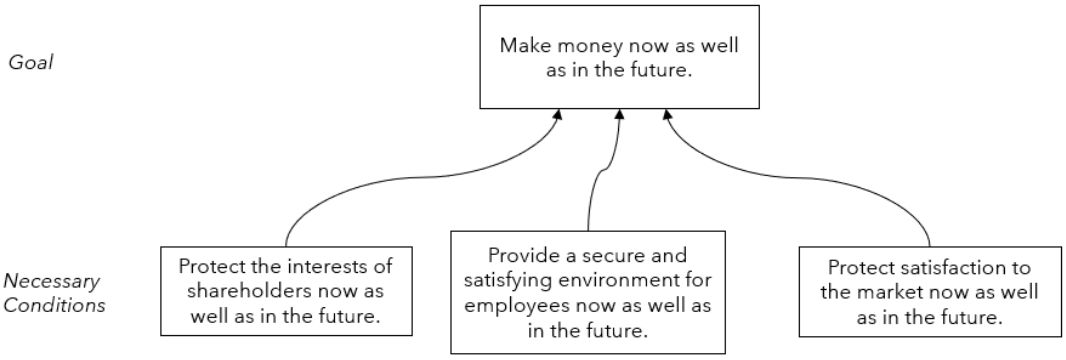


Figure 1: Alex Rogo's "UniCo Goal Tree"

1. Make money now as well as in the future.
2. Provide a secure and satisfying environment to employees now as well as in the future.
3. Provide satisfaction to the market now as well as in the future.

In this module, Dr. Goldratt also points out that "market" refers to any client, vendor, and other external stakeholders in the community as well. These necessary conditions from the Goldratt Satellite Program are summarized in the TOC Handbook as:

1. Increase goal units (e.g., net profit, education units, health units) now and in the future.
2. Satisfy markets (customers, suppliers, community) now and in the future.
3. Provide employee security and satisfaction now and in the future. (Cox 2010, Chap. 18, Kendall, 520).

As multiple TOC sources identify these components as the first necessary conditions for any strategy to succeed, it stands to reason that these are also excellent candidates for critical success factors in our tree. The process of creating a goal tree asks the designer to distinguish between the many conditions which may be necessary to bring about the goal and the few factors that are critical to attaining successful attainment of the goal. Dettmer asserts that distinguishing between necessary conditions and critical success factors enables future implementers of the tree to achieve focus.

The word focus holds special importance in the TOC body of knowledge and may provide an important clue as to how one might approach goal attainment in government. Eli Goldratt was once asked if he could distill the most important teachings of TOC into one paragraph or sentence. In response, he said that he could accomplish it not in a sentence, but in a single word: focus (TOCICO Handbook, 3). Since the responsibilities and challenges of government are so wide and encompassing, it is often necessary for administrators and elected representatives to provide focus to the agencies that they direct or manage. The elevation of some necessary conditions to a handful of critical success factors can accomplish this purpose and, to citizens

participating in the process, provide assurances that their priorities hold the attention of government leaders.

Governments are owned by the people, their leaders are often chosen by the people, and government policies are influenced by the people. People—that is, the stakeholders in the community at large—are the most critical element of government. As noted in Assumption 10, the goal of government is to increase quality of life for the people governed, now and in the future. Our system boundary includes those governments "of the people" and "for the people" and it therefore stands to reason that the critical success factors for governments must consider the major stakeholder groups in the community that a government serves. These include the people in the governed community, specific stakeholders in the markets of government, and the public servants (the employees) that provide or assure government services.

What is Different About the Government Environment that Shapes Our Goal Tree?

Understanding that a government must raise sufficient resources to provide services to the public, government has a different relationship with its markets than most other organizations. Governments do not have to entice people into purchasing their services, and are not generally subject to fluctuating market pricing for their services. Governments have the legal authority to impose on their markets prices, which we call taxes. It may be of some comfort that laws generally prohibit profit-making on government services, and restrict taxes to the costs incurred to provide service. But this comfort may not extend too far, if we believe that government agencies are being run ineffectively and inefficiently.

The goal of making more money now and in the future can be restated as "generate sufficient resources now and in the future" to be able to provide service. But the general expectation of government is to restrict the amount imposed on the community to the minimum level required to provide service. Consequently, rather than phrasing that entity as generating sufficient resources, we logically phrase this entity as "maintain affordability", which implies that sufficient resources must be generated now and in the future, but only to the point where it does not begin to negatively affect quality of life.

There is one more consideration to make regarding a government environment that shapes our goal tree. Whereas most organizations have the responsibility to comply with laws that protect the environment, governments have the responsibility of setting laws to protect the environment. In most organizations, the requirement to comply with environmental laws is reflected in efforts to "satisfy" markets—the government being one of those markets. In government, however, the environment itself is the stakeholder that the government must satisfy. But the environment is such a different stakeholder than other markets, that we have created a separate entity for it in the goal tree. The environment does not have the ability to directly interact, collaborate, or lobby for itself in any fashion that other community stakeholders do. To avoid a tragedy of the commons, the government must function as the steward and advocate for the environment and other shared resources.

The environment's response to human activity is often difficult to discern. It provides such indirect, latent and often lagging feedback that some stakeholder groups debate whether the environment is affected by

what we do at all. Regardless of one's convictions in regard to the impact severity of human activities on the environment, it cannot be denied that laissez faire human activity, such as witnessed during the industrial revolution or before the establishment of the EPA in the US, has a negative impact on our environment. This defining characteristic of the environment has prompted us to separate it into a category that, all on its own, is a necessary condition of the goal of increasing quality of life. We have stated this as: "create a sustainable environment, now and in the future."

What Is Our Goal Tree?

Consider the goal tree developed for this paper and which, the authors of this paper assert, has the potential to be a foundational goal tree draft for the vast majority of governments around the globe, or at least those governments that profess they are "of the people" and "for the people." We suggest the government goal tree be read in necessity logic fashion by reading the critical success factors from left to right and considering whether they are necessary to achieve the goal.

Next, we recommend that each critical success factor be scrutinized while considering whether its constituent necessary conditions are required to bring about the critical success factor. This makes it possible to analyze each critical success factor with "in order to, we must" statements. For example, we might observe that, in order to increase the quality of life now and in the future, a government needs to have a sustainable environment, provide employee wherewithal, create public value, provide security, satisfy external partners, and satisfy government authorities.

Note that these elements, when taken together, may not be sufficient, in and of themselves, to bring about the critical success factor. Goal trees only rest on necessity-based logic, not sufficiency-based logic. Thus, the goal tree for government presented here is aspirational and unifies necessary conditions, but it does not capture all the elements that are sufficient to create increased quality of life among all nations and cultures.

A succinct version of the tree is presented below. This version used the space available and text legibility to be a limiting factor. Put curtly, if a critical success factor or necessary condition seemed important, but did not fit and was not as important as the other elements on the tree, it did not "make the cut" and was not included in this version.

Entity Phrasing in Our Goal Tree

The authors of this paper have seen different entity phrasings in various goal trees. Some trees describe end states in their entities, while others describe actions (the means to the ends) in their entities. Our understanding of the goal tree is that each of the entities should contain an end state (or condition) that must be achieved for the next end state in the chain to be achieved. This is why goal tree entities are necessary "conditions". We note that Dettmer drives this point home by phrasing many of the verbs that appear in necessary conditions in his goal tree chapter as gerunds, thereby allowing the entities to both contain a verb, and to present as an end state (Dettmer 2016, Chapter 3). While Dettmer's approach is ideal in terms of creating conceptual conditions, it is often difficult or lengthy to convey nuanced content about

government using exclusively gerund verb constructions. For example, compare the necessary conditions descriptors “ability to resolve resource conflicts” with “the government is effectively and consistently *resolving* resource conflicts.”

In light of this discussion, this paper presents the entities in the goal tree as supporting end states or capabilities, and the authors suggest that they should be read as such. But the authors generally avoid using gerunds to allow for smoother reading. The authors maintain that an end state or a condition can be represented by the ability to do something. For example, “to provide justice” is an action, but “to be able to provide and assure justice” is an end state. Both phrases, however, represent a government in a condition where it is ready to provide justice when the need arises, or it is already providing justice. For brevity, succinct language was chosen for the goal tree descriptors, but each stated entity action includes the ability to provide a condition which is a supporting end state that contributes to the goal. For our phrasing, our intent was to ensure that the cause and effect arrows make sense when read from the bottom up in the, “in order to... we must...” format, while still meeting the clarity test and the completeness test (an entity existence test) under the categories of legitimate reservation (see Dettmer, 2016, chap. 2).

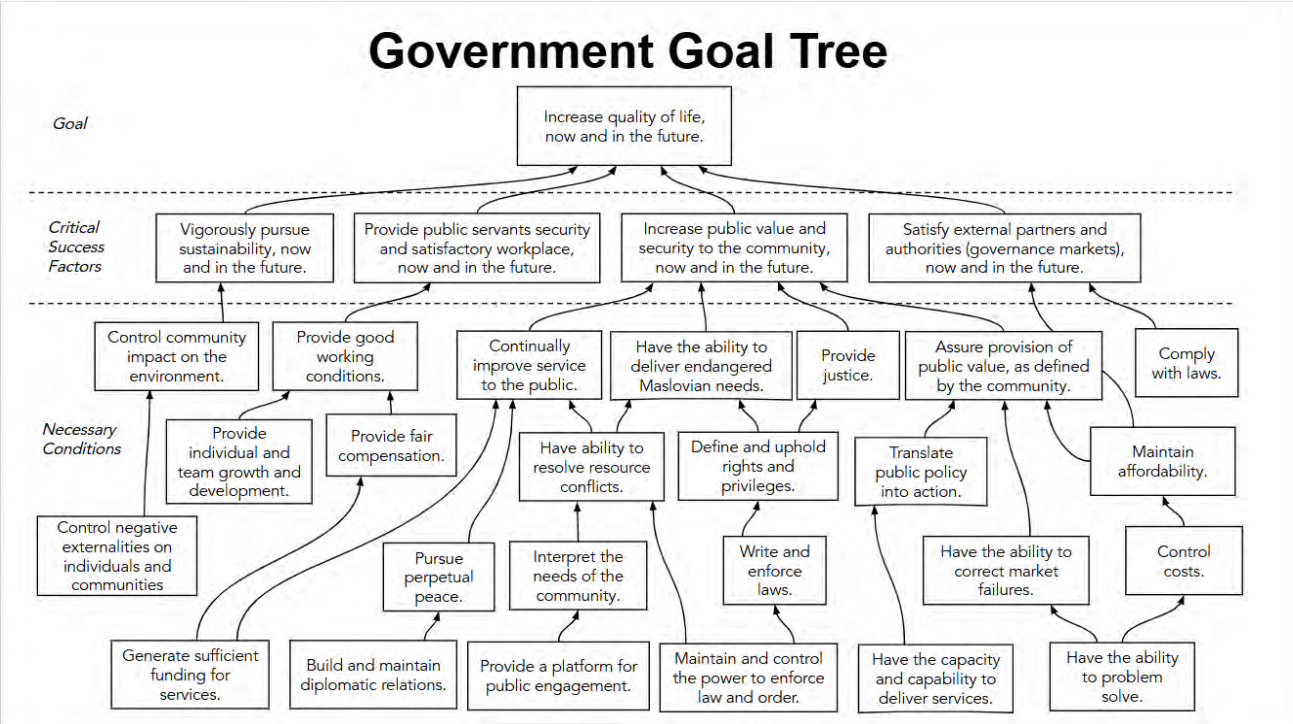


Figure 2: Government Goal Tree

The Goal - Increase Quality of Life, now and in the Future

Consider this quote from Aristotle from "The Politics" Book III in *The Politics of Aristotle* (Jowett 1885, 84), which discusses the means to the ends of *a good life*. Aristotle emphasizes the *collective* benefits versus individual benefits of group activities by conveying an element of synergy. Aristotle asserts that when individuals come together, they get more out of the collective enterprise than simply the sum of the parts. Put another way, when three individuals come together to form a community the result is something greater

than three and can approach or even surpass four (1+1+1 > 3)! The median team-member is thus part of something greater than the aggregate of the individuals on the team. This represents an interaction which creates a whole that is superior to the parts when they are simply added together, but do not interact to form the new whole. Thus, people form this social whole so they can collectively "pursue their needs and aspirations better in groups and organizations than alone," which is the second assumption of this paper. To ensure Aristotle's meaning is conveyed, he is quoted at length:

> "It is clear then that a state is not a mere society, having a common place, established for the prevention of crime and for the sake of exchange. These are conditions without which a state cannot exist; but all of them together do not constitute a state, which is a community of well-being in families and aggregations of families, for the sake of a perfect and self-sufficing life. Such a community can only be established among those who live in the same place and intermarry. Hence arise in cities family connexions, brotherhoods, common sacrifices, amusements which draw men together. They are created by friendship, for friendship is the motive of society. The end is the good life, and these are the means towards it. And the state is the union of families and villages having for an end a perfect self-sufficing life, by which we mean a happy and honourable life. Our conclusion, then, is that political society exists for the sake of noble actions, and not of mere companionship. And they who contribute most to such a society have a greater share in it than those who have the same or a greater freedom or nobility of birth but who are inferior to them in political virtue; or then those who exceed them in wealth but are surpassed by them in virtue." This quotation is from "The Politics" Book III page 84 in *The Politics of Aristotle* by B. Jowett published in 1885 (Aristotle 2000, Book III, 84).

