



**THEORY OF CONSTRAINTS  
INTERNATIONAL CERTIFICATION ORGANIZATION**

**TOCICO 2016 Webinar**

# **The Development of TOC Part 1 From the Production Shop Floor to the Whole Organization**

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# An Incomplete Adventure

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- In any adventure one has to **learn from the past**, especially the failures, in order to be able to proceed
- TOC is a school of thought behind a pragmatic and very effective management approach
  - The development of TOC was an adventure
  - And it is still an ongoing adventure to make it the way to manage organizations
- A key to progress while being fully aware to the way so far is to be attentive to signals that clash with your logic or expectations
  - And then be ready to update your paradigms when the analysis show it is necessary
  - Let's find the right and safe way to go ahead

# From a rough idea to a fully effective methodology

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- Most great ideas point, at first, to just a broad **direction**
  - There is an **intuitive belief that there are benefits to gain**
  - But, usually not all the negatives are recognized
  - The hard task is to preserve the benefits while realizing the required changes
- Eli Goldratt was a genius who fought all the way to improve his own innovative ideas
  - We better learn from Goldratt's own paradigm shifts!
  - And gain the courage to challenge what we strongly believe now

**Change your paradigms when you realize they are not in line with reality**

Let's learn how the basic ideas of TOC have developed and changed through time



# Periods of developments between major changes

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1. OPT 1 - Software for scheduling the shop floor
2. OPT 2 – Changing the mind of managers
3. Simplicity, *The Goal*, DBR
4. TOC – the five focusing steps – the big generalization of ideas
5. TP and Marketing, the big leap in generalization of TOC
6. CCPM – back to developing specific methods with wide applications
7. Focusing on the value of software – *Necessary but Not Sufficient*
8. Integration of the knowledge, Viable Vision, Strategy and Tactic, and even more simplicity in Operations



# It All Started with a Big MISTAKE Called OPT

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- TOC was born in the **manufacturing shop-floor**
  - Its first name was **OPT**, Optimized-Technology
- OPT was a software package, based on ideas from Goldratt PhD dissertation
  - The software scheduled any type of manufacturing shop floor, considering finite-capacity limitations
  - The software could model the most complicated shop floors
  - The kernel of the scheduling algorithm was kept secret
  - The sophistication of the software was not in doubt
  - It was very successful during the early 80s, but then sales dropped
  - The rising difficulties called for diagnosing the core problem and coming with a solution



# A new insight that was difficult to swallow

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- **There is a key difference between bottlenecks and non-bottlenecks!**
  - The emerging algorithm first planned resources that were considered **bottlenecks** and then continued to plan the rest in an MRP way
- **Production managers faced a huge problem**
  - The ideal achievement for any production manager was to **fully utilize every single resource**
  - The software didn't try to load every resource to a good enough level
    - Trying to “fix” the schedule by increasing the batches and creating more stock caused huge problems
      - Because some of the scheduled production orders were delayed
  - The “black box” algorithm could not be understood
  - Eventually, the software was blamed for poor results!

# Diagnosing the problem

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- When such a discrepancy between software and users happen there are two ways to fix the problem:
  - **Change the software** to match the expectations of the users
  - **Change the mind of the users**
  - Which one is the common way? Which one is easier?
- Once the common flaw was identified and analyzed – a dramatic change in the behavior of OPT had to be established
  - **How can software company deal with the flawed paradigms of its clients?**
    - Software is unable to fix flawed paradigms!
  - Goldratt decided to develop **a management education program!**



# OPT 2: The real challenge

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- How to change the mind of experienced managers?
- OPT came up with a new motto:

**The sum of the local optimums is not equal to the global optimum**

- The motto sets the target to achieve **a global optimum for the organization as a whole**
  - This motto had since become a central non-trivial message to management
- In itself the motto was not enough
  - Without examples, the motto did not convince
  - The motto did not say how to achieve the global optimum
  - A series of insights had to be in place to deliver the message



# Explaining the Basic Logic of Good Planning

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- **The nine rules of OPT:**
  - 1. Balance flow, not capacity.**
  - 2. The level of utilization of a non-bottleneck is not determined through its own potential but through 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 the constraints simultaneously. Lead times are the result of a schedule and cannot be predetermined.**



