



THE HISTORICAL VIEW OF THE DEVELOPMENT OF THE CONCEPT OF THE CONSTRAINT

By Oded Cohen

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The historical view of the development of the concept of the Constraint

The reasons for this webinar:

- It is apparent that there is no agreement within the TOC community regarding the definition of the Constraint within TOC.
- There have been many discussions that have not converged into an agreeable definition.
- Some members of the community state that they do not see the point in further attempts in bridging between the different point of views [especially, where their definition is working for them]
- I think it is important to have a clear definition of the constraint, and I can shed light on some of the different definitions through historical development that I have been closely involved with.



An example of the confusion

Theory Of Constraint Handbook 2010

Section I, page 4:

Introduction to TOC – My Perspective, by Eli Goldratt:

“In organizations, there are numerous interdependencies and relatively high variability; ***therefore, the number of elements that dictate the performance of the system – the number of constraints – is extremely small***”



An example of the confusion

Theory Of Constraint Handbook 2010

Yet, in the same book,

In Section III Chapter 7, page 149:

Derivation of DBR using five focusing steps, John Blackstone writes:

“TOC says that constraints (*anything that limits a system from achieving higher performance versus its goal*) determines...”

Limit

Versus

Dictate



Why a clear and agreed definition is important?

- TOC was developed by the desire to establish a robust process of on going improvement (POOGI). The approach has been based on rigorous logic (Cause and Effect) of its solutions. The logistical solutions are based on the constraint.
- The consistency of the definition of the constraint in TOC is relevant to the practitioners who implement TOC based solutions, as what matters is achieving the expected results.



The historical view of the development of the concept of the Constraint My personal journey

I met Eli in 1978 and have worked with him until he died in 2011.

- 1978-82 implemented OPT and OPT concepts
- 1982-86 Creative Output UK
- 1987-2001 AGI, partner (UK)
- 2002-11 Goldratt Group (Goldratt Schools)

**The concept of the Constraint evolved and was developed
throughout the years.**



The historical view of the development of the concept of the Constraint Overview

- 1975 – Eli’s PhD on flow of fluids.

Disruptions to the flow were defined as point of irregularity.

Eli developed an algorithm to find optimised solution for increasing the flow.

- 1975 – OPT (Israel) Optimized Production Timetable

The algorithm was used in order to schedule production.

- 1975 to 1982: Finite Forward Scheduling (realistic Due Date, speed up the flow, transfer batches). In 1979 name was changed to OPT - Optimized Production Technology.

- 1982 – Due to the recession (in the US) OPT needed to be adjusted to the new reality of no bottlenecks.

The software was Upgraded to: OPT-Split. The “Drum” – the plan for strategic points was done by the Brain of OPT, the rest by the Split.

- 1984 – The Goal – Bottleneck (Herbie)
- 1986 – The Race (inventory reduction)



The Race (1986)

- The core problem: Inventory is a second-class citizen
- Direction of the solution: Inventory Reduction through synchronized manufacturing
- DBR – through the concept of the slowest soldier leading to the CCR
- Constraint appears in page 83 (implying the constraint should determine the drum beat)
- In page 84 bottleneck and non-bottleneck appear
- CCRs as weakest soldiers appear in page 98.
The major CCR is used for the Drum.
- Two constraints are indicated: Market Demands and the Capacity of the CCR



Theory of Constraints Practitioners Alliance

www.tocpractice.com

The Race (1986)

The OPT Rules

The Race pp 179

YOUR BUSINESS?

GLOBAL RULES

1. Balance flow not capacity
2. The level of utilization of a non-bottleneck is not determined by its own potential but by some other constraint in the system.
3. Utilization and activation of a resource are not synonymous.
4. An hour lost at a bottleneck is an hour lost for the total system.
5. An hour saved at a non-bottleneck is just a mirage.
6. Bottlenecks govern both throughput and inventories.
7. The transfer batch may not and many times should not be equal to the process batch.
8. The process batch should be variable not fixed.
9. Schedules should be established by looking at all of the constraints **simultaneously**. Lead times are the result of a schedule and cannot be predetermined.

