Introduction to the Theory of Constraints

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Introduction

- Theory of Constraints - TOC) was formulated approximately in 1980 in the USA. Some important roots of this theory were connected to the ideas incorporated in programs for planning and production control (Optimized Production Technology)
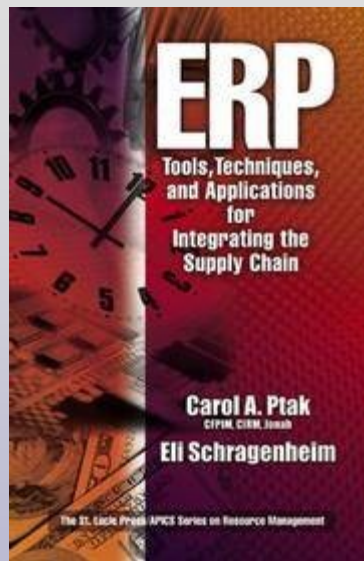
Introduction
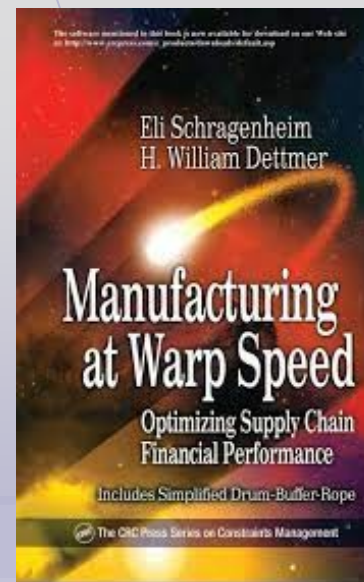
- Author: Eliyahu Moshe Goldratt

Important experts in the field of TOC

- ## Carol Ptak

In our faculty library

- ## Eli Schragenheim

The Goal by Eliyahu Goldratt

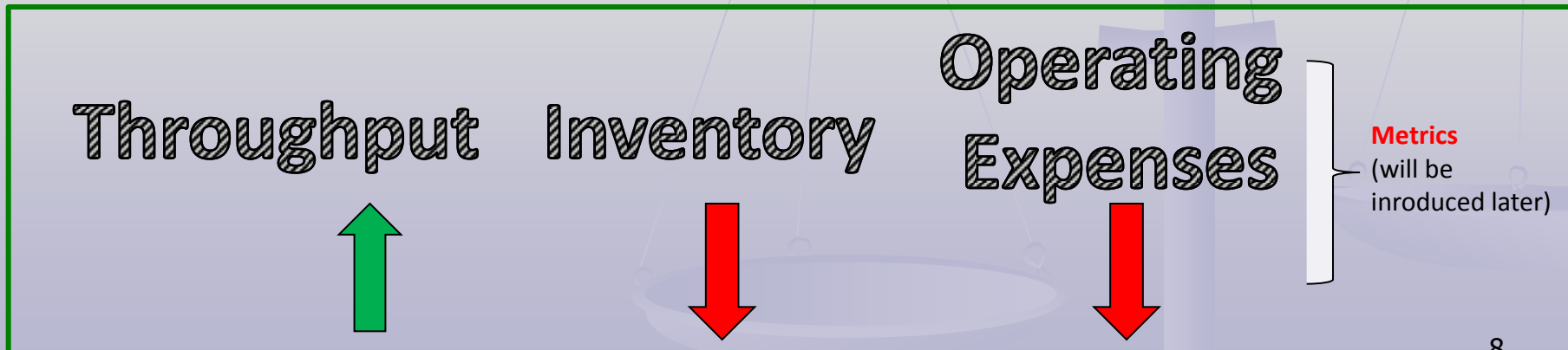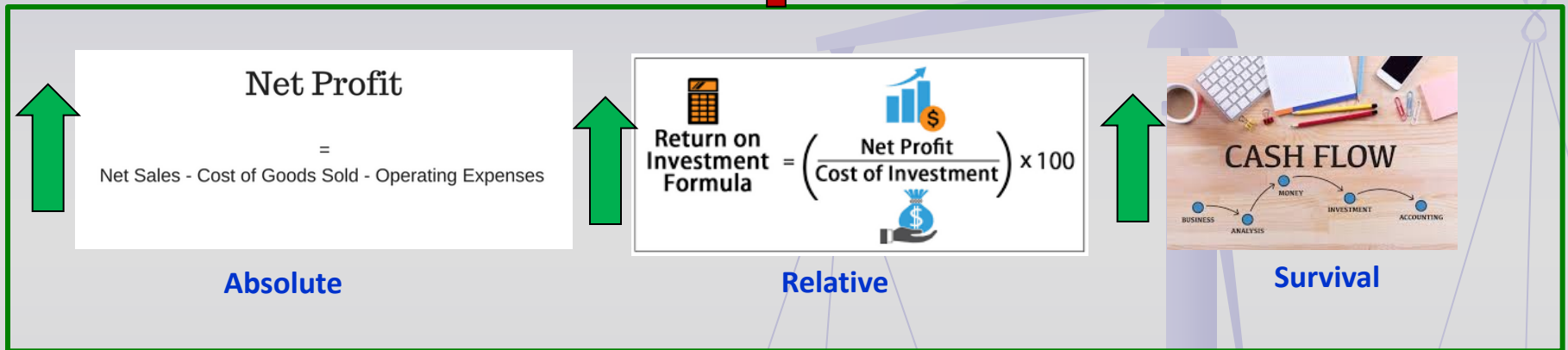- The goal of a manufacturing company?