From Aristotle's statement one can discern a few key concepts that form the foundation for our "goal of government" inquiry. First is that, while the dearth of crime and the establishment of a place to exchange goods are an important element of statehood, they are not sufficient conditions to create a state. A state, and the government that enables the state, creates a community which makes possible "the good life." The good life is the increasing quality of life that is made possible by society and its government. The good life is the additional value one gets from a state that well exceeds its component parts. This is reinforced by a quote often attributed to Aristotle, "the whole is greater than the sum of the parts." While Aristotle said in *Metaphysics* something more akin to "the totality is not, as it were, a mere heap, but the whole is something besides the parts," the meaning is clear (Aristotle 1908, Book VIII, 1045a., 8–10). The component parts of the state combine to create a value that exceeds the value of the components, and that increase in value is the quality of life that government makes possible and seeks to increase for its constituents.

Second, it is evident in Aristotle's assertions that this additional value is manifest in many of the things he lists: friendship, a happy and honorable life, noble actions, and freedom are a few. In appreciating the words of Aristotle, we can begin to see a transcendent goal of government: to increase the quality of life of the lives the state touches. When Aristotle says, "The end is the good life, and these are the means towards it," we interpret this to indicate that the *end* is a life of relative good quality and the critical success factors and necessary conditions are the *means* to pursue and increase that quality of life.

The Aristotelian definition of "the good life" corresponds to the definition of "quality of life" in the American Psychological Association Dictionary, which is "the extent to which a person obtains satisfaction from life." The definition, therefore, depends on and is inherent upon what people (i.e. the stakeholders of government) believe will satisfy them. Therefore, the goal of increase quality of life requires the critical success factor, "satisfy external partners and authorities (governance markets) of government stakeholder groups, now and in the future."

Governments consequently have an obligation to "put their ear to the rail" and understand how their constituents and stakeholders would like "increase quality of life" to be defined and pursued. This is not an easy pursuit. Such divining of intent is often challenged by ideological struggles and the political-administrative dichotomy during the execution of governance.

The politics-administration dichotomy raises the question as to whether elected and appointed officials should dictate policy and implementation methods, in which case bureaucrats should "just execute," or whether policy implementation is best left to experienced administrators who gauge and balance many competing factors and values as they turn policy into action. This question is considered in Part 4 of this paper: Evaporated Clouds and Sticky Wickets. Yet, regardless of ideologies and the challenge of this dichotomy, governments have an obligation to heed the druthers of the system's owners.

Interpreting what "the good life" is for community members can be quite difficult, but governments have the responsibility to earnestly construct a working definition of "quality of life" from legitimate inputs such as politics, law, constituent participation, and stakeholder engagement. The presented goal tree depicts this dynamic, especially in the necessary conditions that contribute directly to the critical success factors of "increase public value" and "satisfy external partners and authorities (governance markets)".

Community Needs and Quality of Life

This inquiry has identified a major requirement that government must accomplish as it pursues the identified goal. This is the ability to interpret the needs of the community and the ability to define quality of life, which Aristotle sought as an end. The two tasks are strongly related because constructing a working definition of quality of life requires an understanding of community needs. On the representative side of government, elected officials from different sides of the political spectrum are often locked in a struggle to advance what they interpret as the "good life." Furthermore, this ideological debate often extends to the *means* by which these *ends* will be pursued by the government institutions. Failure of governments to appreciate this can result in the *means* becoming the *ends* unintentionally. This is because it may not be clear to the implementers of government how the good life is defined, nor is it always clear what they should be doing to obtain it. Values and interests may collide as the government tries to sort out what quality of life is and to what lengths the government must go to help citizens achieve it. Nonetheless, an important part of getting to where one wants to be is the first requirement of determining where one aims to be. Arguably, government has an obligation to divine what quality of life is before government can pursue its increase.

Take, for example, drinking water. Representatives and administrators may agree, as in the recent case of Flint, Michigan, that water should be potable, but there might be disagreement as to whether it should be free of color, odor, or unpleasant aftertaste. Some might argue that if a citizen wants crisp, clean-tasting water they can purchase it. Others might contend that providing good-tasting water for all citizens, including those without resources to purchase drinking water, is an obligation of the water utilities. Public managers can seek clarity from elected representatives, but there is no guarantee that they will be provided with viable definitions of community needs and the good life. Nor can they expect timely and effective conflict resolution or resource allocation guidance. In such cases, public servants may find it necessary to define community needs and the good life for themselves, or to engage with citizens, to determine what (in our example) "good water" is.

The authors of this essay acknowledge that the definition of the "good life" is the result of values, interests, and needs that are often held in tension with each other. The political process or the judicial system may sometimes offer a clear definition, but representatives and public administrators, informed by feedback from the public, beneficiaries, and stakeholders, need to be prepared to define the quality of the services they offer and prudently allocate resources to achieve that quality. Egregious transgressions against the good life may be obvious, such as fouled, undrinkable water. But many complex cases will require a critical assessment of available evidence and necessitate difficult resource allocation decisions. Ultimately, pursuit of the good life for the community will require an application of judgment by those who run government for their sovereign citizens.

As a result of these definition and guidance limitations, this inquiry assumes that the implementers of government have the ongoing obligation of reconciling and unifying the needs of the community and the concept of a "good life" into a working definition of a quality of life. For the reasons discussed above, this is a difficult and often Sisyphean task. However, this must be done in order to guide the bodies of government to pursue and increase its citizen's quality of life, which, as offered here, can be upheld as the goal of government.

Selection of the Critical Success Factors

The goal tree in Figure 2 contains four critical success factors. The critical success factors are not portrayed in any order of priority, although more specific applications of the tree in the future will likely find benefit in prioritizing their own critical success factors. For brevity and clarity, the authors determined that "sustainability" and "employee satisfaction" are largely self-explanatory when paired with their supporting necessary conditions. "Increase public value" and "satisfy external partners," however, require clarification, discussion and perhaps justification. The initial critical success factor that we will examine is "satisfy external partners and authorities (governance markets) now and in the future." This describes a condition that is central to achieving the goal, namely a deep understanding by the government of the needs, interests and constraints of external partners at home and abroad. They form a kind of marketplace of pressures and competing forces that seek to influence the value creation of a government agency (Talbot 2010, 15). These force fields swirl around and vie for influence. For government to have any chance of improving the quality

of life of its citizens, it needs to understand and engage with these governance markets and the forces that emanate from them.

The term “markets” is traditionally used in the economic sense, but this paper broadens the term to apply to state actors and other forces of influence. It is important to note that the broad application of the term “markets” used here is consistent, not only with Eli Goldratt's use of the term, but also with the use of markets in the public choice theories developed by economists Charles Tiebout, Anthony Downs, Vito Tanzi and Kenneth Arrow. The public choice movement has sought to aggregate and politically represent the forces of democratic systems. The movement views voter preference in a way similar to how consumers seek greater utility through the exchange of goods or labor. These economists see voter preference as an exercise of citizen demand in a market-like environment. Colin Talbot, the author of *Theories of Performance*, also recognized a type of market when the forces of the performance system (examiners, elected officials, judiciary, review boards, etc.) make demands on government systems (Talbot, 2010, 18). By using the concept of markets well beyond its economic moorings, these writers established the view that a government “of the people” is subject to market forces that exert influence in social, political, and administrative domains.

Moreover, governments have partners at higher, lower and parallel levels at home and abroad. Coordination and mutual support are important requirements for creating public value and ensuring that government work done at one level or in one region is not constantly undone or unraveled at other levels and in other regions. The goal tree is an aspirational representation. It depicts the conditions necessary to make goal achievement possible. It does not necessarily indicate what is currently happening or not happening, rather, it is an optimistic picture of how we would pursue and achieve the goal.

The authors offer the goal tree as a generic representation of what good looks like on the way to goal fulfillment, but we acknowledge that each reader and each community has different values and unique historical traditions, and they would therefore prepare the goal tree differently. Every reader will likely see necessary conditions that need to be added or removed, or they might take issue with the critical success factors. The goal tree is offered as a foundation, what a jurisdiction builds on that foundation remains to be seen. The authors encourage each person and every community to question this generic tree and recraft it as they would see appropriate.

This paper does not generally distinguish between the administrative and political functions of government, although this theory is explored in the “sticky wickets” section of Part 4. The reason for this is that while the administrative and political functions play different roles within government structures, the definition of an overall government goal may best be based on the overarching goal of promoting societal well-being. A government is formed when political and appointed leaders work together with administrative leaders to translate law and policy into actions that positively impact citizens and shape society. Therefore, the goal, the critical success factors, and the necessary conditions are not presented separately for politics nor for administration. In order to achieve the goal of improving the quality of life, both the political and administrative sides must work together. This is rarely smooth and sometimes dysfunctional, but it is a reality of government, old and new.

Parsing Out the Critical Success Factor: "Increase Public Value"

As one takes in the goal tree it becomes evident that a considerable amount of government duties and responsibilities are packed into the critical success factor: "increase public value and security to the community now and in the future." This may cause readers who are looking for governmental roles that they recognize as traditional, such as sponsoring science, educating citizens, and promoting economic growth, to consider the goal tree to be lacking in substance. One could argue for including these traditional roles in the goal tree, and many more, as necessary conditions which support the "increase public value and security" critical success factor. For example, to create opportunity for people, as urged by the Nobel laureate Amarta Sen, governments might be asked to provide public education, especially in democracies where there is a need for informed electorates.

While there may be merit to including all or most of these traditional governmental roles that produce public value, there are four considerations that logically led to keeping the critical success factor of "increase public value and security" at a more encompassing level. These considerations stemmed, first, from an effort to keep the paper generic, second, to accommodate a wide set of public sector values, and third, to apply a space or "real estate" discipline to limit the number of necessary conditions. And finally, we borrow from economic theory to point out that each jurisdiction offers a particular bundle of services to its residents.

The first consideration involved a key objective of the paper which was to create a generic goal tree composed of elements that are common to the lion's share of governments in the world. However, this objective rapidly became challenged and complicated when the generic tree tried to define what public value means for a specific community. This is because the definition of public value for a particular community ceases to be a generic concept when it needs to be specifically delineated and pursued by the owners of a certain government. Such specific definition of public value is a necessity for all practical applications of the public value concept (Moore 1995, 52-54). This difficult and often messy job of defining public value in light of community objectives is required whenever the concept of public value is put into practice for a city, region, state, or nation (55).

In the construction of the goal tree, the authors sought a balance between general and specific. To have meaning and utility, the goal tree needed to be generic and generalizable enough to apply to a broad group of governments and jurisdictions. But it needed to be specific enough to invite those who are familiar with the functions and challenges of government to mentally apply the presented concepts to the art and science of governance. On the other hand, if the tree held too much particular detail, then it would be analogous to a manufacturing goal tree that lays out specific steps toward product production and proposes ways to attain that organizational capability. If that were to occur, the generic nature of the goal tree would be lost. Consequently, the authors struck a balance between specifically defining the capabilities required for governance and outlining the general necessary conditions for goal attainment .

The community and its leaders can build upon a generic goal tree, such as the one offered in this paper, to create their own particular definition of public value, with its own specific necessary conditions. When this is

accomplished, then the way is clear for the community to pursue their distinct public value vision. Such an undertaking is dependent on many factors such as culture, political philosophies, and geopolitics. A Western democracy will prioritize their values for governmental responsibilities differently than an Asian democracy. A national government that leans away from liberal values and robust political dialogue will be different still. Each community, or polity, is the owner of its government and needs to construct its own necessary conditions that are required to bring about public value, as defined by that particular community. In order to remain generic and be useful as an exemplar, the goal tree must remain at a general, consensus-gaining level.

The second consideration concerns different perspectives as to how large of a role government should have in the lives of those it governs. Should health care, for example, be provided or assured by government, or should that be left to competitive forces in the marketplace? The necessary condition, "capability to deliver endangered Maslovian needs," allows communities to decide for themselves what conditions and situations call their government to action.

The third restricting consideration was based on the derivative and restrictive concept of "limited real estate" available on the physical (or electronic) page for the tree to branch out and take root. Although some might consider it a relatively arbitrary constraint, the authors decided that this goal tree version should fit into a defined space of "real estate." This was determined to be a single slide-sized illustration that is legible and understandable to readers.