Bottlenecks

Govern

Constraints



OPT Thoughtware 1985-1986

The term Constraint and steps of its application for managing systems were used internally in Creative Output.

At this period the early stages of the Thinking Process were developed: The Negative Tree and the Positive tree.

In late 1986 (after departing from Creative Output):

- Verbalization of the 5 focusing steps
- Definition of the Constraint:

Anything that prevents the system from achieving higher performance versus its goal.

(First published in an article by Oded Cohen in a production management book, 1987).



AGI – The Goldratt Institute 1987

When departing from Creative Output – Eli was banned from using the term OPT (that was later trade marked by Scheduling Technologies Group). Hence, when establishing AGI Eli invented the name: TOC – Theory of Constraints (1987)

The official definition of the Constraint used by AGI was:

Anything that prevents the system from achieving higher performance versus its goal.

- Materials included policy constraint even though it was stated explicitly that the 5 Focusing Steps could not be applied, as management must break the constraint and move back to step one.
- A variation of this definition was also used:

Anything that limits the performance of a system.



The Haystack Syndrome - 1990

The emphasis moved to Throughput World versus the Cost World, with this – the introduction of the chain analogy and the weakest link.

In page 53 Eli writes:

“What determines the performance of a chain? “The strength of the chain is determined by the strength of its WEAKEST link.”

“What is an appropriate name for the concept of the weakest link, the link that limits the overall strength (performance) of the chain? A very appropriate name is CONSTRAINT.”



The Haystack Syndrome - 1990

Determine

In page 58 Eli writes:

“Where should we concentrate? That is totally obvious, isn’t it?”

On the weakest links, on the constraints. They are the ones that determine the overall performance of the company.”

At the same time few lines below Eli argues that every system must have a constraint, as otherwise a company with nothing to limit it should have infinite net profit.

Hence, the understanding of the constraint as a ***limiting factor***.



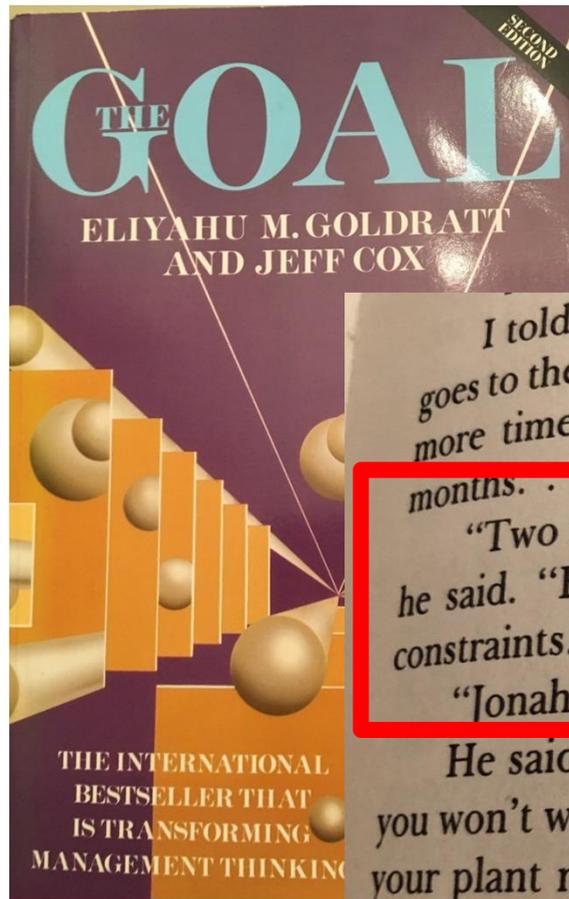
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The Goal

second edition – 1993

Bottlenecks and Constraints



Chapter 19 pp 149

I told him, "We've only got two months left before my boss goes to the board of directors with his recommendation. If we had more time, maybe we could do something, but with only two months. . . ."