Make money !!!

What is TOC ?

- A business philosophy which seeks to strive towards the global objective, or goal, of a system through and understanding of the underlying cause and effect.
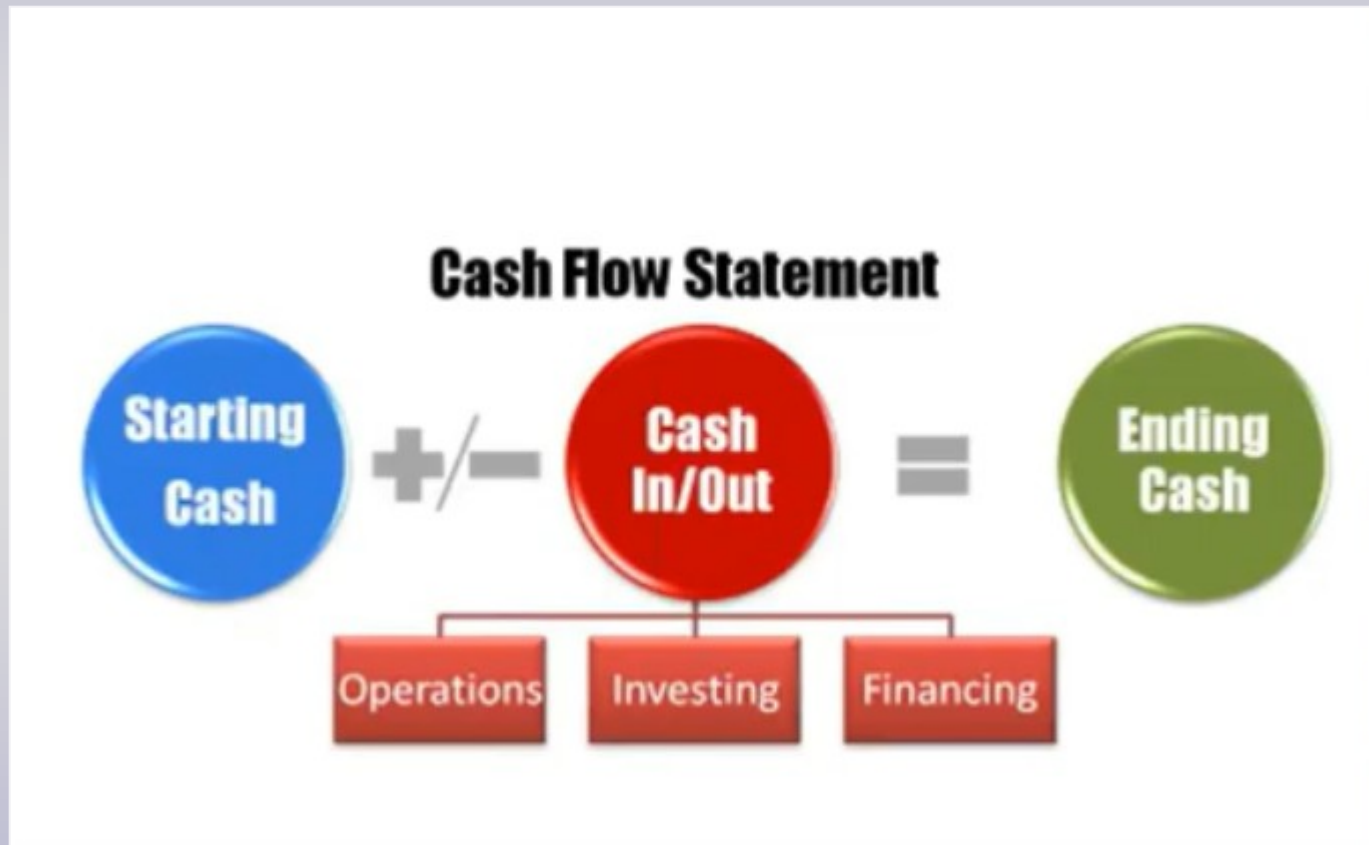
- Based on holisitic approach