This spatial constraint required that the authors consider critical success factors and necessary conditions that were raised as possibilities in discussions and research. The outcome of this discussion was a contemplated and deliberate placement of selected factors and conditions on the limited real estate of a single slide-sized goal tree. When an author or a reviewer suggested a new necessary condition, the authors asked: "Ok, which condition would you like to take off the tree to make room for the new one?" The result was a succinct goal tree that distilled important government capabilities into a limited number of entities. For example, the goal tree distilled the multiplicity of public value into "assure provision of key elements of public value, as defined by the community" and leaves communities and their representatives to determine on their own what that means. This also kept the authors from diving down too far and including trivial concepts on the illustration.

The fourth consideration that limited necessary conditions on the tree stems from a realization that each community offers a different offering, or basket, of services that create public value for the residents. Charles Tiebout, in his 1956 article "A Pure Theory of Local Expenditures," observed that each governmental jurisdiction offers a particular bundle of services to its residents, especially at the local level (Tiebout 1956, 417). One community might offer a high level of expenditures on schools that is attractive to young families, whereas another community might offer a municipal golf course and cater more toward retired community members (Tiebout 1956, 418). In view of this, this paper avoids such specificity because local public value offerings differ from market to market of local government jurisdictions.

Remaining Critical Success Factors and Necessary Conditions

As noted above, some critical success factors and many necessary conditions are not described in detail in order to preserve "real estate" for other more crucial necessary conditions. Additionally, If the authors deemed that the chain of necessity-based logic was strong enough to stand on its own or could be intuitively understood, then the cause and effect chain was not discussed in detail. For example, "provide good working conditions" and other conditions that feed into "provide employee security and satisfaction, now and in the future" did not precipitate exhaustive deliberation among the authors nor did it invite further research into the success factor. The causal chain leading into "vigorously pursue sustainability, now and in the future" was likewise assessed as very clear. Therefore, as a measure of economy, the authors did not provide a narrative justifying the "sustainable environment" nor "employee security and satisfaction" critical success factors.

In conclusion, the four critical success factors each represent an aggregate of their component necessary conditions. Some of these factors were difficult and contentious, such as the concept of public value and governance markets. Heavily debated necessary conditions are discussed in this paper, often in the "sticky wickets" section. Factors that were not perceived as contentious were not discussed in detail. Importantly, regardless of the time spent on each critical success factor, this paper argues that if the four critical success factors are pursued ardently, then the goal of government will also be earnestly and auspiciously pursued. If and when this happens, the authors maintain, the quality of life of those in the governed community will rise.

Part 4. Evaporated Clouds & Sticky Wickets

An essential objective of the logical thinking process is to gain agreement with our key stakeholders about the current, combined view of the situation, and to build consensus as to the direction of the road ahead. However, agreement is not always forthcoming and many times stakeholders have different views of the current reality; conflict can also arise when determining what the next steps should be. The paper terms these problematic and contentious conflicts "sticky wickets." In most of these situations, the evaporating conflict cloud method was successfully used to surface hidden assumptions, to challenge them, and in the course of doing so, to find agreement regarding the situation and the writing team's direction. In some cases, the "sticky wickets" remained unresolved, but they are discussed in the paper as evidence of the debates that energized the research and writing process.

Evaporating clouds also enabled the authors to identify and verbalize legitimate interests on both sides of the conflict cloud. This helped the authors distinguish between legit governmental aims and presumed prerequisites. On more than one occasion, the cloud helped to discern what was in the public interest, which helped determine the way forward for the writing team. More often than not, initial disagreement worked itself out in Socratic dialogue, research and deliberation. However, during this process there were

also points of discussion where the authors could not forge agreement. Values occasionally differed. Either our philosophies and perspectives were too disparate or political views diverged when a topic was analyzed. The authors are each from different nations (US, Canada and Germany) with different political cultures. As will be evident in the examples discussed below, the ensuing inferences were sometimes incongruous and consensus among the three authors occasionally remained elusive.

In general, whenever consensus was attained, the topic was included in the goal tree. These elements became key points and were woven into the paper's argument that increasing quality of life is the goal of government. Topics that were deemed to have value to the readership, but where consensus was not reached among the authors, were included in this section to assist the reader in forming their own perspective on some of the more difficult questions regarding the goal of government.

One of the first challenges to Aristotle's view that government's purpose is to make "the good life" possible concerned the question of survival, security, and safety. As suggested by Thomas Hobbes and Adam Smith, perhaps the provision of security is the quintessential role of government (Hobbes 1651, chap 14; Smith 1776, Chap. 1, Part 1;). As an extension of this assertion, it can be argued that once security is achieved for a community, then commerce, collaboration, and pursuit of prosperity becomes possible. In this line of reasoning, the other functions of government become ancillary and function as societal enablers, but are not the most important provision of government. The apotheosis of security suggests that the goal of government is to provide security to enable trade, order, and justice.

Security as the primary purpose of government was claimed by Hobbes who in *The Leviathan* asserted that commonwealth is formed when individuals give up some of their rights to an overlord in exchange for the assurance that the ruler will protect them from "a war of every one against every one" (Hobbes, chap. 14). A government in the form of a leviathan, argued Hobbes, has the power to prevent such violent chaos and, although it requires that every person give up some elements of their freedom, it is necessary to safeguard a community because all things and all good intentions crumple in the absence of security, safety and stability.

Taking up Hobbes' line of reasoning, one of the authors argued that the goal of government was ensuring the survival of its constituent community. Another author argued the goal of government was to increase the quality of life of its constituent community. This brought us to loggerheads on agreement and for a while we could not determine a way forward. Directly stating what each of us saw as the solution to the conundrum did not help the authors navigate forward. The third author, who didn't specifically have a defined goal articulated at this point, viewed the disagreement as a sidestep of the TOC sales and buy-in process outlined in *It's Not Luck*, and consequently urged a more deliberate TOC-based approach to cases of initial disagreement and possible value conflicts.

To resolve this conflict, the authors modeled the conflict with an evaporating conflict cloud diagram.
(See fig. 3)

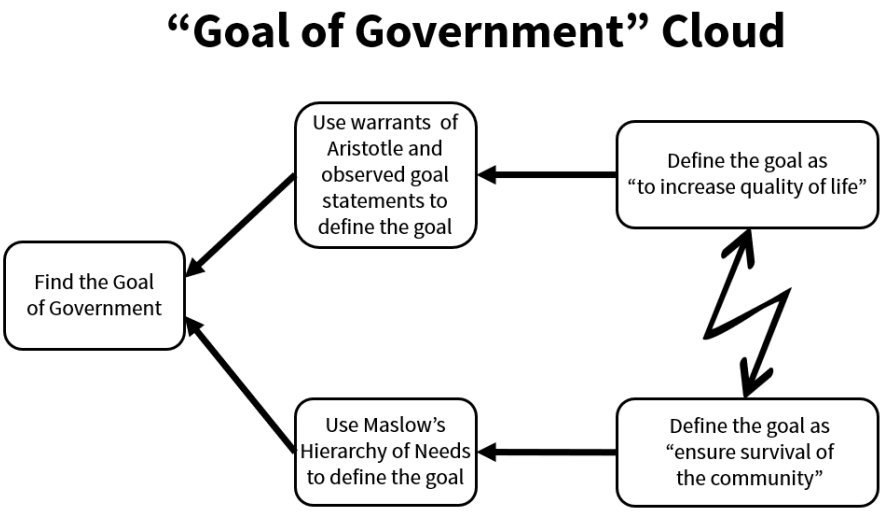


Figure 3: "Goal of Government" Cloud

As the cloud was analyzed, Maslow's hierarchy was recognized as a set of requirements that applied to individuals, but could not be grossly applied to an entire society in the order that Maslow outlined. For example, a group of people may choose to forgo physiological needs and safety needs, which are at the bottom of Maslow's pyramid, in order to fight for freedom. Questioning whether one could assume that Maslow's hierarchy of needs could be applied on a community level, led to another insight: physical needs and safety needs are really necessary conditions, rather than interests that compete with a goal of increasing quality of life. In other words, because survival of the community is a basic necessary condition to achieving an increased quality of life, it is inherently included in the goal "to increase quality of life" and not in competition with it. A government cannot work to increase the quality of life of its community members without addressing, to some extent, the Maslovian levels of physiological and safety needs. However, the reverse is not true, perfunctory achievement of those needs does not necessarily increase quality of life. As Aristotle noted, other dimensions such as friendship, family, prosperity, community, and opportunities for noble acts also need to be ascertained to some degree in order to enable an increase in quality of life.

In light of this reasoning, the evaporated cloud took this form: (see fig. 4)

Another values disagreement emerged concerning what kind of countries the generic goal would apply. Globally, there is a grand schism between democracies and autocracies; and it therefore seemed from the onset that the goals of these very different forms of government fundamentally differed. The goal of the United States government, the reasoning went, cannot be lumped together with the goal of the Communist Chinese government. Yet it was also evident that if a generic goal of government only applied to democracies, then it would exclude half of the governments and 71% of the people on earth (V-Dem 2024, 6). Exclusion at that magnitude could potentially invalidate a generic goal for government. Research into the founding documents of the world's major autocracies revealed that they too drew legitimacy and credibility from their people, avowed to better the lives of their people, and stated that they were committed to

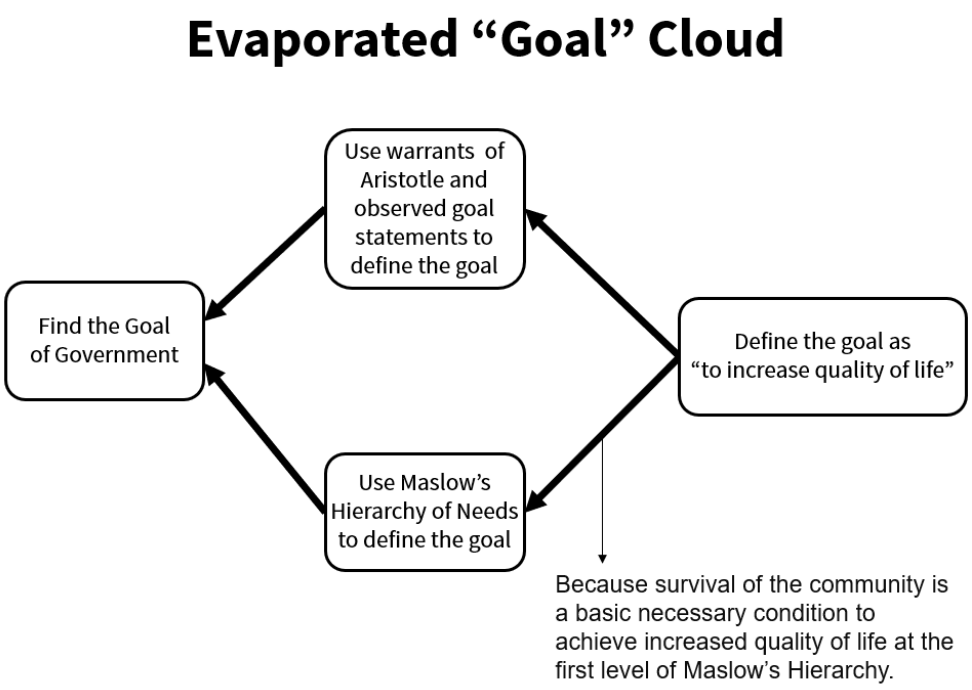


Figure 4: Evaporated "Goal" Cloud

creating a better future for their nation. The constitutions of those autocracies, which included China and Russia, revealed that those documents avowed to subscribe to the listed ten assumptions.

While the authors did not conduct a comprehensive assessment of the constitutions of authoritarian governments, we did examine the constitutions of China, Russia, Myanmar, and Venezuela. Each of these authoritarian regimes have articles of unification that refer to and affirm increasing quality of life as an important function of the government. This acknowledgement ties the regime to its people, affirms the importance of their welfare, and bolsters the legitimacy of the government. An example of this is *The Constitution of the People's Republic of China* (1982) which proclaims that "The state shall… gradually improve the material and cultural wellbeing of the people." (Constitution of China, Chap. 1, Art. 14).

The Constitution of the Russian Federation (1993) similarly affirms rights, freedoms, and stresses the role of the state in creating conditions increased quality of life of its peoples. The Russian Constitution maintains that "Man, his rights and freedoms are the supreme value. The recognition, observance and protection of the rights and freedoms of man and citizen shall be the obligation of the State." (Constitution of Russian Federation, Chap. 1, Art. 2). This constitution specifically focused on quality of life in asserting that "The Russian Federation is a social State whose policy is aimed at creating conditions for a worthy life and a free development of man" (Chap. 1, Art. 7). While the status of individual rights and liberties in Russia is questioned by many at the time of this paper, it does not diminish the affirmation of the intended goal of government as stated in the Russian constitution.

The Constitution of the Republic of the Union of Myanmar (2008) likewise upholds principles that, if respected and pursued in earnest, would contribute to a better quality of life among its peoples. The preamble to the Myanmar Constitution proclaims that "We, the National people, firmly resolve that we

shall… stalwartly strive for further burgeoning the eternal principles namely justice, liberty, equality and perpetuation of peace and prosperity of the National people;" (Constitution of Myanmar 2008, Preamble).