"Two months is still enough time to show an improvement," he said. "But you have to learn how to run your plant by its constraints."

"Jonah, we've analyzed the situation thoroughly—"

He said, "Alex, there are two ways that the ideas I'm giving you won't work. One is if there isn't any demand for the products your plant makes."

"No, we have a demand, although it's shrinking as our prices go up and service deteriorates." I said, "But we still have a size-



The Goal

second edition – 1993

Chapter 25 pp 206

another. They ...
"How much of Y's 600 hours can the system use here?" asks
Jonah.
"All of 'em," says Bob.
"Absolutely not," says Jonah. "Sure, at first glance it looks as
if we can use one hundred percent of Y, but think again."
"We can only use as much as we can absorb,"
I say.
"Correct. By definition, Y has excess capacity," says Jonah.
"So if you work Y to the maximum, you once again get excess
inventory. And this time you end up, not with excess work-in-
process, but with excess finished goods. The constraint here is not
in production. The constraint is marketing's ability to sell."
As he says this, I'm thinking to myself about the finished
goods we've got crammed into warehouses. At least two-thirds of

**Marketing's ability to sell
as a constraint**



The Goal
second edition – 1993
pp 255

with demand, not the capacity.

“*Two*, the incentives we usually offer are based on the assumption that the level of utilization of any worker is determined by his own potential,” I tell them. “That’s totally false because of dependency. For any resource that is not a bottleneck, the level of activity from which the system is able to profit is not determined by its individual potential but by some other constraint within the system.”

Hilton says impatiently, “What’s the difference? When some-



The Goal

second edition – 1993

Chapter 33 pp 274-275

First time the term CCR appears and the explanation of the distinction between Bottleneck” and “CCR”, and of the importance of monitoring the CCR

...real. And it became even more interesting when we realized that we were visiting the same six or seven work centers every time. They're not bottlenecks, but the sequence in which they perform their jobs became very important. We call them 'capacity constraint resources,' CCR for short."

Capacity Constraint Resource

the whole plant. I m

"Don't you reali

efforts too narrowly. We tried so

necks, when what we should do is improve the CCRs as well.

Otherwise we'll run into an 'inter-active' bottleneck situation.