What is TOC ?

- The method provides logical tools to construct, test and communicate strategic intent:

  - Logical Thinking Process-> logical trees that lead to the roots

  - Two approaches to increase the flow of value in areas such as

    - Projects->CCPM-> Critical Chain Project Management
    - Production> DBR->Drum-Buffer-Rope

  - How to measure the goals:

    - Constraint Accounting (Throughput Accounting)
    - CA is a framework to maximize profit and drive optimal operations.

What is the goal?

Net Profit
=
Net Sales - Cost of Goods Sold - Operating Expenses

Absolute

Return on Investment Formula $= \left(\dfrac{\text{Net Profit}}{\text{Cost of Investment}} \right) \times 100$

Relative

CASH FLOW

BUSINESS   ANALYSIS   MONEY   INVESTMENT   ACCOUNTING

Survival

Throughput   Inventory   Operating Expenses

Metrics
(will be inroduced later)

Cash Flow Statement

Cash Flow Receivables-Payables

Lines

PERIOD START	PERIOD NAME	CUST. BALANCES DUE	VENDOR BALANCES DUE	RECEIVABLES– PAYABLES
09.02.2020	neděle	0,00	0,00	0,00
10.02.2020	pondělí	4 101,00	0,00	4 101,00
11.02.2020	úterý	0,00	0,00	0,00
12.02.2020	středa	0,00	3 422,74	-3 422,74
13.02.2020	čtvrtek	0,00	3 616,49	-3 616,49
14.02.2020	pátek	0,00	0,00	0,00
15.02.2020	sobota	4 101,88	0,00	4 101,88
16.02.2020	neděle	0,00	0,00	0,00
17.02.2020	pondělí	2 224,96	-1 937,40	4 162,36
18.02.2020	úterý	0,00	0,00	0,00
19.02.2020	středa	0,00	0,00	0,00
20.02.2020	čtvrtek	8 182,35	0,00	8 182,35
21.02.2020	pátek	2 583,20	0,00	2 583,20
22.02.2020	sobota	968,70	0,00	968,70
23.02.2020	neděle	-322,90	0,00	-322,90

2224,96+(-1937,40)=4162,36

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Cash Flow approach by MS Dynamics 365 Business Central I.

ERP MS Dynamics 2018 NAV covers fully Cash Flow functions as well.

Cash Flow Statement

Period: 01.01.20..28.02.20
CRONUS International Ltd.

Fiscal Start Date: 01.01.20
All amounts are in GBP.

Description	Net Change
Operating Activities	
Net Income	43 744,64
Adjustments to reconcile Net Income to net cash pro	
Accounts Receivable	-52 891,27
Prepaid Expenses	
Inventory	
Current Liabilities	84 508,44
Payroll Liabilities	
Net Cash Provided by Operating Activities	**-12 127,47**
Investing Activities	
Equipment	147,73
Accumulated Depreciation	
Net Cash Provided by Investing Activities	**147,73**
Financing Activities	
Long Term Liabilities	
Distributions to Shareholders	
Net Cash Provided by Distribution to Shareholder	
Net Cash Increase for the Period	11 979,74
Cash at Beginning of the Period	253 221,15