# Key insights to learn

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- Software in itself is unable to change paradigms
- One cannot ignore the deep convictions managers believe in
  - Especially the impact of the cost accounting concepts
  - Goldratt had to create the alternative for cost accounting - the initial ideas of Throughput Accounting
  - In 1983 Goldratt created huge controversy in APICS when he said:  
**Cost Accounting is Enemy no 1 of Productivity**
  - Many did not like it – others became curious to know more
- A more substantial insight in perspective:

**When your client does not understand the value – it is YOUR responsibility to make it clear!**



# Moving from software to structured Management Education

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- Also from **super-sophistication** to **SIMPLICITY**
- The “**The Goal**” demonstrated the huge conceptual change:
  - Simple, yet based on solid logic
  - The basic planning rules of DBR are described in the book
    - Demonstrated by a story of scouts three important insights were developed: **Drum, Buffer and Rope** (DBR)
  - Convincing managers through a story
- The development of **DBR** marked **a drastic change** in the approach with few insights left from OPT
  - The most important remaining OPT insight was distinguishing between **bottlenecks** and all **non-bottlenecks**
  - DBR initial approach was to focus only on **one bottleneck**



- The concept of the **DRUM**:
  - The bottleneck is what dictates the **pace of the output!**
  - The **plan/schedule** of the bottleneck, or capacity-constrained resource (CCR), sets the specific **drum** for all the shop floor
    - Note, the drum is not the bottleneck, but **the plan for it**
    - When there is no bottleneck, then the demand determines the drum
- The concept of the **BUFFER**:
  - Time giving to a production order to move to a protected area
  - The recognition of **uncertainty** and including **visible buffers** in the plan were dramatic new insights
- The concept of the **Rope**:
  - Do NOT start BEFORE the time set by the Drum and the Buffer!
  - The rule of not increasing the buffer just because we can

# The Buffers in DBR

CCR stands for capacity-constrained-resource

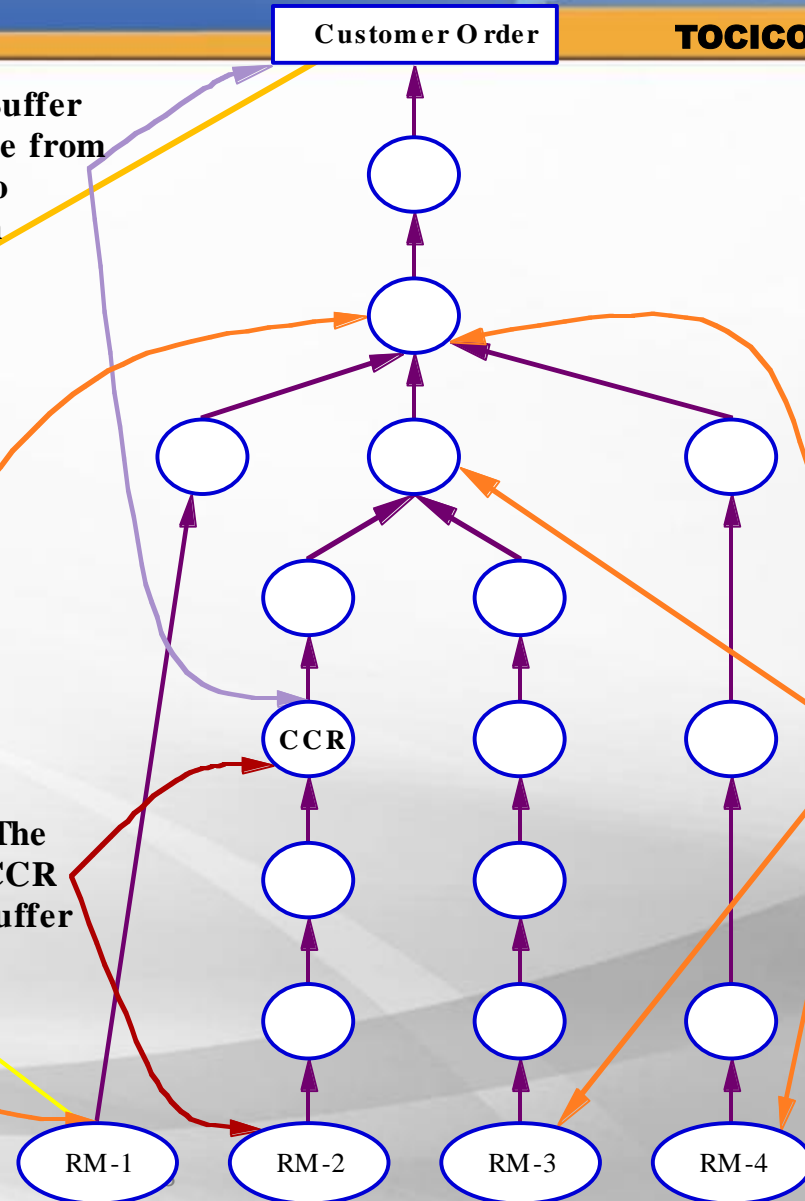
The Shipping Buffer provides the time from the CCR to completion