The Constitution of the Bolivarian Republic of Venezuela (rev. 2009) is yet another example of an authoritarian country that nonetheless avows to pursue an increased quality of life for its people. Venezuela's Constitution recognizes that, "The essential purposes of the State are the protection and development of the individual and respect for the dignity of the individual, the democratic exercise of the will of the people, the building of a just and peace loving society, the furtherance of the prosperity and welfare of the people and the guaranteeing of the fulfillment of the principles, rights and duties established in this Constitution" (Title I, Article 3). Some may dismiss the language of the Venezuelan and Myanmar constitutions as hollow, in light of how the two governments are reported to treat many of their citizens; nonetheless, these governments, as evidenced by their founding documents, publicly profess the importance of improving quality of life, and draw legitimacy from that declared objective.

This analysis has revealed that the vast majority of governments at least purport to meet the ten assumptions of this paper. While it is clear that some governments are much further from the ten assumptions in practice, they nonetheless profess to meet them. But clearly, electoral and closed autocracies are not true to the spirit of democracy as defined by "the rule of the people." In other words, although the governments of this world exist on a grayscale between pure democracy and pure autocracy, the vast majority of governments in this world would not have "a problem" with the ten assumptions, because they have adopted official language declaring that they represent the people of their nation and operate in their best interest. While this avowal may be a perfunctory, or even an outright false assertion in some cases, the fact that this assertion is ostensible, provides the opportunity to create these ten assumptions so as to capture the spirit of Lincoln's statement "government of the people, by the people, for the people" without necessarily excluding about 48% of the nations on earth that are assessed as non-democratic (Lincoln, 1863/2008; Bastian et al., 2024). One can hope that what is current rhetoric has the potential to give way to practice – the ten assumptions reinforce the spirit of a democracy without the label and simultaneously permit inclusion of "benevolent dictatorships" or other forms of authoritarian government that do not object to the ten assumptions.

It is important to recognize that in the relationship between a government and its people there can be considerable distance between actual quality of life and an expressed desire for an increasing quality of life. Nonetheless, if professed conviction and constitutional language provides evidence that a government has an aspirational goal to pursue increased quality of life, then such authoritarian governments should not be summarily excluded from the government goal tree depicted in this paper.

The authors often attained consensus using evaporating conflict clouds, research and debate. However, some sticky wickets that emerged during the paper-writing process remained sticky. They include the separation of politics and bureaucracy, the question of war, whether correcting market failure is an essential government function, and an exploration of the limits of the use of this goal tree.

Politics-Administration Dichotomy

Another persistent sticky wicket concerned the politics-administration dichotomy, also known as the "Wilsonian Dichotomy." It is a theory that explores and advocates the separation of politics and administration in government. Although there are antecedents, it was primarily introduced by Woodrow Wilson, the 28th President of the United States when he was a professor of political science in an 1887 essay titled "The Study of Administration." The essay and the theory it promulgated was more a reaction to the corrupt and patron-based government systems of the day than a viable way to manage politics and policy implementation in a democracy. The basic idea behind this theory is that there should be a clear distinction between political decision-making and administrative implementation within a democratic governance system. Such a separation has always been problematic in the practice of both politics and administration because the determination of policy and the administrative wherewithal to implement that policy have always been joined at the hip in democracies.

The necessary and fruitful exchange of ideas between policy makers and policy executors makes trying to separate the politics and bureaucracy problematic. This is because one of the ways a democratic government engages with the citizens it serves is through the services it provides them. Every service counter and every street-level bureaucrat (e.g. police officer, firefighter, teacher, etc.) is not only a government representative, they are government sensors that pull in data about citizen needs and provide them to their organization's leadership. Interaction with citizens helps to steer the governmental ship. This input complements and reinforces the primary way that the sovereign citizen expresses what she thinks needs to change in society: voting for, or direct communication with, her political representative.

Consistent with the problems it causes in the practices of governance, the idea that a government can separate politics from administration caused logical problems and inconsistencies during the development of the goal tree. For example, if one subscribes to the politics-administration dichotomy, then perhaps there should not be one tree but two, one for the political determinants of policy and another one for the administrative efforts that are required to bring those policies to bear. Perhaps, on the policy side, the tree should reflect the dueling values and policy consensus that help to define what "increase in quality of life" really means. Following this line of thought, a separate policy goal tree may help politicians determine whether government should shrink to provide only Hobbesian security and safety, or if the role of government should expand to provide health, justice, fairness, and financial resources for the society it serves? It might be possible that a separate administration goal tree might help public managers "stay in their lane" and concern themselves primarily with making street-level implementation successful.

Yet, when policy and bureaucracy fall out of alignment, difficulties often arise. "Staying in one's lane" can contribute to misunderstanding and misalignment. Successful administration and governance are made possible when policy implementation is a confluence of aspirational political objectives and earthy bureaucratic wisdom and advice (Wilson, J.Q. 1989, 205; Allison 1971, 176-178). In view of this, the authors decided on a Hegelian approach. The thesis and antithesis of the political dichotomy was conflated into the value-tensions and value-decisions that every community must contend with as they pursue the goal of government. A single goal tree conveyed these competing priorities as part of the processes that increase

public value and satisfy the demands of stakeholders. As long as there is an earnest pursuit of an increase in quality of life, syntheses between competing ideas and values may offer recourse to political debates that have resulted in political polarization in the US, European nations, and other democratic countries. This is a form of constructive conflict (Lencioni 2002, 92, 204-206).

One of the aims of this paper is to put forth a generic goal of government that can inspire constructive conflict as outlined by Mary Parker Follett and later expanded by John Dewey. Constructive conflict, as advocated by Follett is pursued by "bringing the desires of both sides to a place where they can be clearly examined and valued is [so] that evaluation often leads to *reevaluation"* (Follett 1926, 38). Dewey's vision for creative democracy echoes this perspective and reinforces the advantages of using TOC instruments such as the evaporating conflict cloud to address conflict. "A genuinely democratic faith in peace" argues Dewey, "is faith in the possibility of conducting disputes, controversies and conflicts as cooperative undertakings in which both parties learn by giving the other a chance to express itself, instead of having one party conquer by forceful suppression of the other…" (Dewey 1939, 64). In summary, a goal tree for government offers a way to achieve consilience and thereby converge governance solutions around objectives and ideas that are consistent with the goal tree proposed here.

War and Peace

The question of whether government should ensure the provision of any, all or some of Maslow's hierarchy of needs inevitably arises when the roles and responsibilities of government are investigated. How much of the safety and physiological needs, such as security and food, should be ensured by government and how much is the responsibility of any given individual to obtain? Will the provision of some of the bottom physiological and safety needs undermine an individual's motivation to achieve a higher need such as self-actualization?

These debates concerning Maslow's hierarchy of needs led to a sticky wicket that centered on the subject of security and whether government has an obligation to search for and provide peace. Recognizing that there are occasions that war might be the only way to ensure future peace and prosperity, the question raised was whether the pursuit of peace should be a necessary condition on the goal tree? One idea offered by the philosopher Immanuel Kant is that government has the responsibility to progress the nation "toward perpetual peace" and that government has a commensurate obligation to collaborate with other like-minded countries to make this possible (Kant 1795). One can easily see the connection between peace and security. Freedom from the scourge of war can provide a country stability and enable economic prosperity, thus ensuring that the country's individuals are secure. However, the specter of appeasement prior to WWII is a strong reminder that sometimes a nation must go to war to preserve peace.

The necessity of peace is one of the major questions that a person could struggle with when determining the necessary conditions for quality of life. To address the subject as it fits within this paper, we refer back to Maslow's hierarchy of needs in explaining general human aims and the motivation for behavior. Peace is the existence of security and safety, which are necessary conditions that fall lower on Maslow's hierarchy than the higher-level needs of belonging, status, and self-actualization (Maslow 1943). War, on the other hand,

causes one to move back down the ladder, both individually and collectively, from self-actualization to once again securing safety and security. That is, unless an individual finds their higher-level needs on the battlefield, as in a warrior culture, or if avoiding war causes an existential threat to the nation desiring peace, then peace is a lower-level condition that allows for security and safety to be met, and therefore enables the pursuit of higher-level Maslovian needs.

The decision of when to fight and when to not fight is an important question for all governments. A war can be waged for peace (and not for greater possessions or for the aggrandizement of the state), or a war can be avoided at all apparent costs, as in the case of Neville Chamberlain's "peace in our time" appeasement policy. This is because while the historical record documents the misery and tragic consequences of war for mankind, the record also depicts occasions when warfare is justified as a way to preserve the lives, rights, and quality of life of peoples who are at risk of losing them to tyrants or aggressor states. Michael Walzer, in *Just and Unjust Wars*, investigated when going to war is just and how to prosecute war, an inhuman condition, in a just and human way (Walzer 1977/2014). The objective here is not to recount Walzer's conclusions about justified war, but rather to point out that the pursuit of peace, security and stability is not a simple matter and may, at times, ironically justify the use of violence and war. The pursuit of perpetual peace as envisioned by Kant, is the *end*, although the *means* may include war. The pursuit of peace, therefore, is an inherent part of the goal of government as recognized in the Maslovian needs of citizens and the ten assumptions regarding legitimate government discussed above.

Address Market Failures

Some of the authors of the paper observed that economists have demonstrated that government has an obligation to correct for market failure. The supply and demand microeconomic model which predicts an optimal outcome at an equilibrium point that establishes price, production, and sales to consumers does not always work to effectively and efficiently distribute resources. Economists point out that asynchronistic information, externalities, monopolistic tendencies, conflicting interests between principals and agents, and tragedies of the commons can lead to disruptions of the classic economic model and market failure (Weimer & Vining 2011, 71). Thus, some scholars have suggested that government has an existential responsibility to intervene to reestablish economic stability and rectify market failure (Wolf 1993, 17; Barry Bozeman 2007, 60-61).

Other authors of the paper, on the other hand, found adequate assurances that the other critical success factors, if met, would establish the conditions to address a wide range of threats to the goal, to include market failure. For example, "increase public value and security to community, now and in the future" was seen by some of the authors as a sufficient critical success factor to attain the goal of government. Put succinctly, one author insisted, on the basis of Keynesian economic theory and historical experiences such as depression, recession and trusts, that a critical function of government is to address market failure; the other authors disagreed.

It remains a subjective judgment call as to whether the capability of government to correct a market failure is a critical success factor, or whether the capacity to handle such an economic challenge should be a necessary condition on the goal tree. Nonetheless , it is obvious that government has a significant role in nurturing economic activity and buffering economic crashes consistent with Keynesian economic theory. To what extent, however, remains a political decision and this paper deliberately skirts around this political debate to focus on a general government goal of increasing quality of life, now and in the future. Furthermore, the authors would like to leave the development of a detailed and specific definition of quality of life to politicians and political deliberation. After all, that is what the political process is designed to do. This paper would not want to rob our political representatives of that duty.

Can the Goal of Government Be Used to Accomplish Ill Will?

If this paper is successful at introducing a generic goal of government, does that achievement also harbor unintentional undesirable effects that pose a danger to the polity that that government serves? A goal of increasing quality of life holds the promise of bringing coherent logic to the diaspora of polarizing political convictions and conflicting values. The goal invites engagement and deliberation in the polity, potentially leading to alignment and unity. But one must consider whether that goal is also inadvertently creating a mechanism that can be used in ways that can ultimately subvert the goal of government and promote systems of government inconsistent with the spirit of the goal. In other words, is the creation of a common goal of government something that can be used by future bad actors or bad governments to accomplish their own selfish ends, thereby *decreasing the quality of life* of the people that they purport to serve, but really manipulate?

This question can be assessed through two lenses: first, through the eyes of the political aggregate, the polity, and, second, through the efforts of one person to opportunistically seize and hold power in government. It is not difficult to find historical examples of the first perspective. Religion, nationalism, communism, and technology are seemingly noble concepts that governments and societies have wrought into political weapons to control the people. The tendency toward self-preservation is a persistent example of this stratagem. The authors observed that nearly all organizations, to include governments at all levels, possess an existential will to persist. In other words, similar to an individual in Maslow's hierarchy, once an organization is successfully established, it begins to fight for its survival, especially if it detects a menace.

This inclination toward self-preservation has many just applications that support the goal of government to include governments defending themselves against external aggression, as discussed in Part 4 "War and Peace." However, this predisposition toward self-defense can also lead to the misuse of power and result in aims that are inconsistent with the goal of increasing quality of life. Perhaps the strongest modern memory of this is the series of treaties and military mobilizations that tragically yanked the entire European continent into World War I. Clearly, the owners of government need to recognize this tendency toward violent self-preservation and ensure its leaders are actively pursuing perpetual peace, even in situations where violence may appear to be required and justified. It is also important to recognize that this tendency toward war and

violence is often not due to subterfuge and is frequently not intentional. All the more reason to be wary of this danger to the goal.