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Cash Flow approach by MS Dynamics 365 Business Central II
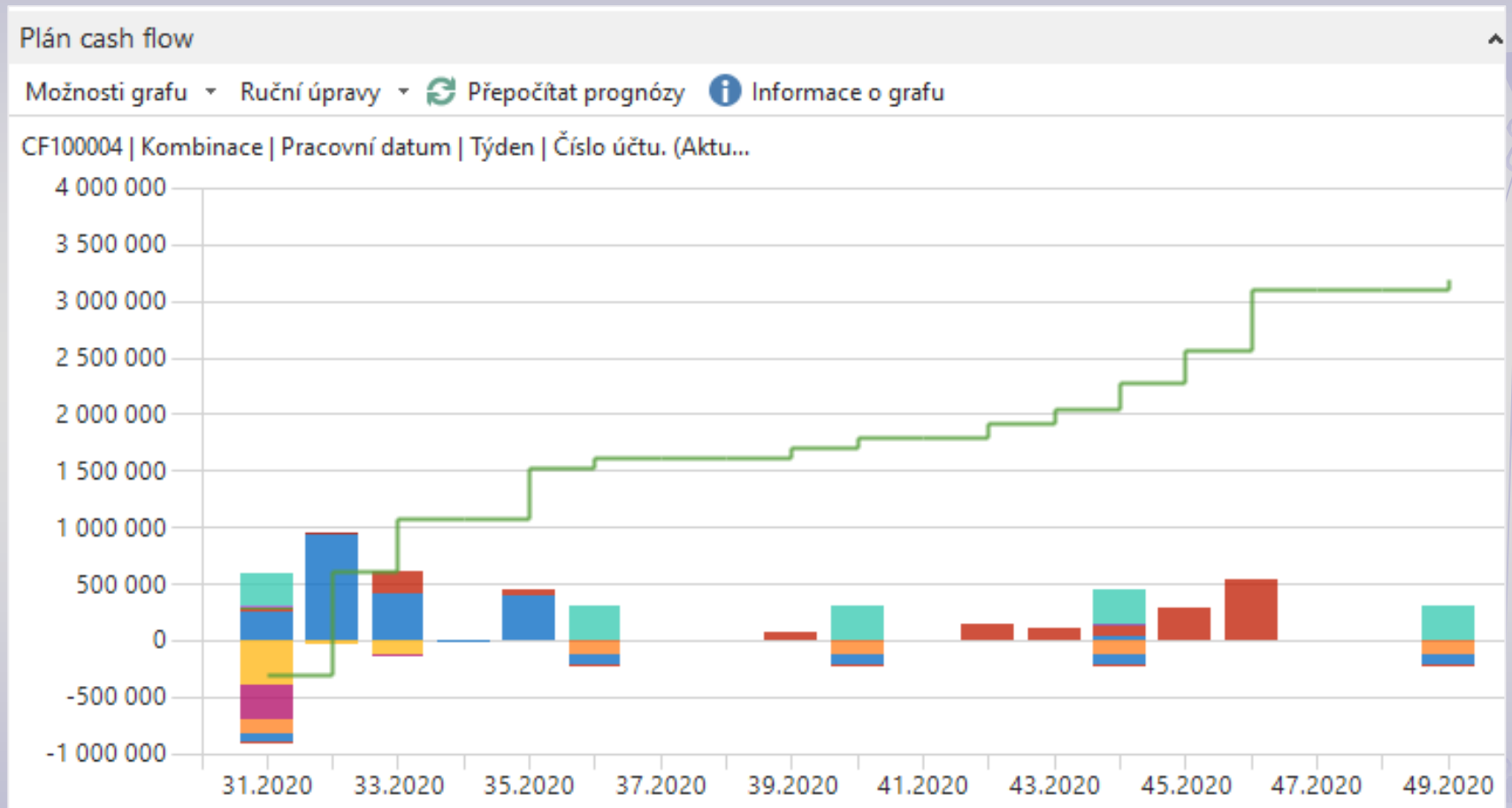
Introduction -novels