The Assembly Buffer provides the time for a non-constraint part to reach the assembly point with a CCR part.

When no internal CCR is active: there is only one buffer: the shipping buffer!

The CCR Buffer

Assembly Buffer



# The development of the ideas so far

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- **Until the mid-80s OPT and DBR dealt only with the shop-floor of manufacturing organizations**
  - The emphasis on being **holistic** already emerged, but within the boundaries of plants and without going into marketing, sales and HR
  - Even the T,I and OE were concentrated on manufacturing
    - Actually the ‘I’ was called “inventory”
    - The concept of ‘A’, ‘V’ and ‘T’ plant categories used to reduce the inherent complexity of the shop-floors
- **The shared paradigms of manufacturing would accompany Goldratt until the 90s**
  - It is a slow process to get rid of the environments of your career so far



# The focus on teaching

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- One idea about effective spread of the new messages was using special format books – The Goal became a critical tool
  - The Race, has organized the main slides used in workshops to lead the reader through the new logic
- A new educational tool was The OPT Game
  - A simulator/game to teach the concepts
    - Identifying the bottleneck and basing the overall plan on its capacity
- Additional ideas for teaching were the effect-cause-effect trees – mainly current-reality-trees (CRT) and the cloud
  - Most of the use was focused on the shop-floor
- The Avraham Y. Goldratt Institute was established in 1986
  - And its goal was to **teach how to think (in management)**
  - Without consultancy or software!



# New Verbalization: The Five Focusing steps

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- A definition: A **constraint** is anything that significantly limits the performance of the organization in achieving its goal
- The five focusing steps:
  1. **Identify** the system constraint.
  2. Decide how to **exploit** the system constraint(s).
  3. **Subordinate** everything else to the above decisions.
  4. **Elevate** the system constraint.
  5. If in the previous step the constraint was broken – go back to step 1. **Beware inertia!**

# The Impact of the Five Focusing Steps

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- The verbalization of the five steps came **after** writing The Goal and the main ideas of DBR!
  - Insights of the details sometimes precede the generic idea!
- The move from “bottleneck” to “constraint” was meaningful because:
  - The **market** could be a constraint!
  - A resource that is **not a bottleneck**, meaning it has excess capacity, **might still be a real constraint**
    - because its impact on the lead-time reduces the demand
  - **A specific raw material** could be a constraint!
    - Later this idea was rejected as no material **should be** the constraint (?)
  - At some time Goldratt spoke also about: “inventory constraints” as secondary trouble-makers

# Throughput per Constraint-Unit: T/CU

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- The ruling idea during the late 80s was that **the constraint should be internal**
- Hence, a good performing organization should have **one Capacity Constraint Resource (CCR)** within its operations
  - When different families of products go through different resources, then each family could have its own CCR
- The above paradigms led the way to prioritize products by their **throughput per constraint-units - T/CU**
  - It seemed a very appropriate **exploitation** of the CCR capacity
  - Goldratt stopped using T/CU when the Viable Vision concept emerged in 2002/3

# A new insight: **Buffer Management**

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- Buffer Management appeared first in **The Race**
  - Talking about the “holes” in the buffer
- It took considerable time to understand the insight:  
**The actual behavior of the buffer consumption tells us vital information for determine the priorities in the execution phase**
- It is enough to handle **just three priorities**: Red, Yellow and Green
- Additional vital information for monitoring the state of the buffers is the **validity of the buffer size!**

# Buffers and Buffer Management as two major paradigm shifts

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- When Goldratt wrote *The Haystack Syndrome* he admitted he did not fully understand the full **meaning of buffers** and **buffer management** when the ideas emerged
- The new insight put special emphasis on including **visual buffers** as an integral part of any planning
  - Protecting the truly sensitive areas from Murphy
  - Making the planning much more robust in handling normal uncertainty
- Once buffers are planned then the idea to **use the actual state of the buffers to make decisions in the execution phase** was not, to my mind, used elsewhere
  - Even now I don't know of any similar idea