"So, the key is not in the hands of the materials people. If

while there is still time, they should be used mainly to focus our

local improvement efforts. We must guarantee that the improve-

ments on the CCRs will always be sufficient to prevent them from

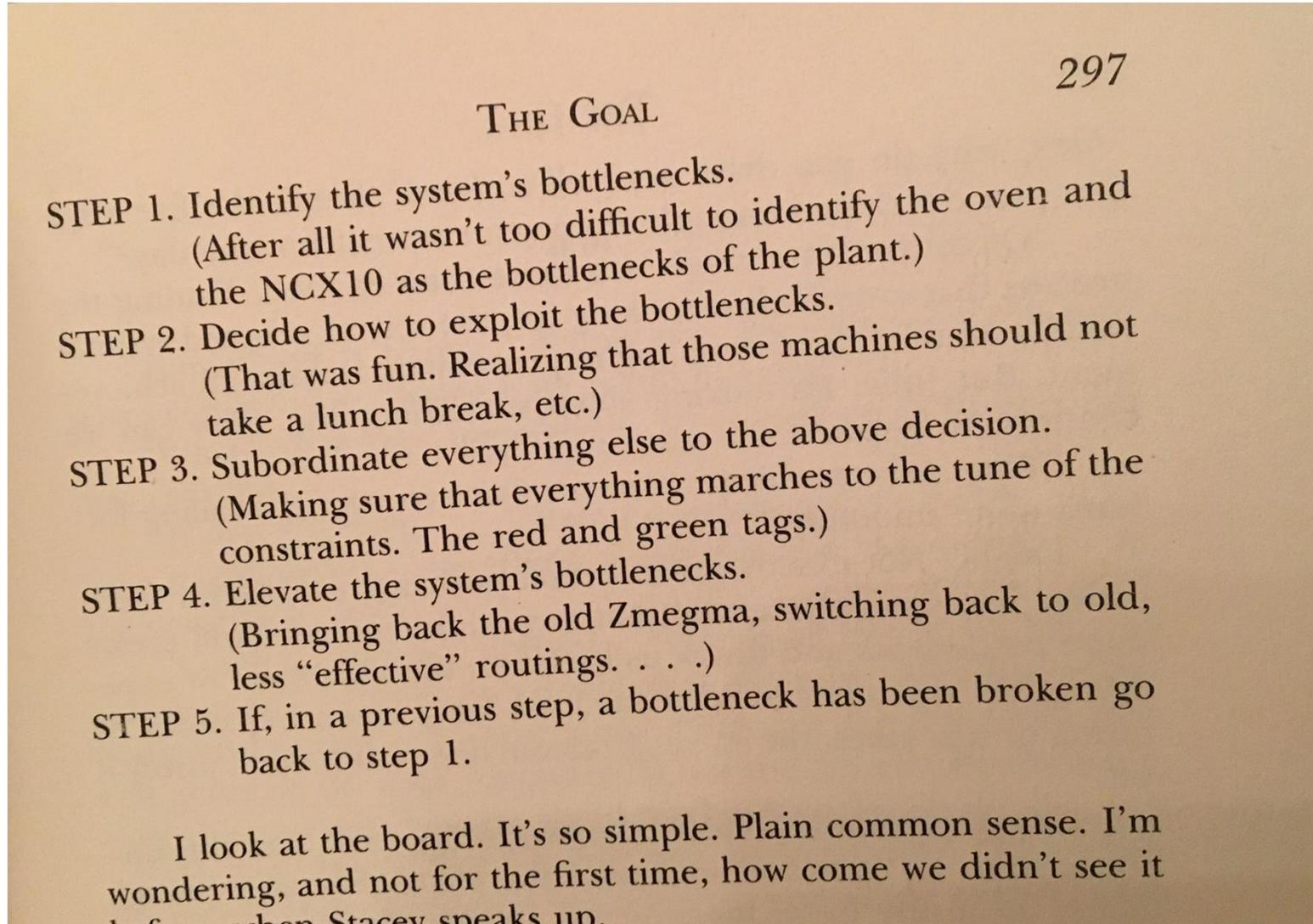
becoming bottlenecks.



The Goal

second edition – 1993

Chapter 36 pp 297





The Goal second edition – 1993

Chapter 36 pp 297

I look at the board. It's so simple. Plain common sense. I'm wondering, and not for the first time, how come we didn't see it before, when Stacey speaks up.

“Bob is right, we certainly followed this process, and we cycled through it more than once—even the nature of the bottlenecks we had to deal with changed.”

“What do you mean by the ‘nature of the bottlenecks?’” I ask.

“I mean a major change,” she says. “You know, when the market changes, the nature of the bottleneck changes. It’s different, and it’s not the same market as before.”

A major change to the nature of the bottlenecks

Market as a constraint

“I’ve gone through this five-step cycle the nature of the bottleneck has changed. First the bottlenecks were the oven and the NCX10, then it was the material release system—remember the last time when Jonah was here?—then it was the market, and I’m afraid that very soon it’ll be back in production.”

“You’re right,” I say. And then, “It’s a little odd to call the market or the system of material release a bottleneck. Why don’t we change the word, to . . .”

“Constraint?” Stacey suggests.

We both nod. “That’s a good idea,” I say, admiring our wisdom.

System of material release as a constraint



The Goal
second edition – 1993
Chapter 37 pp 303

THE GOAL

303

Alex be careful not to do it too fast, remember the bottom-line ramifications.”

It's Stacey's turn to be puzzled. “Why shouldn't we get rid of the finished products as fast as possible?” she asks.

“Never mind,” I impatiently say. “Lou can, and I will explain it to all of you later. Right now we should correct the step process. Now we all know to what extent Ralph's something is definitely missing.”

“Can I correct it?” Stacey says sheepishly, and goes to the board.