TOC has became popular particularly thanks to the novels :
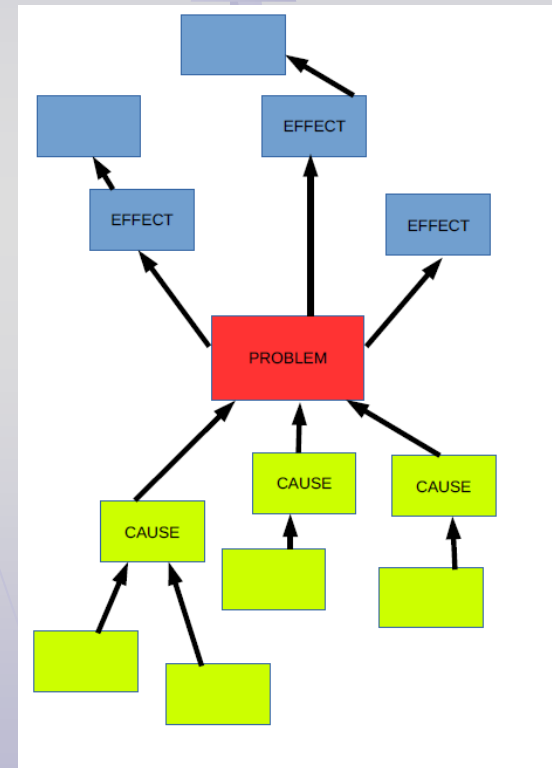
- The Goal - A Process of Ongoing Improvement
- It´s Not Luck
- The Race
- The Critical Chain
- The Haystack Syndrome
- Necessary But Not Sufficient
- Late night discussion
- TOC was together with TQM (Total Quality Management) and JIT (Just-In-Time) classified as one of the most important managerial methods of the last two decades of the twentieth century
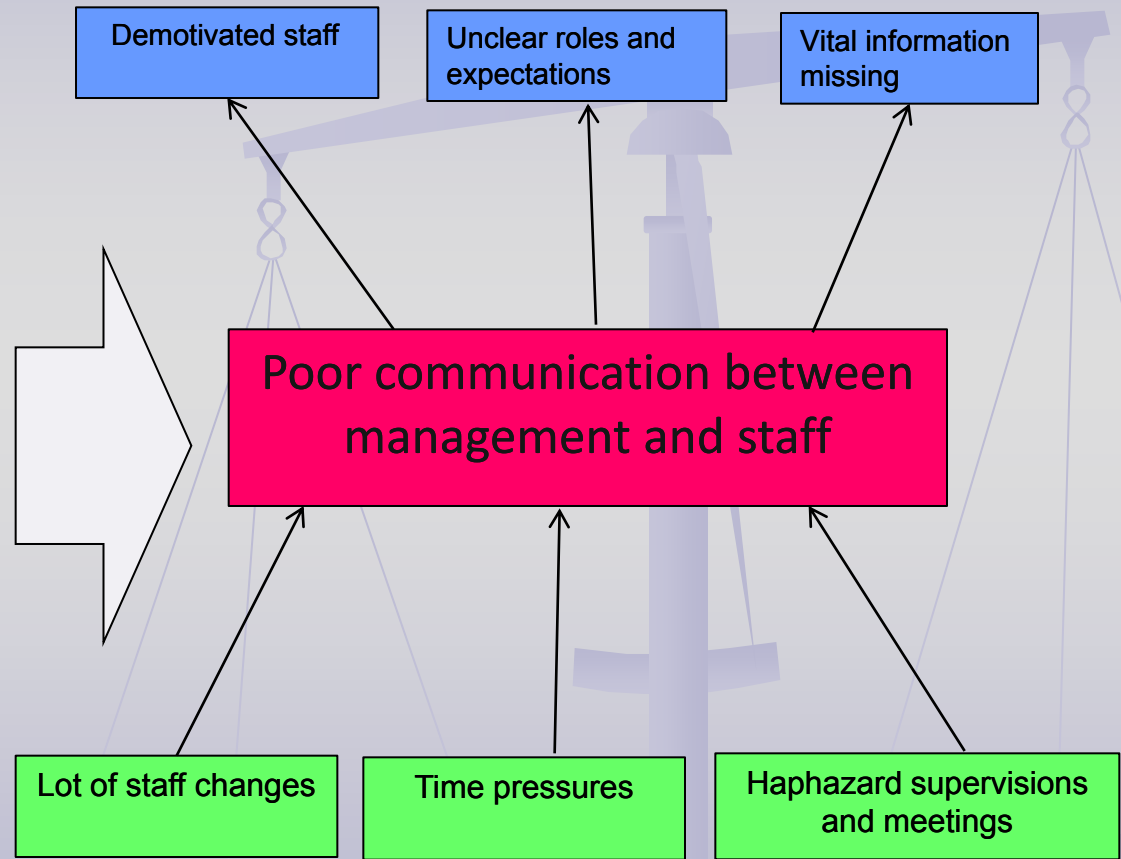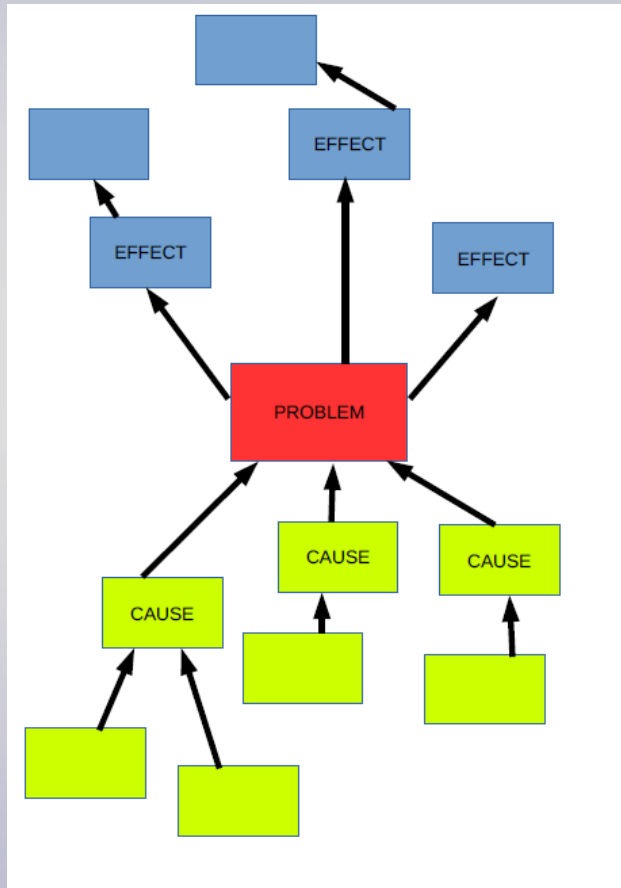
TOC Application Areas