The question of whether the goal of government can be used to accomplish ill can also be investigated through the challenges posed by power-hungry leaders. Such leaders often troll for ostensible foes who can be portrayed as existential threats. These self-serving leaders do this in order to preserve their own power, which they depict as synonymous with the well-being of the community. The concern here is that such opportunistic leaders could persuade members of the community that the goal of increasing quality of life can only be assured by banding together under the leader's banner to defeat the concocted existential threat. This outcome could be an unintended undesirable effect of adopting the goal of government and the goal tree. Political leaders might be tempted to use the goal to justify their power and unify the peoples they lead. One possible undesirable effect raised was the historical tendency for political leaders to find, or manufacture, internal or external "enemies" of the state. Such self-serving leaders then used the hyperbolized threat as a machination to galvanize support for their candidacy and political agenda.

The historical pattern seems to be that when a political leader's position is threatened, they look about for some expedient foe, especially one that can be characterized as an existential threat, in order to engender unity in a polity that otherwise might have replaced the troubled leader. Such discovery or creation of existential threats, for example, enabled Otto von Bismarck to consolidate power as he sought to unify Germany through the application of the sword, diplomacy and administration (Eyck 1968). Leaders such as Bismark have obtained popular support in the name of security and then used this garnered unity to pursue their own ends. The concern expressed here is that the goal of government could be used by opportunistic leaders to attain more governmental power. This undesirable effect needs due consideration from scholars and practitioners, and such scrutiny is beyond the scope of this analysis. Nonetheless, surfacing the issue may help future governments be wary of the possibility that critical success factors, such as security, can be used in ways inconsistent with the goal of increasing quality of life by actors pursuing self-serving ends.

Which Should Be the Goal of Government? *Rights Preservation* or *Increase Quality of Life?*

In a canvas for a common goal of all government, it is important to recognize the relationship between safeguarding individual rights and increasing quality of life. The preservation of individual rights and liberties played a much more prominent role in Locke's writings than Hobbes' work, which focused on the security reasons for granting portions of individual liberty to governmental leviathans. Locke intertwined the priorities of liberty preservation and the pursuit of the public good as he reasoned out the purpose of political power, which Locke maintained is the accomplishment of "the public good," (Locke 1689, p. 338; Tully 1991, p. 625). In Locke's eyes, both are reasons that the governed would willingly enter into a social contract with their governors.

Voltaire and Jefferson also recognized accomplishing the public good and safeguarding individual rights as two important functions of legitimate government. Voltaire, for example, observed that "Human law must in

every case be based on natural law. All over the earth," he exhorted, "the great principle of both is: Do not unto others what you would that they do not unto you" (Voltaire 1763, sec. 4). The US Declaration of Independence, drafted largely by Jefferson, states that all people have "certain unalienable Rights, that among these are Life, Liberty, and the pursuit of Happiness" (Jefferson, et al. 1776). And Jefferson, opining on the purpose of government a few weeks after he departed the presidency, observed: "the care of human life & happiness, & not their destruction, is the first & only legitimate object of good government" (Jefferson 1809, 31 March). The public good and happiness as referenced here are closely linked with quality of life and, as Aristotle put it, "the good life." Thus, by stressing the importance of both rights preservation and a happy, good life, Voltaire and Jefferson make it clear that there is a close reciprocal relationship between the two.

It remains an open question, however, as to how Locke, Voltaire and Jefferson would order "increase quality of life" and "define and uphold rights and privileges." Nonetheless, the libertarian political philosophy movement, which often claims Locke and Jefferson as two of their own, places a higher value on the preservation of individual rights than values affirming a collective well-being (Duncan 2005, xi, 153; Nozick 1974). Unlike the political philosophers discussed here, libertarianism contends that government must never initiate an action to create a better world because libertarianism maintains that it is not the business of government to make an advance decision about what counts as a benefit (Hospers 1971, 84, 305).

John Hospers, author of *Libertarianism: A Political Philosophy for Tomorrow*, argues that government should not pursue the public good because "under a system of limited government such as libertarians advocate, government is confined in its function to the protection of individual rights" (Hospers 1971, 420). The libertarian position is that the only proper role of government is to protect citizens against aggression by other individuals (Machan 1974, 12; Nozick 1974, 113). Put another way, libertarianism sees the public good as being accomplished simply through government action (and inaction) that is focused on protecting rights and liberties. Consequently, Hospers would likely argue that preserving individual rights is the goal of government and that individual efforts to increase quality of life in the aggregate is a necessary condition that supports that goal.

Which should be the goal of government, rights preservation or pursuit of the good life? Consider the government goal tree and the ten assumptions outlined in this paper. It demonstrates that the owners of government determine the values that guide governance and identify the individual rights that they want safeguarded. These expectancies cumulate into the critical success factor "increase public value and security to the community now and in the future." As argued in Assumptions 4 and 7, the owners of government are its citizens whose government has an intrinsic obligation to meet their needs. If the citizens in a jurisdiction determine that individual rights are an intrinsic part of how they define quality of life, then government has an obligation to safeguard those rights. Because this inquiry sets out to find a generic goal of government, a libertarianism goal may be too specific, too culturally bound, and too idyllic to apply to all governments.

Critics of libertarianism have argued that because libertarianism ranks individual rights over collective well-being and supports laissez faire economics, it puts quality of life at risk (Zenger 2014; Cohen 2008, 92, 221).

Detractors also maintain that libertarianism jeopardizes quality of life by rejecting most broad social investment such as education, public health, and infrastructure (Craig & Machan 2005, xii, 52; Cohen 2008, 175-6). These critics of libertarianism suggest that this will cause undesirable effects such as relegating education, favoring privileged interests, and not supporting the vulnerable (Anderson 2017, 62-63; Okin 1989, 84).

The aim here is not to recount all of the arguments against a conceived, but largely untried, libertarian system of government. It is difficult to compare and contrast libertarianism's benefits and costs with other temporal forms of government. This is because there are no libertarian governments (known to the authors) to analyze, and libertarians themselves are split between leftist and rightist libertarianism.

This paper does not promote one type of government over another. Nor is it attempting to justify or establish an ideal form of government. Rather, this inquiry examines the current state of governance and the reasons that governments purport to exist. Arising from this inquiry is a hypothesis that the prime expectation of government, and a primary source of its legitimacy, is to promote an increase in quality of life of those who live within its jurisdiction.

Despite the fact that they are vying for the generic goal of government in this analysis, protecting individual rights and an increase in quality of life are not at odds. The ideals of libertarianism can be pursued by a government whose owners subscribe to the goal of increase quality of life. Assumption 3 recognizes the right of owners of an organization to set the goal for an organization and Assumption 4 observes that the owners of government are citizens. Under the auspices set by these assumptions and the necessary conditions in the goal tree, specific jurisdictions may choose to define quality of life as a condition supporting a government's goal is to first safeguard all natural individual rights.

Thus, according to the logic of this paper's approach, each community defines its own rights and privileges, ultimately determining a specific goal for its own government. A libertarian government would be an example of this. It would be an administrative regime pursuing a higher quality of life for those in its jurisdiction by safeguarding individual rights and freedoms, as sanctioned and circumscribed by the owners of government. This would be consistent with the generic goal urged in this paper which is for government to increase the quality of life that the community desires and defines.

Usability and Applicability of the Goal Tree

One topic that started as a sticky wicket, but rapidly achieved consensus, revolved around whether, and to what extent, the goal tree represented a viable generic solution that governments, peoples, and regions could adopt to meet their own purposes. For example, questions considered during this discussion were: how much of the goal tree is "one size fits all" and is it ready to use "off the shelf"? The conclusion reached in this paper is that the general and generic goal, "increase quality of life" applies to any government that meets the ten assumptions.

It is important to note that this conclusion and the goal tree does not claim to offer sufficiency. In other words, if the listed necessary conditions are all being accomplished, this does not mean that they will cause the goal to be achieved; there may be other conditions needed to ensure that this occurs. In Part 3, "What Is a Goal Tree," it was established that the goal tree is a tool that only makes statements of necessity. This means that the necessary conditions offered by the goal tree are rarely, if ever, sufficient in total to achieve the critical success factor that they support. Further additional conditions, especially those specific to particular communities and regions, may be necessary to achieve the critical success factors.

Eli Goldratt reflected on purported “definitive solutions” and advised a bit of caution. "Since truth does not exist in science, ultimate solutions do not exist,” Goldratt reasoned, “The highest rank given to a solution is ‘powerful.’ When a powerful solution is applied, it changes the entire situation for the better" (Goldratt 1990b, 158). The aim here is to offer the goal tree not as an ultimate solution, but one that is powerful enough to be adaptively integrated into the cultures and traditions of communities and societies seeking to change their situation for the better.

Tony Bryk, co-author of *Learning to Improve: How America’s Schools Can Get Better at Getting Better*, defined adaptive integration as “Learning how to integrate a change package into different settings. This may require significant changes in the intervention, and the work settings into which it is being introduced, for the intervention to fit and achieve quality outcomes locally” (Bryk, et al. 2017, 200). The goal of government and the goal tree that elucidates it can perhaps best be applied with the knowledge that it will be most effective and useful when it is adapted to the governance environment that surrounds the current government.

While the authors maintain that the model has considerable value to all government forms, types, and sizes, we came to the same conclusion that the statistician George Box came to: “All models are wrong, but some are useful” (Box 1979, 201). Put another way, the goal tree is a model after all, not an ultimate solution, but in terms of recognizing the purpose of government in so many cultures, nations, and peoples, we do offer it as a viable way forward for all contemplating the purpose of governance.
Ultimately, the authors decided that the goal and its tree is only a foundational and comparative tool. The goal tree is not immediately ready to use, nor is it a “one size fits all” instrument. It must be adapted to the culture, needs, political structures, and historical experiences of the jurisdiction that intends to create a goal tree for itself.

The goal tree offered here may have the potential to open doors leading to research and future findings on the subject of TOC in government. The value of this paper should likely be measured by the extent to which this paper can function as a basis for future research in this field. Here are a few suggestions for further research:

First, a question raised by this paper, but not fully answered, is what are the necessary conditions of an effective government that is actively pursuing an increase in quality of life? Research, for example, may reveal that necessary conditions have to be found for each culture, or possibly for each community. Perhaps this goal tree model may be laden with assumptions and dependencies that are specific to western governments; they may need to be rebuilt to meet the needs of other jurisdictions in the world.

Second, does the application of TOC in the public sector necessarily lead to ethical government behavior? Third, does the implementation of the generic goal we have defined for governments, "increasing quality of life, now and in the future," inherently promote ethical behavior? Research into this last question could explore whether the pursuit of an improved quality of life by governments generally leads to ethical behavior by those governments and in those governments. Finally, what constitutes ethical behavior by governments, and how can it be defined independently of cultural and state differences? Perhaps such research could even lead to a universal framework for understanding and evaluating ethical behavior in different contexts.

Part 5. The Goal of Government and Beyond

This paper had two major aims: to develop a generic goal of government and to initiate the translation of the TOC BOK into a lexicon that resonates with those who do the work of government around the globe. An assessment of both objectives is in order as this paper concludes.

The first aim of this paper was to propose a generic goal of government in the TOC tradition of the 1990 business novel, *The Goal*, by Eli Goldratt. This ambitious objective was, at least in part, accomplished by a goal tree that sought to use its "real estate" space to convey the most essential critical success factors and necessary conditions that support the goal of government. The sticky wickets discussion helped to coherently report on the lively debates that the authors had concerning the best use of the goal tree's real estate.

The hope of the authors is that this generic goal can be used by governments as a starting point to delineate what should be done to increase quality of life in their jurisdiction in the near future. The goal tree template does not purport to directly apply to all governments at all levels. Rather, they are advocated here as a foundational model on which jurisdictions can construct their own uniquely adapted and consensus-built goal tree. Specifically, such a tailored and circumscribed model may help public officials and public administrators to develop their own definition of public value and construct their own strategies and tactics that are adapted to their region's traditions, culture, needs, and body of law.

The second aim of translating the TOC BOK into a government language invites public managers to learn about and acquire the robust suite of TOC problem solving tools and approaches. This paper aims to fill the gap between traditional manufacturing-based TOC literature and the application of TOC concepts to the nonprofit, service based, political, and administrative environments. The authors drew inspiration from the way TOC for Education has applied TOC to the fields of instruction and schooling in classrooms across the world. Similar to the way Georg Cantor reimagined mathematics in the 19th century based on a few axioms, one could use TOC thinking tools to create a new system for governing state organizations. This paper advocates that this jurisdictional or regional process begins with a basic and general goal of governance. The authors urge that such efforts be adapted from the goal and goal tree presented here.