When she returns to her seat the board has the following:

1. IDENTIFY the system's constraint(s).
2. Decide how to EXPLOIT the system's constraint(s).
3. SUBORDINATE everything else to the above decision.
4. ELEVATE the system's constraint(s).
5. 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.

**5 Focusing Steps
in full version**



The Goal second edition – 1993 Chapter 40 pp 330

much without buying more capacity?”

“But we changed almost every aspect of how we operate them, and how we operate everything around them.”

30 That is exactly my point,” I say. “What aspect of operation did we change?” Mimicking his voice I answer, “The measurements, the policies, the procedures. Many of them were cast into behavioral patterns. Lou, don’t you see? The real constraints, even in our plant, were not the machines, they were the policies.”

“Yes, I do see. But still there are differences,” he says stubbornly.

“What differences? Name one.”

Policies as constraints...



The Goal

second edition – 1993

Chapter 40 pp 331

ask Jonah to teach me?"

"I don't know," he answers. "But if the five steps are valid, maybe what you should ask for are the techniques required to enable us to carry those steps out. We already found the need for one technique, why don't we continue to examine the other four steps?"

"Good idea," I say enthusiastically. "Let's proceed. The second step is," I read from the board, "decide how to exploit the system's constraints. That doesn't make any sense to me. What is the point in trying to exploit an erroneous policy?" 331

"It makes sense only if the constraint is physical, but since we do deal with policy constraints, I guess we'd better move to the next one," Lou agrees with me.

"Subordinate everything else to the above decision," I read. "Same reservation. If the constraint is not physical this step is meaningless. The fourth step is, 'Elevate the system's constraint(s).' Hmm, what are we going to do with this one?"

"What's the problem?" Lou asks. "If we identify an erroneous policy we should elevate it, we should change the policy."

"How lovely. You make it sound so simple." I say sarcasti-

That denotes the move to the Thinking Processes



The Goal

second edition – 1993

Chapter 40 pp 331

LOOK what happened... of getting more...
sales. As a direct result of the French order we threw the plant
into a very unpleasant two weeks and we killed or at least delayed
a good marketing campaign. If we just thought systematically be-
fore we implemented it, rather than after the fact, we could have
presented many problems. Don't tell me that it was impossible.
All the facts were known to us, we simply didn't have a thinking
process that would force and guide us to examine it early in the
game.
"What do we change to?" Lou says.
That throws me off balance. "Pardon me?"
"If the first thinking process should lead us to answer the
question 'what to change?' the second thinking process should
lead us to answer the question 'what to change to?' I can already
see the need for a third thinking process."
"Yes, so can I. 'How to cause the change.'" Pointing to the
fifth step I add, "with the amount of inertia that we can expect in
the division, the last one is probably the most important."
"So it seems," Lou says.
I stand up and start to pace. "Do you understand what we
are asking for?" I cannot contain my feelings. "We are asking for

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The Goal Movie - 1995

JONAH

Tell me. What do you think a bottleneck is?

BOB

I'd say, well, that they are a constraint in a system. Like narrowing three lanes down to two.

JONAH

More precisely a bottleneck is any resource whose capacity is less than the demand placed upon it. Bottlenecks control the rate of output for the entire plant.

STACY

O.K. So how do we find them?

Control



The Goal Movie – 1995

The last monolog of Alex

ALEX (thinking)

Jonah. Without his guidance I would have been looking for a new job and so would a lot of other people at the plant. He showed me a process of on going improvement. **A theory of constraints.**

First you need to look for your **bottleneck**. Identify the system constraint.

Then decide how to exploit it, how to get everything you can out of it?

Next, subordinate everything else to the above the decision's.

Then elevate the constraint to a new level of productivity, strengthen.

Once you've done that it probably isn't a system constraint anymore.

And so then you need to go back to step one and start looking for your new constraint all over



Deming and Goldratt – 1999 Lepore & Cohen

Addressing the constraint but not really defining it.

Step 4 of the Decalogue is: Identify the constraint and carry out the five focusing steps.