- Company logistic
- Project management (Critical chain=CCPM)
- Marketing
- Sales
- SCM=Supply Chain Management (Distribution)
- Finance management and metrics
- Production control
    - Material
    - Capacities
    - WIP (Work In Process)

TOC wider use and application horizons

- Support of decision making
- Support of process improvements
- Root problems detection

Causes-Problem-Effects

Demotivated staff

Unclear roles and expectations

Vital information missing

Poor communication between management and staff

Lot of staff changes

Time pressures

Haphazard supervisions and meetings

Decision making

- Problem identification (TOC)
- Objectives (Max Margin, Stability, Market Share, Lower Costs,…)
- Alternatives (different solutions) – Payoffs
  - Activity Based Costing
  - Contribution Margin (CM) and CM Ratio
- Comparing alternatives (Max, Max, MaxMin,…)
- Best alternative is chosen
- Solution is implemented

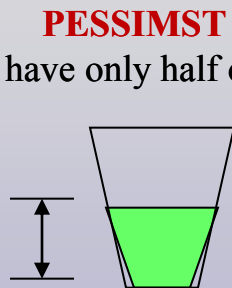# TOC and Business Process Reengineering approach
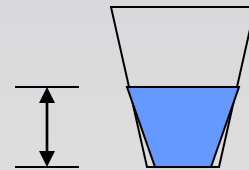
Not traditional approach
Positive expectations

Traditional approach
Negative expectations
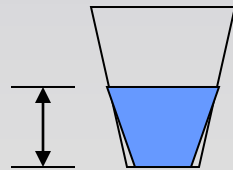
OPTIMIST
„Half of the glass is still empty !

PESSIMST
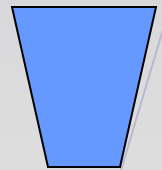„We have only half of the glass!"