The authors of this paper also invite public servants at all levels of responsibility to use this paper as a basis for addressing issues their agency faces with the "all conflicts can be resolved" TOC mindset and suite of TOC thinking tools (Goldratt & Goldratt-Ashlag 2010, 51, 222). Imagine public managers all over the world

outfitted to use the problem-solving, decision-making, and strategy-designing tools of TOC to address the challenges their communities face. Our proposition is that, if this is accomplished, the quality of life across humankind will rise and the world will literally become a better place. For example, the thinking tools could help detect hidden assumptions that have restricted policies and solutions for generations. Current reality trees and interference diagrams can assist in identifying unintended consequences of governmental decisions. Future reality trees and prerequisite trees can work to mitigate those challenges. Goal selection, measurement, and the five focusing steps discussed below can identify constraints that restrict the flow of public value in government processes. The five focusing steps can also help to cut through modern day Gordian knots and focus improvement efforts on the decisive constraints of government.

The evaporating conflict cloud perhaps holds the most promise for government agencies wrestling with competing priorities and clashing values. When faced with discord and conflict, public managers could use the evaporating conflict cloud to address the governance and development problems faced by the most diverse forms of government, from dictatorships to grassroots democracies. Routine use of this tool could be used to address disagreement and, at the very least, work to reduce illogical, emotion-driven decisions by revealing long-held assumptions. Evaporating conflict clouds help to make both sides of the conflict transparent and intelligible to the other side by identifying legitimate interests on either side (Scheinkopf 1999; Dettmer 2016; Fisher and Ury 1981). Logic and legitimate reservations can be used to scrutinize persistent disagreements. Once assumptions and competing convictions are visible, the path toward consensus and win-win solutions readily becomes apparent.

Another powerful TOC tool that could be of use to elected leaders and public managers is the strategy and tactics tree developed by Eli Goldratt (Goldratt, et al. 2002). Future practitioners and researchers could develop a general strategy and tactics tree for governments with the aim of developing a framework for a sustainably prosperous state thriving in a “what good looks like” international setting. The strategy and tactics tree could offer ways for governments to pursue “increase quality of life” goal trees that they have adapted to their unique characteristics and traditions. A strategy and tactics tree, for example, may have the potential to address the competitive nature of international relations in which states compete for influence and limited resources. In such a situation, the primary strategy could focus on creating a sustainable, equitable and prosperous society by optimizing benefits for all nations and all stakeholders while responsibly addressing global challenges and tragedies of the commons. Tactics could include building strategic improvements through innovation, managing resources efficiently and minimizing risk to ensure long-term stability. Such an approach could be positioned to emphasize ethical behavior in international competition, aiming for win-win solutions to global problems. This imagined strategy and tactics tree could then serve as a basis for future research on effective governance strategies in a global context.

Arguably, public servants and public managers, once outfitted with robust improvement tools such as TOC, Lean, and Six Sigma, could also be entrusted and empowered to solve workflow problems at organizational levels where those problems occur. Bottom-up ideation and problem-solving can productively blend with top-down guidance that is borne from executive understanding of the organization’s performance regime (Talbot 2010, 90-91). This has the potential of giving political leaders the potential to co-create public value

with administrative leaders in a bold new way. Such a new, overall system would be outfitted to use the proven tools and techniques of TOC, and other methodologies of continuous improvement, to enlist governments around the world in the process of ongoing improvement.

This paper has only begun the journey of translating the language and solutions of TOC to the government environment. So far, we have only accomplished the first prerequisite of the seven actions in the focusing process: a proposed generic goal of government (Ronen et al., 2018, p. 35; Fox, 2015, pp. 29, 34, 36). To continue the translation of TOC to the domain of governance, we must still yet accomplish:

Prerequisite 2. Establish global performance measures (determine how goal achievement will be measured).

As introduced in Part 1, the Five Focusing Steps provide the operational process for ongoing improvement. In the governmental context, Prerequisite 2 requires the establishment of appropriate global performance measures before the Five Focusing Steps can be meaningfully applied.It is the intention of the authors to write an accompanying white paper on Prerequisite 2 and the challenges faced when attempting to measure progress toward the goal of government. Beyond that, we invite the collective TOC and government service community to develop papers that cover topic-specific solutions for the remaining steps.

'Everything has already been said, but not yet by everyone,' said the German cabaret artist Karl Valentin at the beginning of the last century. This paper contains much that is familiar to the political and social sciences, and is therefore an invitation to scholars to investigate and test the propositions offered in this work. Cross-fertilization between TOC concepts and public administration research promises to be a way to further connect praxis-based understanding and academic research into what factors help public organizations progressively improve. Both professional communities have a profound motive to learn the causal and mediating conditions which enable improvement in the public sector. For example, research into the topics investigated in this paper could reveal causal connections between embracing goals and improving public service.

The introduction and integration of TOC into the operations of governance offers the promise of an increase in quality of life for governed humanity. So why not start with a goal of government that aspires to that noble end and incorporate TOC as a means to pursue that goal? Put another way, nearly 2400 years ago, "The end is the good life, and these are the means towards it."

Bibliography

Allison, Graham, T. (2012). Public and private management: Are they fundamentally alike in all unimportant respects. In J. Shafritz & A. Hyde (Eds.), *Classics of Public Administration* (pp. 395-411). Wadsworth Cengage Learning. (Original work published 1979)

Anderson, Elizabeth (2017). *Private Government : How Employers Rule Our Lives (and Why We Don't Talk about It)*. Princeton, NJ: Princeton University Press.

Anderson, D. M. & Stritch, J. M. (2016). Goal clarity, task significance, and performance: Evidence from a laboratory experiment. *Journal of Public Administration Research and Theory*, 26(2), 211–225. https://doi.org/10.1093/jopart/muv019 Baldrige Foundation (2023). Https://baldrigefoundation.org/

Aristotle. (2000). *Politics*, Book III (B. Jowett, Trans.). Dover Publications, Inc. (Translated in 1885; Original work undated)

Aristotle. (1972). *The Works of Aristotle: Vol. 8. Metaphysics*. (W.D. Ross, Trans.). Clarendon Press. (Translated in 1908; Original work undated)

Aristotle (`315 BC). Nicomachean Ethics.

Bogner, David. (2007, May 13). The *chupchik* for the *kumkum*. *Treppenwitz: the wisdom of the stairs*. https://www.treppenwitz.com/2007/05/the_chupchik_fo.html

Bastian Herre, Rodés-Guirao, Lucas and Ortiz-Ospina, Esteban (2024). "Our World in Data: Democracy." https://ourworldindata.org/democracy. Accessed 4 September 2024.

Box, George, E. P. (2014). Robustness in the Strategy of Scientific Model Building. In R. Launer R. L. & G. Wilkinson (Eds.), *Robustness in Statistics* (pp. 201-236). Academic Press. https://doi.org/gd32bv. (Published from workshops held in 1979)

Bozeman, Barry. (2007). *Public Values and Public Interest: Counterbalancing Economic Individualism*. Georgetown University Press.

Campbell, Donald T. and Stanley. Julian C. (1963). *Experimental and Quasi-Experimental Designs for Research*. Houghton Mifflin Company.

Constitution of the Bolivarian Republic of Venezuela. (revised 2009). https://bityl.co/PVDA

Constitution of the People's Republic of China. (1982). https://bityl.co/PV83

Constitution of the Republic of the Union of Myanmar. (2008). https://bityl.co/PVBS

The Constitution of the Russian Federation. (1993). https://bityl.co/PVAD

Cox, James F., & Schleier, John Jr. (Eds.). (2010). *Theory of Constraints Handbook*. McGraw-Hill. https://bityl.co/RETV

Cox, J.F., Boyd, L.H., Sullivan, T.T., Reid, R.A., & Cartier, B. (2012). *The TOCICO Dictionary* (2nd Ed.). McGraw-Hill Inc. https://bityl.co/QIUd

Cox, Kristen and Ashlag, Yishai. (2018). *Stop Decorating the Fish: Which Problems to Ignore and Which Problems Really Matter, 2nd Ed*. North River Press.

Dettmer, H. William. (2016). *The Logical Thinking Process: A Systems Approach to Complex Problem Solving*. ASQ Quality Press.

Dettmer, H. William. (2022). The Origin of the Goal Tree. TOCICO Website, TOC Body of Knowledge, New Knowledge and Papers. https://www.tocico.org/page/TOCBodyofKnowledgeTheOriginoftheGoalTree

Duncan, Craig., & Machan, Tibor R. (2005). *Libertarianism: For And Against*. Rowman and Littlefield.

Eyck, Erich. (1968). *Bismarck and the German Empire* (No. 235). WW Norton & Company.

Ferguson, Lisa. (n.d.). *The Six-Step Process for Standing on the Shoulders of Giants*. TOCICO. https://www.tocico.org/page/TOCBodyofKnowledge

Ferguson, Lisa. (2012). Understanding more about the Standing on the Shoulders of Giants Process. [Video]. TOCICO Website. https://www.tocico.org/general/custom.asp?page=UnderstandingmoreabouttheStandingontheShouldersofGiantsProcess

Fisher, Roger, & Ury, William. (1981). Getting to Yes: Negotiating Agreement without Giving in. Penguin Books.

Follett, Mary Parker. (2013). Constructive Conflict. In H.C. Metcalf & L Urwick (Eds.), Dynamic Administration: The Collected Papers of Mary Parker Follett. Mantino Publishing. (Original work published 1926)

Fox, Kevin. (2015). Aligned and Engaged: Hidden Keys for Turning Teamwork Into Profit. Viable Vision. www.teamworkforprofit.com.

Gallup Polls (2020). Accessed 17 August 2024. "More in U.S. Say They Are Better Off Than in Past Elections." https://news.gallup.com/poll/285593/say-better-off-past-elections.aspx

Ghneim, Staci (2018). "The Shortcut to SUCCESS in Social Services." Conference Presentation, Utah Ops & Goldratt Consulting, Salt Lake City. Utah Governor's Office of Management and Budget, Kristen Cox, Director,

Goldratt, Eliyahu M. (1990a). The Haystack Syndrome: Sifting Information Out of the Data Ocean. North River Press. https://amz.run/98QD

Goldratt, Eliyahu M. (1990b). What is This Thing Called Theory of Constraints and How Should it Be Implemented? North River Press. Kindle Edition. (p. 158).

Goldratt, Eliyahu M. (1999). Goldratt Satellite Program: GSP Series. Video Sessions 1-8. [DVD]. Goldratt's Marketing Group, Ltd. https://bityl.co/PUPe

Goldratt, Eliyahu M. (2006). *Beyond the Goal*. (Eliyahu M. Goldratt: Narr.) [Audiobook]. Gildan Media, LLC. https://amz.run/98PO

Goldratt, Eli, Goldratt, Rami, and Abramov, Eli. (2002) Goldratt Research Labs. https://www.goldrattresearchlabs.com/pdf/other-authors/_Strategy_and_Tactics__-_by_Eli_Goldratt,_Rami_Gol.PDF Accessed on 19 August 2024.

Goldratt, Eliyahu M. (2009). Standing on the Shoulders of Giants: Production Concepts Versus Production Applications. The Hitachi Tool Engineering Example. Gestão & Produção, 16(3), 333-343. https://bityl.co/PUOp

Goldratt, Eliyahu M., & Cox, Jeff. (2014). The Goal: A Process of Ongoing Improvement: 30th Anniversary Edition. North River Press. https://amz.run/98QC

Goldratt, Eliyahu M., & Goldratt-Ashlag, Efrat. (2010). The Choice (rev. ed.). North River Press. https://amz.run/9QVu

Hobbes, Thomas. (2008). Leviathan. (J.C.A. Gaskin, Ed.). Oxford University Press. (Original work published 1651)

Hospers, John (1971). *Libertarianism*. Los Angeles: Nash Publishing.Kant, Immanuel. (1939). *Perpetual Peace*. Columbia University Press. (Original work published 1795)

Ingraham, P. W., Joyce, P. G., Donahue, A. K. (2003). *Government performance: Why Management matters*. The John Hopkins University Press.

James, O., Jilke, S. R., Van Ryzin, G. G., eds. (2017). *Experiments in Public Management Research: Challenges and Contributions*. Cambridge University Press.

Jefferson, Thomas., et al. (1776). *Declaration of Independence*. Retrieved from the Library of Congress, https://www.loc.gov/item/mtjbib000159/.

Jefferson, Thomas (1999). *Jefferson: Political Writings*. Cambridge Texts in the History of Political Thought (J. Appleby & T. Ball, Eds.). Cambridge University Press.

Jefferson, Thomas (1809). *The Papers of Thomas Jefferson*, Retirement Series, vol. 1, *4 March 1809 to 15 November 1809*, ed. J. Jefferson Looney. Princeton: Princeton University Press, 2004, pp. 98–99.

Jefferson, Thomas (1809). Thomas Jefferson to the Republicans of Washington County, Maryland, 31 March 1809. *Founders Online,* National Archives, https://founders.archives.gov/documents/Jefferson/03-01-02-0088.

Koyré, A. (1952). An Unpublished Letter of Robert Hooke to Isaac Newton. *Isis*, 43(4), 312–337. http://www.jstor.org/stable/227384

Kroll, A. (2015). Drivers of performance information use: Systematic literature review and directions for future research. *Public Performance & Management Review*, 38(3), 459–486. https://doi.org/10.1080/15309576.2015.1006469

Lincoln, Abraham. (1995). *The Gettysburg Address and Other Speeches*. Penguin Books.