# Expediting – not necessarily bad

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- **Buffer Management gave legitimacy to “expediting”.**
  - The usual treatment of “expediting” is **failing to meet the plan**
  - Thus, it should NEVER be used
  - Buffer management means we accept a certain level of “expediting” as a necessary part of an overall well-protected environment
  - When no expediting is required than the system is clearly over-protected
- **Buffer management, by the use of expediting, leads to smaller buffers and less pressure to size them accurately and still be properly protected**
- **Managers cannot ignore uncertainty when buffer management is used**
  - Just including buffers in the planning is not enough and people in the execution phase do not connect them with the reality of facing uncertainty

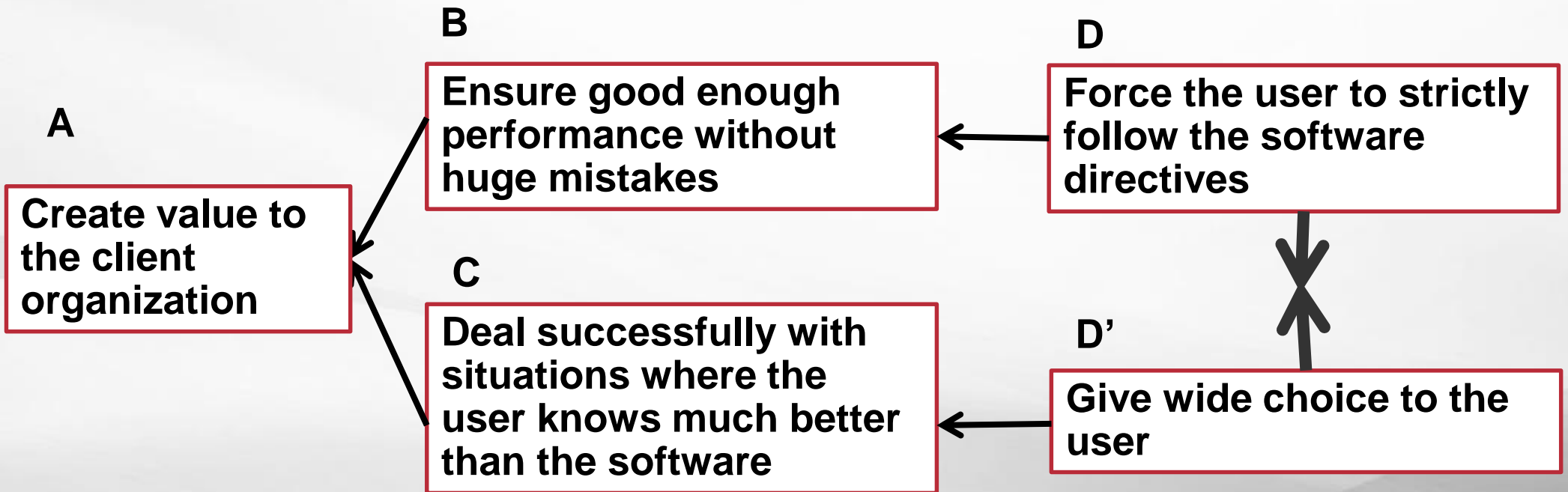
# The dilemma with software

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- **When the rules of planning are very simple – why should we need software?**
- **There is a basic clash between the fuzzy common sense of managers and the strictness of the software algorithm**
- **The negative branches of using software:**
  - **What is simple to human beings, like considering informal information about specific clients, is too difficult to include in the software**
    - **What happens when the intuition and the common-sense of the human manager clashes with the software?**
  - **Whenever we upgrade our insights and understanding – updating the software is a lengthy task**
    - **And what should be do until that time?**