The step contains a definition of a bottleneck that “*(we call it the constraint)*”.

Step 8: Eliminating the external constraints.

The step contains a reference to the constraint as *The limiting factor of the system*.

There is also a reference to the external constraint as the “*unwillingness of the market to buy everything that we produce*”.



Goldratt Satellite Program - 1999

In Session 1:

Prevent

“Constraint

- Any element or factor that prevents a system from achieving a higher level of performance with respect to its goal. Constraints can be physical, such as machine center or lack of material, but they can also be managerial, such as a policy or procedure.”

“Policy constraint

- In the theory of constraints, a constraint which is not physically in nature.

This category includes the entire system of measures and methods and even the mindset that governs the strategic, tactical, and operations (day-to-day) decisions of the organization.”

(the quote is from the GSP book)



The Insights - 2000 by Eli and Rami Goldratt

Discussions and thoughts about the choice of the term
Constraint.

Suggested alternative by Eli G: Anchor to give the feeling of
pulling up (but was dismissed by him).

In the Insights there are references to the Constraint but no clear
definition.

Nevertheless, in the Insights there are critical words that are
associated with the explanation of what the constraint is.

Defining the Constraint Eli uses words: **“Determines”** and
“Governs”

And not only “Limits”!



The Insights - 2000 **by Eli and Rami Goldratt**

In no. 1 (operations) - “Underlying every problematic policy there is a constraint.”

In no. 2 (measurements) – Constraint as the weakest link

“Step 1: IDENTIFY the system’s constraints

The strength of the chain is determined by the strength of its weakest link. Therefore the first step is always to find the weakest link.”

The Constraint could be a physical constraint e.g. a bottleneck

The Constraint could be an organizational entity e.g. a department

The Constraint could be external e.g. the market”

In no. 4 (distribution): “The constraints govern the throughput of the system.”

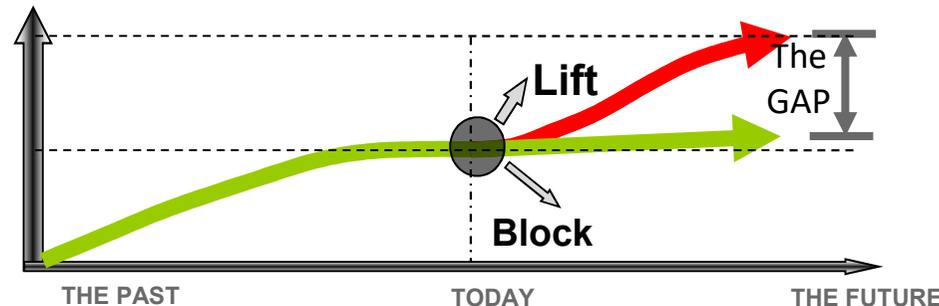


Goldratt Schools 2006

What prevents us from achieving the goal?

CONSTRAINTS –

factors or elements that determine how much the system can accomplish



This definition is

(1) in line with Sat Program

Session1: **Any element or factor** that prevents a system from achieving a higher level of performance with respect to its goal.

TOC Insights #4 (distribution): “The constraints **govern the throughput of the system**”

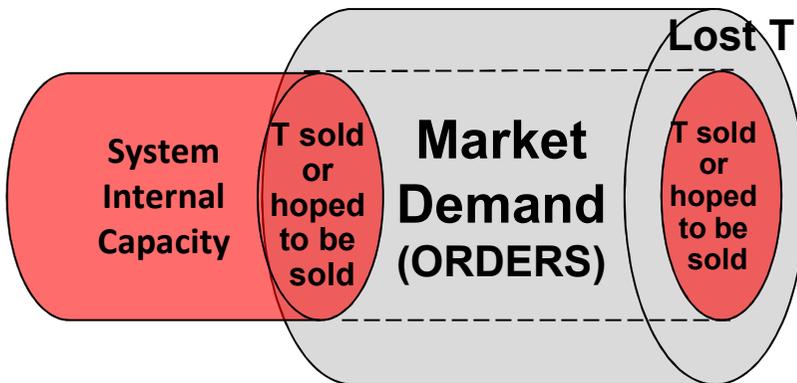
(2) And it removed the erroneous perception that the Constraints “ONLY LIMITS”.