Lincoln, Abraham. (2008). *The Collected Works of Abraham Lincoln* 1858-1860, *Vol. 3*. Basler, Roy P. ed., originally pub. 1903 John Hay, John and Nicolay, George eds. Rutgers University Press.

Lencioni, Patrick. (2002). The Five Dysfunctions of a Team: A Leadership Fable. Jossey-Bass.

Locke, John. (1689). *Two Treatises of Government*. Cambridge University Press.

Locke, John. (1988). *Two Treatises of Government*. (Peter Laslett, Ed.). Cambridge University Press. (Original work published 1690)

Mintzberg, Henry. (1996). Managing Government; Governing Management (Balancing the Private and Public Sectors). *Harvard Business Review* 74 (3), 75-83. Harvard Business School Press.

Mabin, Victoria J., & Balderstone, Steven J. (1999). *The World of the Theory of Constraints: A Review of the International Literature*. CRC Press. https://bityl.co/QISB

Machan, Tibor. R. (1977). *The Libertarian Alternative*. Nelson-Hall.

Maslow, Abraham. (1943). A Theory of Human Motivation. *Psychological Review* 50, 370-396.

Mycue, Alfredo, & Schragenheim, Eli. (2022). *Unique Features of Government and How Governance Could be Assisted by the Theory of Constraints*. TOCICO. https://www.tocico.org/page/TOCBodyofKnowledge

Nodelman, U., Allen, C., & Perry, J. (1995). *Stanford Encyclopedia of Philosophy*. Stanford University.

OECD. (2020). *How's Life? 2020: Measuring Well-being*. OECD Publishing. https://doi.org/10.1787/9870c393-en.

Okin, Susan. M. (1989). *Justice, Gender, and the Family*. Basic Books.

Oxford Learner's Dictionaries. (2024). Accessed 13 August 2024. https://www.oxfordlearnersdictionaries.com/definition/english/government.

Rawls, John. (1999). A Theory of Justice, revised 1999 ed. Harvard University Press. (Original work published 1971)

Ronen, Boaz, Joseph S. Pliskin & Shimeon Pass. (2018). The Hospital and Clinic Improvement Handbook: Using Lean and the Theory of Constraints for Better Healthcare Delivery. Oxford University Press.

Scheinkopf, Lisa J. (1999). Thinking for a Change: Putting the TOC Thinking Processes to Use. APICS.

Smith, Adam. (1776) An Inquiry into the Nature and Causes of the Wealth of Nations. Canaan, Edwin, ed. ElecBook Classics.

Sproul, Bob, & Nelson, Bruce. (2012). *Epiphanized: Integrating Theory of Constraints, Lean and Six Sigma (TLS)*. North River Press.

Stein, Jess, ed. (1966). The Random House Dictionary of the English Language. Random House.

Talbot, Colin. (2010). Theories of Performance: Organizational and Service Improvement in the Public Domain. Oxford University Press.

The Best Business Books Ever. (2003). Bloomsbury Publishing Plc, Basic Books. .

Tiebout, Charles M. (1956). A Pure Theory of Local Expenditures. Journal of Political Economy 64 (5), 416-424

Tully, James (1991). Locke. In J. H. Burns & Mark Goldie (eds.), *The Cambridge History of Political Thought 1450-1700,* chapter 21, 616-652. . Cambridge University Press.

UN-Habitat. (n.d.). "Quality of Life Initiative" website: *About us: Defining Quality of life*. Retrieved on June 6, 2024, from https://bityl.co/QIaQ. The first World Habitat Day was in 1986 in Nairobi, Kenya and became an annual event.

United Nations General Assembly. (1948). The Universal Declaration of Human Rights (UDHR). https://bityl.co/Rdri

V-Dem; Varieties of Democracy Institute (2024). "DEMOCRACY REPORT 2024: Democracy Winning and Losing at the Ballot" https://v-dem.net/documents/43/v-dem_dr2024_lowres.pdf. Accessed 15 June 2024.

Voltaire (1763). *Toleration and Other Essays by Voltaire*. Translated, with an Introduction, by Joseph McCabe,1912. G.P. Putnam's Sons.

Waldo, Dwight. (1980). *The Enterprise of Public Administration*. Chandler & Sharp.

Walzer, M. (2015). *Just and Unjust Wars: A Moral Argument with Historical Illustrations*. Hachette. (Original work published 1977).

Wolf, C. Jr. (1993). *Markets or Governments: Choosing Between Imperfect Alternatives*. MIT Press.

World Health Organization. (1998). *WHOQOL (World Health Organization Quality of Life) User Manual*. World Health Organization: Division of Mental Health and Prevention of Substance Abuse. https://bityl.co/QIa1

Zenger, C., & Martin, E. J. (2014). Libertarianism and the Realities of Governance. *Global Virtue Ethics Review*, *7*(1), 146-182.

Zwolinski, Matt, and Benjamin Ferguson, eds. (2022). *The Routledge Companion to Libertarianism*. Abingdon, Oxon. Routledge.

The Six-Step Process for Standing on the Shoulders of Giants

By Dr. Lisa Ferguson
www.linkedin.com/in/tocmentor

Founder and CEO, Illuminutopia

© Copyright Dr. Lisa Ferguson. All Rights Reserved

August 12, 2026

The six-step Standing on the Shoulders of Giants (SOTSOG) process is fundamental to the successful development of various Theory of Constraints (TOC) applications, which have resulted in dramatic performance improvements worldwide since the publication of *The Goal* in 1984. Even though the SOTSOG process was first formally presented during Dr. Eli Goldratt's upgrade workshop at the 2011 TOCICO International Conference, its essence led to the creation of the TOC Body of Knowledge (BOK) long before the process was officially documented.

The same logic applies to the TOC five focusing steps (also known as the process of ongoing improvement or POOGI), which were only verbalized and explained in the second edition of *The Goal*, a best-selling novel written by Eliyahu M. Goldratt and Jeff Cox.

Inspired by Isaac Newton's quote, "If I have seen further, it is by standing on the shoulders of giants," the SOTSOG process demonstrates that we can create breakthrough solutions by building on prior work. This approach successfully led to the development of TOC business applications from manufacturing to all other business functions, and ultimately to a holistic solution, aligned with Eli's lifelong goal of teaching the world to think.

In 2008, my final writing test as Eli's apprentice—which I successfully passed—was the creation of the white paper titled *Standing on the Shoulders of Giants: Production concepts versus production applications: The Hitachi Tool Engineering example*. This paper combined my academic expertise as a former operations management professor with Eli's storytelling approach. (Note: it was intended to become part of a TOC reference book.)

This document describes the SOTSOG process for inclusion in the TOC BOK. Each step is outlined below, along with three examples provided in Eli's final 2011 workshop: the first focusing on the TOC production application, and the other two addressing the TOC project management solution.

First Example:

1. **Identify a "giant," not a chupchik.**

   Intuition will guide you to choose a subject matter that is important enough to analyze and improve. An important subject is one in which you already possess a significant level of logic, intuition, and emotion, thus providing a strong foundation and motivation for the work.

   I recommend using logic, intuition, and emotion because of the conclusions reached in Eli's co-authored book, *The Choice*. At the end, a logical conclusion was that we can achieve a more meaningful (full) life by moving up the spiral of logic, intuition, and emotion. We must use

critical thinking skills to verify that our assumptions are facts of life and that our cause-and-effect logic is sound. Intuition is necessary to develop a hypothesis to test and validate these assumptions. Intuition stems from emotion, since we must truly care about a subject to develop an intuitive understanding of it.

The giant chosen for Eli's first example in the TOCICO workshop was based on the SOTSOG white paper, which focused on the Toyota Production System (TPS, later known as Just-in-Time and Lean) invented by Taiichi Ohno. Lean production became globally popular due to Toyota's significant success.

2. **Identify the enormity of the area not addressed by the giant.**

Reality provides the signals that so much more can be done. By evaluating the current reality of the subject matter, one should realize that a huge gap exists between what is happening and what is possible in terms of potential. We are aiming for a broader, not a more confined area, than was addressed by the giant. For example, what was not addressed in the application or solution of the subject matter you chose?

Despite the profound success of the TPS, in addition to the knowledge and skills shared by Toyota in the public domain, less than 20% of the manufacturers in Japan have effectively implemented Lean. Why is this the case?

3. **Get on the giant's shoulders.**

Gain the historical perspective by understanding the giant's solution better than the giant did. Studying the SOTSOG white paper will result in a much better understanding of the TOC production and operations application.

In order to learn more about Ohno's TPS, I read all three books written by him. As a result, I learned that TPS was based on his reading of Henry Ford's book, in addition to knowledge of how U.S. supermarkets handled inventory.

The history of Ford's and Ohno's implementations is presented in that white paper, in addition to an explanation of the four concepts of flow they utilized, which are NOT focused on increasing local efficiencies nor on reducing cost. Instead, they both understood that the way to improve performance dramatically was to increase the flow or throughput by reducing the lead time.

4. **Identify the conceptual difference between the reality that was improved so dramatically by the giant and the area untouched.**

The relative stability of the environment at Toyota is explained in the white paper. That stability was a necessary condition for TPS to work. In fact, Lean was developed specifically for that environment over a time frame of decades at Toyota.

The white paper provides an explanation of the types of instabilities that can exist in manufacturing environments. The conceptual difference between the reality that was improved by the TPS at Toyota and the area untouched was how to **apply the fundamental concepts** utilized by Ford and Ohno to create a breakthrough solution that can be more effectively utilized in a variety of manufacturing environments.

5. **Identify the wrong assumption.**

How manufacturers are (or can rapidly become) stable is described in the paper. An explanation is provided about how TOC time buffers and buffer management can be effectively utilized to apply the four concepts of flow that Ford and Ohno implemented. Those concepts are:

> *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). Ford used space; Ohno used inventory.*
>
> *3. Local efficiencies must be abolished.*
>
> *4. A focusing process to balance flow must be in place. Ford used direct observation. Ohno used the gradual reduction of the number of containers and then gradual reduction of parts per container.*

A better way to prevent over-production is to use time as a mechanism, rather than space or inventory. Using a time-based mechanism is more robust for unstable environments. We need to release material into production a short time, just-in-time, before the due date of the order.

One way to identify the wrong assumption is explained in the book, *The Choice*. The true story of a retailer anonymously identified as BigBrand demonstrated how to conduct the analysis.

First, Eli identified the two most significant undesirable effects (UDEs) suffered by retailers: shortages and surpluses. Then, the erroneous assumption that caused these UDEs was logically identified as forecasts being unreliable. Decisions about how much to order are commonly made far in advance based on unreliable forecasts, thus resulting in lost sales due to shortages and excess inventory of other items. Surpluses block the shelf space, which could be utilized to stock a larger variety of goods to sell and not need to sell goods at a significant discount.

6. **Conduct the full analysis to determine the core problem, solution, etc.**

The rest of the white paper addresses how to achieve exponential performance improvements, even in production environments that experience high instability. The key concepts and logic of the TOC production application known as drum-buffer-rope (DBR) are explained. (Note: DBR has since evolved into simplified DBR or S-DBR)

The way to conduct the full analysis is by applying the TOC thinking processes (TP). First, we begin by identifying the core conflict. A good way to do so is by choosing three different significant UDEs in the reality being evaluated and writing a conflict cloud for each.

Then, those three UDE clouds are combined to become the core conflict cloud, which we then verify is the core problem (root cause) by verifying that it also causes the rest of the UDEs existing in that current reality.

We need to invalidate at least one assumption underlying the core conflict cloud in order to identify a breakthrough solution that achieves the common goal or objective and both needs or necessary conditions.

Second Example:

1. **Identify a "giant," not a chupchik.**

Intuition will guide you to choose a subject matter that is important enough for you to analyze and improve. The giant chosen for Eli's second example in the TOCICO workshop was the critical path method (CPM), a methodology developed in the 1950s for project management.

2. **Identify the enormity of the area not addressed by the giant.**

The enormity of the unaffected area of CPM is the performance of all projects. CPM and the program evaluation and review technique (PERT), which were separately developed in the 1950s, both resulted in improvements in planning and executing projects. Both focus on the critical and longest sequence of tasks. However, those solutions were insufficient for achieving good project performance in terms of time, budget, and meeting specifications and quality targets.

3. **Get on the giant's shoulders.**

Gain the historical perspective by understanding the giant's solution better than the giant did. Standing on the shoulders of CPM resulted in the understanding that defining the project duration based on the longest path provides us with the ability to focus on the few elements that make a real difference in the project's lead time. The critical path is the longest path of tasks in the project network or plan. Therefore, only a small subset of all the project's tasks is important for determining the project lead time. CCPM ensured that the critical chain path took into account not just task dependencies, but also resource contention, which occurs when a resource is expected to perform two tasks at the same time.