# When we do need software – the dilemma of providing wide choice

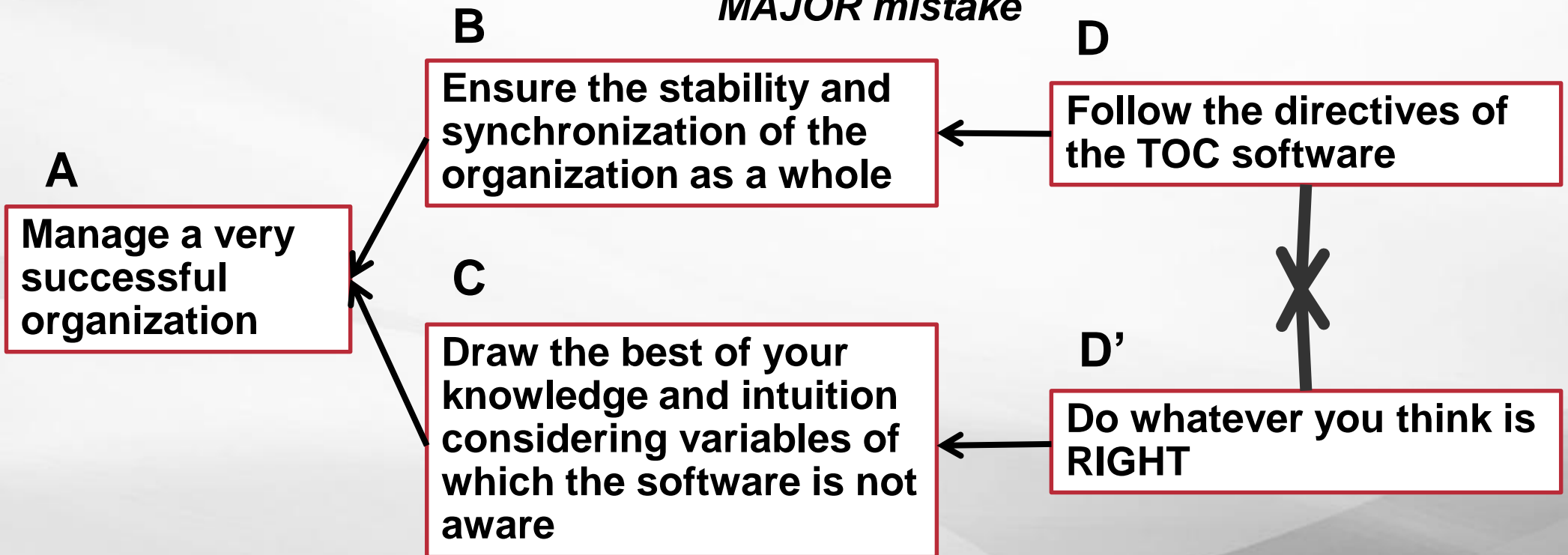
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# The Manager's Software Conflict

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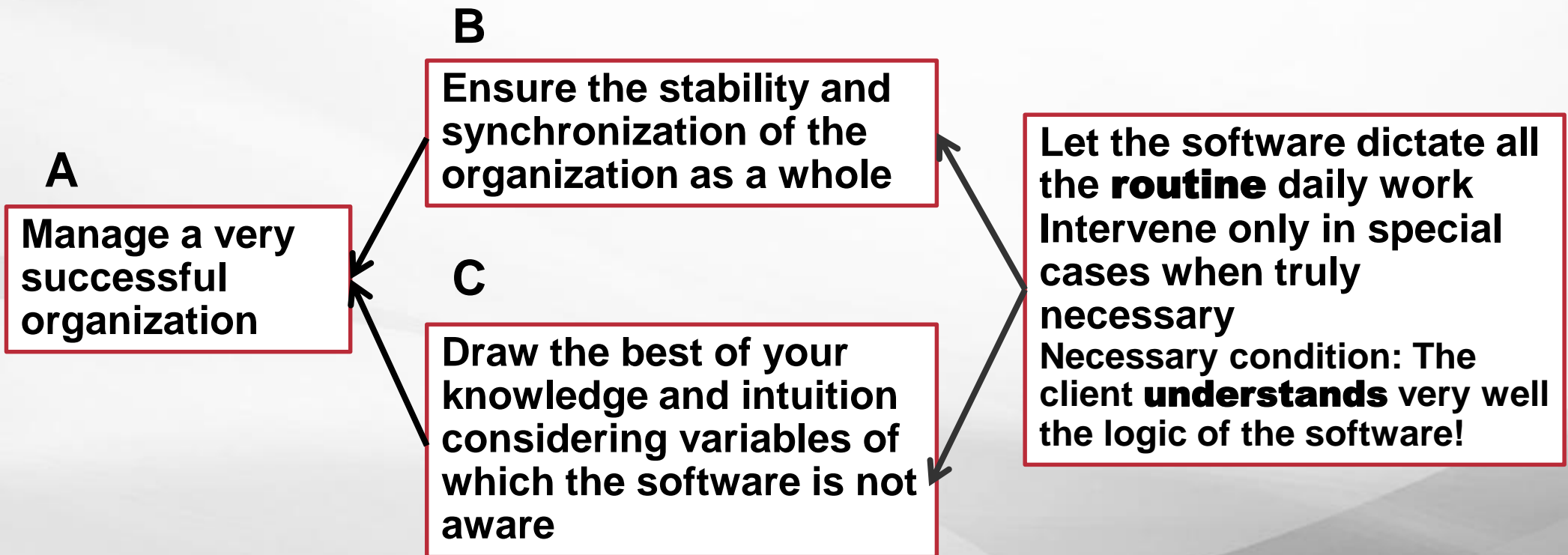
*The TOC algorithms do not allow any MAJOR mistake*