Where is the Constraint?

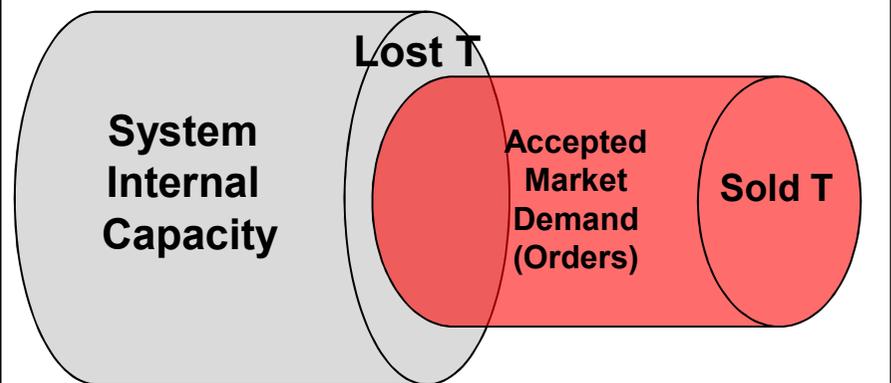
Capacity Constraint -

a resource which cannot provide timely capacity the systems demands from it



Market Constraint -

the amount of customers orders is not sufficient to sustain the required growth of the system





Ever Flourishing Goldratt Consulting (2012)

In the introduction to ever flourishing company workshop the Constraint is defined as:

What prevents the system from achieving more of its goal?

and thereafter:

What limits the company's ability to generate more T?



Management as a constraint

In TOCICO Conference 2008 Eli says:

- **“Management is the real constraint”**
- **“It is important to ensure management is not dealing with chupchiks.”**

We can look at management as CCR

- **“The sales CRT is shown. The key effects are less attention given to introduce real good projects and less attention is given to win real good projects.”**
- **“Limiting opportunities would ensure enough attention is given to each – and improve flow. And the focus can be on ensuring good opportunities are in the funnel.”**



Summary

Even though Eli always stated that logic demands to be very careful with words – the description of the Constraint in Eli's books, satellite program and in AGI material contain several words which are non completely synonymous. No wonder that different definitions are used.

We can split them into two groups:

1. Limiting/blocking Factors

That can include any obstacle

Limit

Prevent

2. Blocking factors that also can lift up the performance.

The second definition is an enhancement of the first one but excludes (in general) obstacles

Determine

Govern

Control

Dictate



Is the difference important and why do we care?

We care because we are teachers (even when we consult)

We want to give our students the best we have and to see them growing and succeeding!

Hence: precision and consistency are crucial for transferring knowledge and know-how.

This can be achieved by:

- **Ensuring consistency within the material we deliver**
- **Providing clear algorithms for implementation**
- **Highlighting typical mistakes and their potential damages**
- **Providing tools and mechanisms that can help them identifying when their decisions do not work or cause damage**



conclusion

The major driver behind the development of TOC was, as long as Eli was alive – to find the process of ongoing improvement and to develop the tools and the approach to support managers in striving for improvement.

Whenever the constraint in the system has been one that could be subject to the 5 Focusing Steps – it has enabled to build stable and sustainable systems to manage.

As TOC has well proven logistical application it is only natural that the focus has been on the “legitimate” types of constraint: Capacity, Market and Time.

A simple and practical way for handling the constraint has been presented by Jelena Fedurko-Cohen in her webinar on 11 February, 2020:



Watch more on the subject



About the Constraint - in a Simple Way

Jelena Fedurko-Cohen, 11 February 2020

Recording available

<http://tocpractice.com/webinars/2017/10/19/tocpa-expert-webinars-by-jelena-fedurko-cohen/>