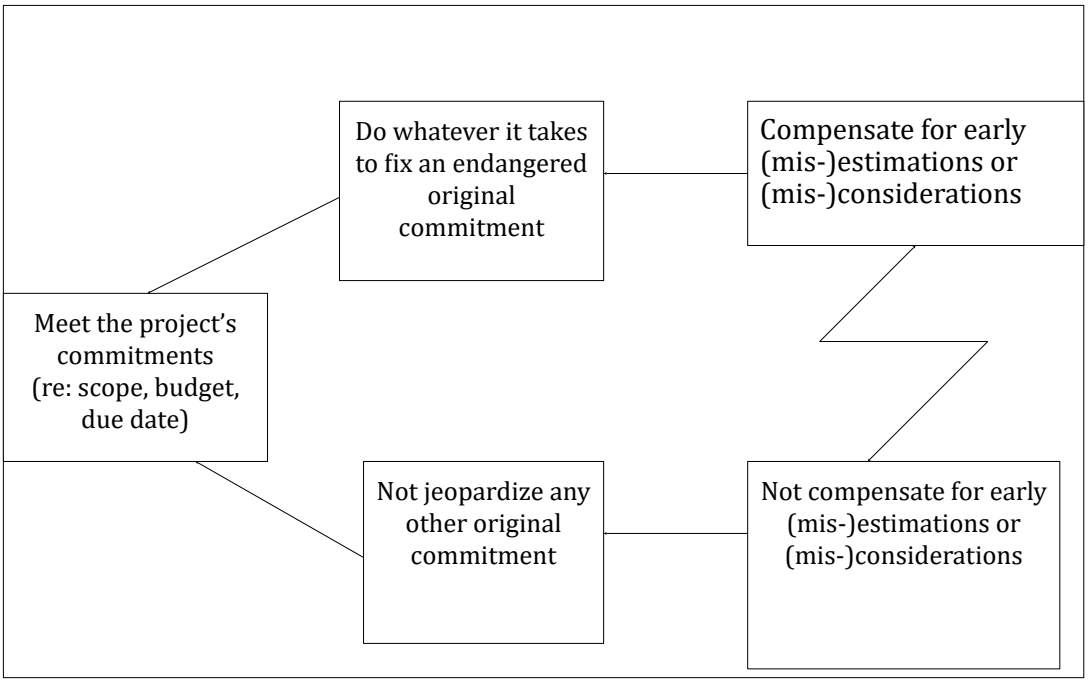
In operations and production management, TOC is focused on the bottleneck that is commonly (though not always) only one resource out of many (i.e., 100). On the other hand, in project environments, we are focused on the critical path, which may be 40 tasks out of 40,000 in the plan. The constraint in operations is capacity-based, and time-based in projects.

4. **Identify the conceptual difference between the reality that was improved so dramatically by the giant and the area untouched.**

When creating the project plan, the time estimate for each task is taken as a commitment. The variability of task time estimates is known to be high in project environments. As a result, a huge amount of safety time is included in the estimate since it becomes a commitment because resources and managers providing the estimates do not want to miss deadlines for task completion. This commitment also leads to a disincentive to finish early or report early finishes because it could lead to estimates being cut in the future. Even if an early finish is reported, it is unlikely that the next resource would be able to start its task early.

5. Identify the wrong assumption.

The project planning conflict cloud is presented below:



The assumption challenged for this conflict was: "The safety we are allowed is not enough to absorb all the glitches." Cutting estimated task times in half (for the majority of the tasks, if not all) and placing half of the safety time removed in buffers, such as the project (completion) and feeding buffers, in addition to motivating correct behaviors, resulted in much better project performance.

6. **Conduct the full analysis to determine the core problem, solution, etc.**

The full analysis resulted in developing the critical chain project management (CCPM) solution in terms of how to plan and execute projects effectively. (To learn more about CCPM, see the recommended resources at the end of this document.)

CCPM Successes:

- CCPM was successfully implemented in the Israeli maintenance depot for F-16 fighter jets. Only allowing three open projects per super engineer reduced the average project duration from **14 months to 7 weeks**, while nearly eliminating overtime, without increasing the engineering staffing levels. (Note: Dr. Eli Goldratt shared this example in various project management materials, such as the *GSP*.)

- Typical CCPM results are faster projects (**20-30% shorter project duration**), more reliable projects (**increasing from less than 20% on time to greater than 80% on time**), and additional projects completed (**20-50% more with the same resources**)! (Note: to learn more, see the *Projects Strategy and Tactic tree*.)

Third Example:

1. **Identify a "giant," not a chupchik.**

The subject matter chosen next was CCPM, which was created by standing on the shoulders of the giant of CPM.

2. **Identify the enormity of the area not addressed by the giant.**

To further improve project performance, we needed to realize that the enormity of the unaffected area is ALL projects. Dr. Goldratt presented the solution for single project environments in his novel, *Critical Chain*. CCPM implementations have resulted in dramatic improvements in performance over the years as cited above.

Still, bad multitasking (BMT) was prevalent in TOC-managed project environments. BMT entails working on one task, stopping before finishing, starting on another task, then coming back to work on the first task.

BMT typically results in a significant amount of time in setups between tasks and extremely elongated task/project lead times. The reduction of the F-16 fighter jet maintenance time from 14 months to 7 weeks could only be explained by the understanding that allowing super engineers only three open projects dramatically reduced their BMT. Even though CCPM significantly reduced the level of BMT, the potential for improvements based on further eliminating BMT was still huge.

3. **Get on the giant's shoulders.**

We needed to understand the causes and impact of BMT to figure out how to eliminate it in project environments. The best way to learn about the full logic of CCPM is to study the Projects Transformational Strategy and Tactic Tree (TSTT) or webcast program recordings. (Note: To learn more about Strategy and Tactic trees, view webinars and conference presentations that I (and others) have offered through TOCICO. In addition, it would behoove those wanting to learn more to read the chapter on S&T trees that I wrote in *The Theory of Constraints Handbook*.)

4. **Identify the conceptual difference between the reality that was improved so dramatically by the giant and the area untouched.**

It was not until later in the process of implementing CCPM that we realized that the impact of BMT was much more damaging than we realized. According to Eli, 80% of the impact of BMT was missed. The full impact of it on the capacity and lead time was not fully understood until the incredible results achieved in the F-16 maintenance depot were analyzed.

5. **Identify the wrong assumption.**

BMT lengthens the lead time significantly, but has little impact on the touch time for completing the actual work on a task. In production environments, typically 10% of the actual lead time is touch time, while the rest of the time is spent queuing. That is why S-DBR usually begins by cutting the lead times in half when the four concepts of flow are implemented.

In project environments, the task times typically have high variability with a long tail, which means that it is possible that the task time will take much longer than the average. It is therefore necessary to institute more changes to improve project performance.

6. **Conduct the full analysis to determine the core problem, solution, etc.**

In order to better plan and execute the projects, we needed to include additional steps in the Projects Transformational Strategy and Tactic Tree. Specifically, the additional steps addressed having freeze mechanisms for projects, tasks, legs, and full kit to eliminate BMT.

We need to **freeze enough of the lowest priority projects** to reduce at least 25% of the load on the resources. We already understood in TOC that releasing projects sooner does not yield a faster completion time.

However, staggering the release of projects was insufficient because most organizations have far too many projects in execution. Therefore, it is necessary in most cases to kill the majority of the projects and only plan to work on those having the greatest predicted impact on improving the performance of the organization.

Since the safety time is reduced and effectively aggregated in the project and feeding buffers, the **legs of the project should not begin earlier than planned**. The legs are scheduled to start when necessary to be on time, while reducing BMT. Those leg durations are protected by the feeding buffers, while the entire project has safety in the project buffer that can also handle the time of the feeding buffer being over-depleted by late completion of the task(s) in the leg.

In addition, we need to create project plans that have a maximum of 300 tasks. Doing so makes it easier for management to effectively focus their attention (a meta-constraint) on successful implementations.

Very large projects are managed effectively by relatively small project network plans. The ones used to build the North Sea oil-rig ($4B) and the overhaul of the largest cargo airplane (the C5) each have less than 300 tasks. While it is possible to effectively manage a project plan of more than 300 tasks using CCPM software, it is better to not exceed that number. The logic for why this is the case is explained in more detail in the Projects TSTT.

Freezing at the **task level** is necessary after the other changes have been made for departments in which BMT is still problematic. The resource manager of that department will need to freeze at least 25% of the tasks that are on the list to be completed by the resources.

Finally, the **full kit** freezing mechanism ensures that a resource does not start work on a task unless all the elements necessary to complete the task are already available. In some cases, it is possible to have enough of the elements available to start the task. Starting the task without the full kit can lead to unnecessary BMT.

Other SOTSOG examples

To learn more about the SOTSOG process, you can view the video proceeding of the presentation I delivered for TOCICO. I share two healthcare examples of applying the six-step SOTSOG process.

Summary

This BOK paper provided an explanation for how to apply the six-step SOTSOG process using three of Eli's examples. This process is very helpful for significantly improving any subject matter chosen by effectively utilizing the TOC theory, tools, and applications.

References

Cox, J. F., III, and J. G. Schleier, Jr. (editors), *The Theory of Constraints Handbook*, New York, NY: McGraw-Hill Education. 2010.

Ford, H. *Today and Tomorrow,* Productivity Press, 1988 (originally published in 1926)

Ferguson, L. A., Chapter 34: Applications of Strategy and Tactic trees in Organizations, *The Theory of Constraints Handbook*, New York, NY: McGraw-Hill Education. 2010.

Ferguson, L. A. *Understanding more about the standing on the shoulders of giants process*, video proceeding, www.tocico.org.

Goldratt, E. M., and J. Cox. *The Goal*. Great Barrington, MA: North River Press, 4th revised edition, 2024 (includes the SOTSOG white paper at the end in the Kindle edition)

Goldratt, E. M., and E. Goldratt-Ashlag. *The Choice, Revised Edition.* Great Barrington, MA: North River Press, 2010.

Goldratt, E. M. "Standing on the Shoulders of Giants; Production concepts versus production applications; The Hitachi Tool Engineering example," 2008. (Two sources: the end of *The Goal* and the December 2008 issue of Weekly Diamond, Japan)

Recommended Resources

To learn the TOC fundamentals:

Goldratt, E. M. *Goldratt Satellite Program: GSP series* (8 sessions). www.toc-goldratt.com and TOC.TV.

Goldratt, E. M. and R. Goldratt, *TOC Insights* (series), *www.toc-goldratt.com*

TOCICO Dictionary, 2nd edition. www.tocico.org (Note: it is currently being revised for release as a new edition.)

Ferguson, L. A. 0 to 60 TOCICO webinar series (Introduction to Operations and Production, Project Management, Finance and Measures, Distribution, Marketing and Sales, Thinking Processes, and Strategy) www.tocico.org

To learn CCPM:

Goldratt, E. M. *Critical Chain*. Great Barrington, MA: North River Press, 1997.

Goldratt-Ashlag, E. *Goldratt's Rules of Flow*, Great Barrington, MA: North River Press, 2022.

Goldratt, E. M. "*NEVER SAY I KNOW – Parts 1 through 5*," *2011 TOCICO International Conference*, www.tocico.org

Goldratt, E.M. *Projects Strategy and Tactic tree*, www.tocico.org

Goldratt, E.M. *The Goldratt Strategy and Tactic Program for Project Based Environments: A Decisive Competitive Edge*, 2008, www.toc-goldratt.com

Updegrove, D. *The Critical Chain Implementation Handbook*, 2014.

Why TOCICO?

The Theory of Constraints International Certification Organization (TOCICO) is a global, non-profit organization with a mission to advance the science, adoption, and effective practice of the Theory of Constraints (ToC) through conferences, webinars, certifications, resources, and community.
Our member-based organization connects individuals, companies, practitioners, consultants, and academics who share a passion for ToC. We're proud to house the world's largest repository of TOC content, and provide access to this knowledge to our members.

At TOCICO, we help individuals and organizations master the Theory of Constraints (ToC) — the proven framework behind breakthrough results in production, projects, supply chains, and strategy. Our mission is to empower people at every level to think systemically, make better decisions, and act with clarity and confidence.

With TOCICO Membership, you gain structured access to the tools, knowledge, and community that accelerate your mastery of ToC. Members learn how to identify and leverage their true constraint — focusing time and resources where they deliver the greatest impact — instead of wasting effort on low-leverage problems.

Through annual conferences, webinars, on-demand learning, certification, and a global network of problem-solvers, TOCICO connects you to the leading minds in TOC and supports you in applying it to achieve meaningful, significant, and lasting improvement.

Whether you're developing your own expertise or leading a team through a transformation, TOCICO helps you build systems-thinking capability, elevate decision-making, and create a culture of ongoing improvement.

Join TOCICO to strengthen your skills, drive breakthrough performance, and be part of a worldwide community advancing the theory and practice of the Theory of Constraints.

Learn more about us https://www.tocico.org/about-us


THEORY OF CONSTRAINTS
TOCICO
INTERNATIONAL CERTIFICATION ORGANIZATION


9 798997 417901