*Software cannot contain all relevant information and even all the logic that humans possess*

# The Manager's Software Conflict

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# A DBR Software Called: Disaster

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- When DBR was developed it was assumed that no software was required to implement it
- **This view changed** due to:
  - Difficulties **in manipulating the MRP software**
  - Software being capable of **instituting processes and policies**
  - Interactive constraints appeared to be a problem
- Goldratt wrote **The Haystack Syndrome** to verbalize the logic of DBR software that was developed at the time
  - It included an algorithm for scheduling several CCRs!
  - The book also reflects the growing understanding of the role of buffer management
  - The name **Disaster** for the new software package meant: **If you do not understand the logic the result will be disaster!**

# Success and Failure with Software

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- **Goldratt became disappointed by the impact of the software on the demand for TOC/DBR**
  - His expectations were that the software would “sell” TOC, rather than the software would just enhance and sustain implementation
    - In retrospect **Disaster was too complicated**
    - Many of the TOC consultants did not master it to be able to sell and implement it successfully
      - Take into account that connecting to MRP was not easy and required good experience in software
  - Next endeavor into software was for CCPM – years later
  - Later he supported development of **Simplified-DBR software**



# Initial Ideas Regarding Distribution

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- Ideas on maintaining availability of stock started around '89
- The problems of **batching** were noticed, per item and per transportation!
- The generic solution was based on maintaining **a fixed target level** and **frequent replenishment**
- **Buffer management** was applied based on the **actual state of the on-hand inventory**
- A simulator demonstrating the effects of maintaining stock at warehouses under large fluctuations of demand was developed
  - No application software was considered at that time

# Re-definition the term “constraint”

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- During the 80s the definition of a constraint was:

**Anything the significantly limits the performance of the organization in achieving its goal**

- In 2012 the TOCICO dictionary came with the following formal TOCICO definition:

**The factor that ultimately limits the performance of a system or organization. The factor that, if the organization were able to increase it, more fully exploit it, or more effectively subordinate to it, would result in achieving more of the goal**



# What is a constraint? A reflection after 30 years!

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- For manufacturing organizations, using **expensive machines**, a bottleneck or a CCR is a natural blocking factor
- The new insight of TOC raised the recognition that the CCR is an **obvious candidate to increase the flow to the market**
  - Before we contemplate elevation of capacity
- But, can a constraint be another type of **limitation** that cannot be “exploited” and “subordinated to”?
  - Like **flawed policies?**
    - Goldratt publically regretted calling them policy constraints
  - During the 80s we did not think much about the characteristics of the products as potential constraints

# The wealth of TOC insights from the 80s

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- Looking back we can see that most of the profound ideas have their origin in the first years of OPT and TOC
  - But, there are changes in the depth of understanding and how the ideas apply to wider area of organizations
- The focus on improving the Flow – was clear from the start
- Understanding how statistical fluctuations and depended events don't allow living with **interactive constraints**
  - The term '**starvation**' described losing capacity of the constraints
  - All resource, except maybe one, have to have **protective capacity**
- Cause and effect, strategy and tactic trees and resolving conflicts are ideas from the 80s that came to maturity in the next 20 years

# To be continued!!!

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- Expanding the scope to manage **all organizations** started in the 90s and continued into the 21<sup>st</sup> century
- Next time we'll deal with more dilemmas, changes and the integration of all the parts
- Please, send me questions, reservations and arguments about the emergence of TOC in the 80s, so we can openly discuss them

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