TOC APPROACH
„We have glass which is twice as big !
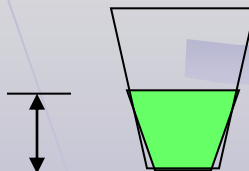
BPR(Business Process Reengineering) approach
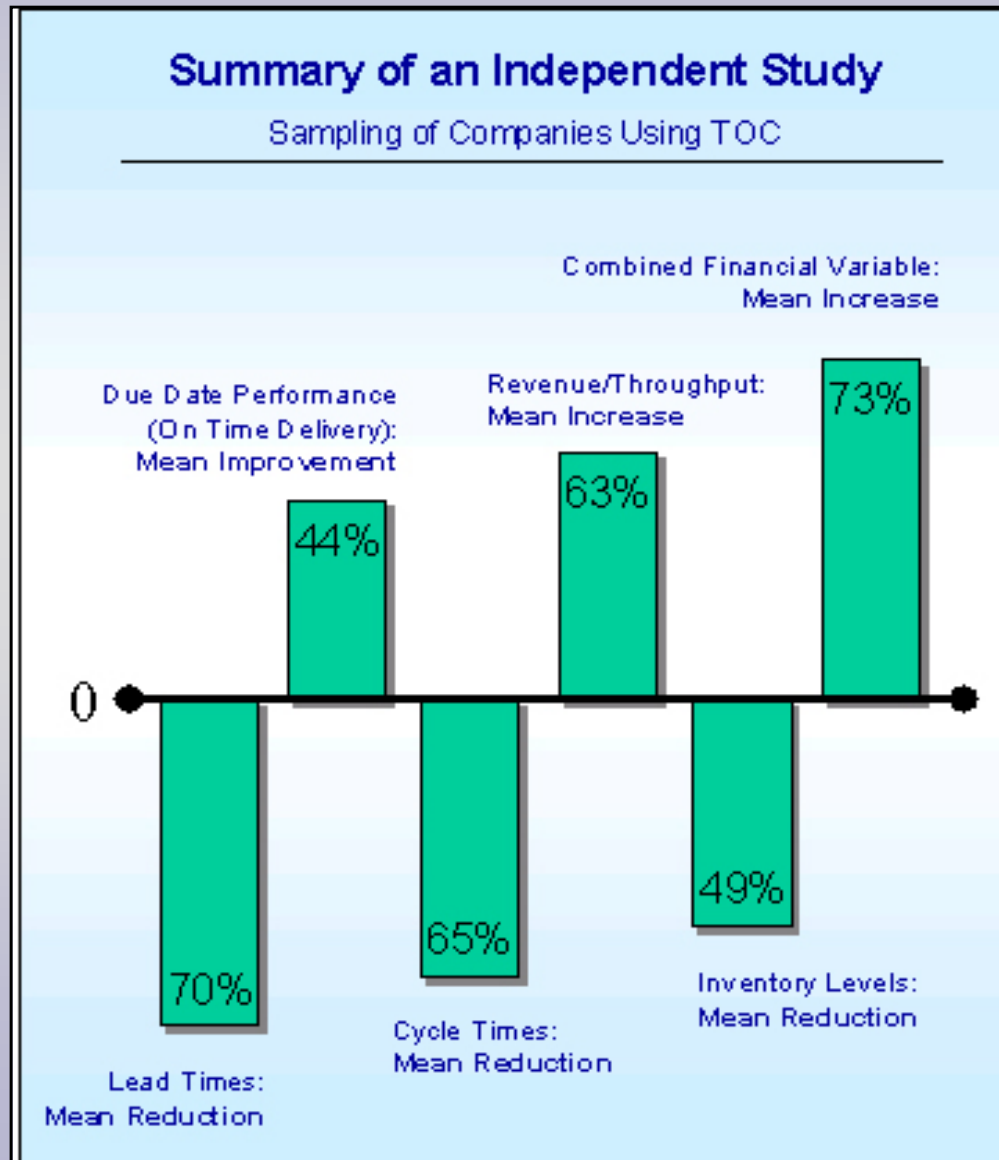„We have two times more than we really need "

The **TOC** result

The **BPR** result

Some impacts of **TOC** implementation

Some impacts of **TOC** implementation

Ford Motor – Electronics Div.

Revenue: $3,000,000,000

Number of employees: 15,000

Implementation Date: 1991

TOC Applications: DBR

Comment: **D**rum-**B**uffer-**R**ope

Some impacts of **TOC** implementation

IMPLEMENTATION RESULTS

Inventory Decrease: Reduced 100 million dollars (50%)
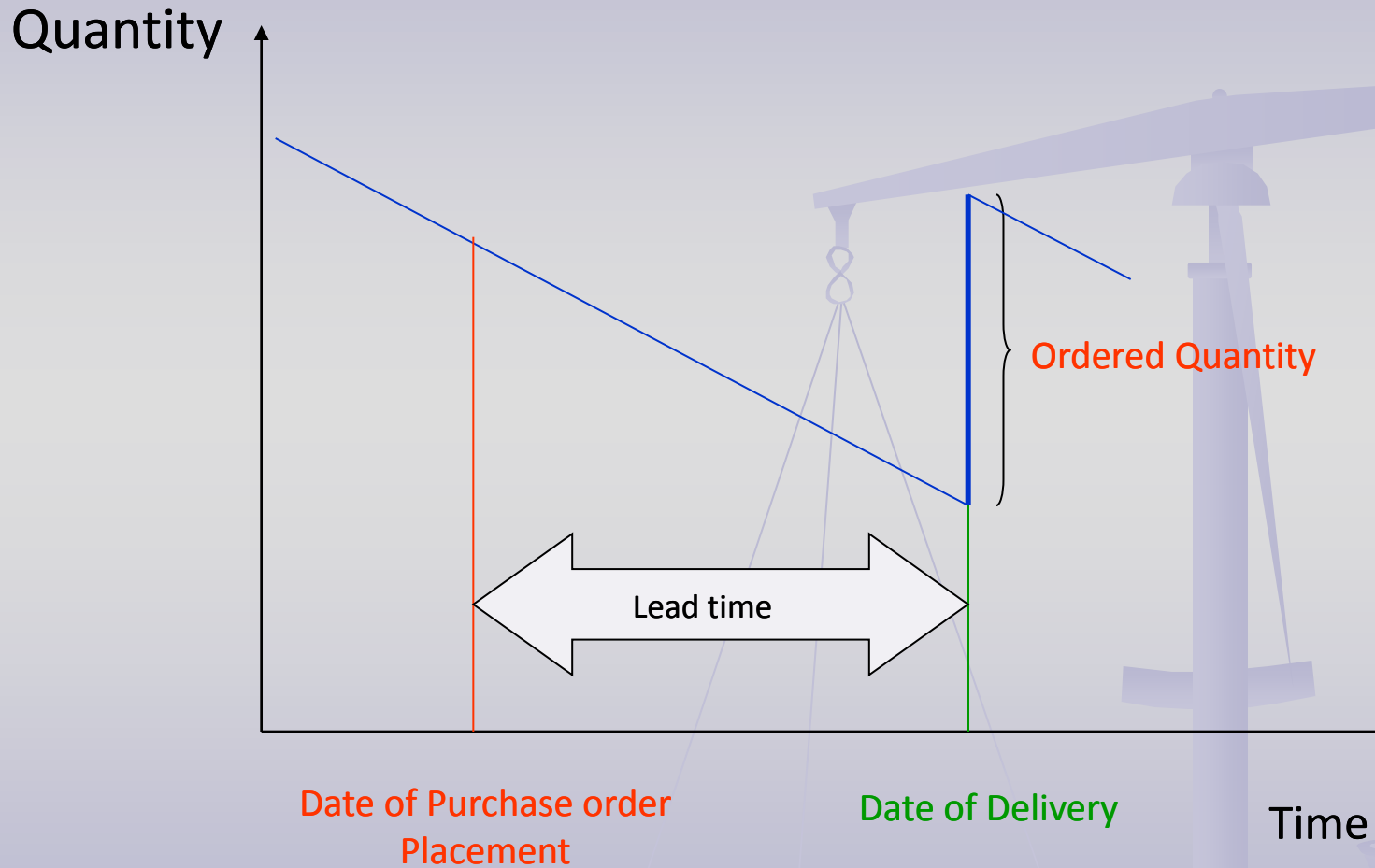
On-time performance: From 89% - to 98%

Lead times: From 6.4 days with JIT to 2.6 days

Cost efficiency: Reduced floor space by 57%

Quality: Reduced quality defects by 50%

LEAD Time explanation-purchase

Quantity

Ordered Quantity

Lead time

Date of Purchase order Placement

Date of Delivery

Time

Lead time in Business Central

Lead Time explanation in purchase form (MS Dynamics 2018 NAV)

LEAD Time explanation-NAV Production Order

Lead Time in Business Central

Some impacts of **TOC** implementation

Some companies using TOC applications:

- BOEING – maintenance departments

- MOTOROLA - research

- GENERAL MOTORS

- LOCKHEAD MARTIN (F 22) – Project management

- BAE SYSTEMS – R&D

R&D->Research and Development area

TOC

A

B

Which is harder to manage? Left or Right?

TOC

- It is based on **system approach**

- A company (enterprise) is to be understood as a chain of dependent processes – this picture below is very, very simplified

Marketing — Orders — Purchase — Production — Packaging — Shipment

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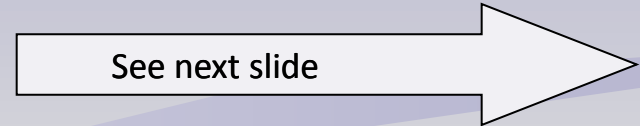
Process Theory – more complex than one way chain

Process Theory – more complex than one way chain

RM →→→→→→→→→→→→ **FG**

Raw Material

Linear or "I" system

FG ← Finished Goods
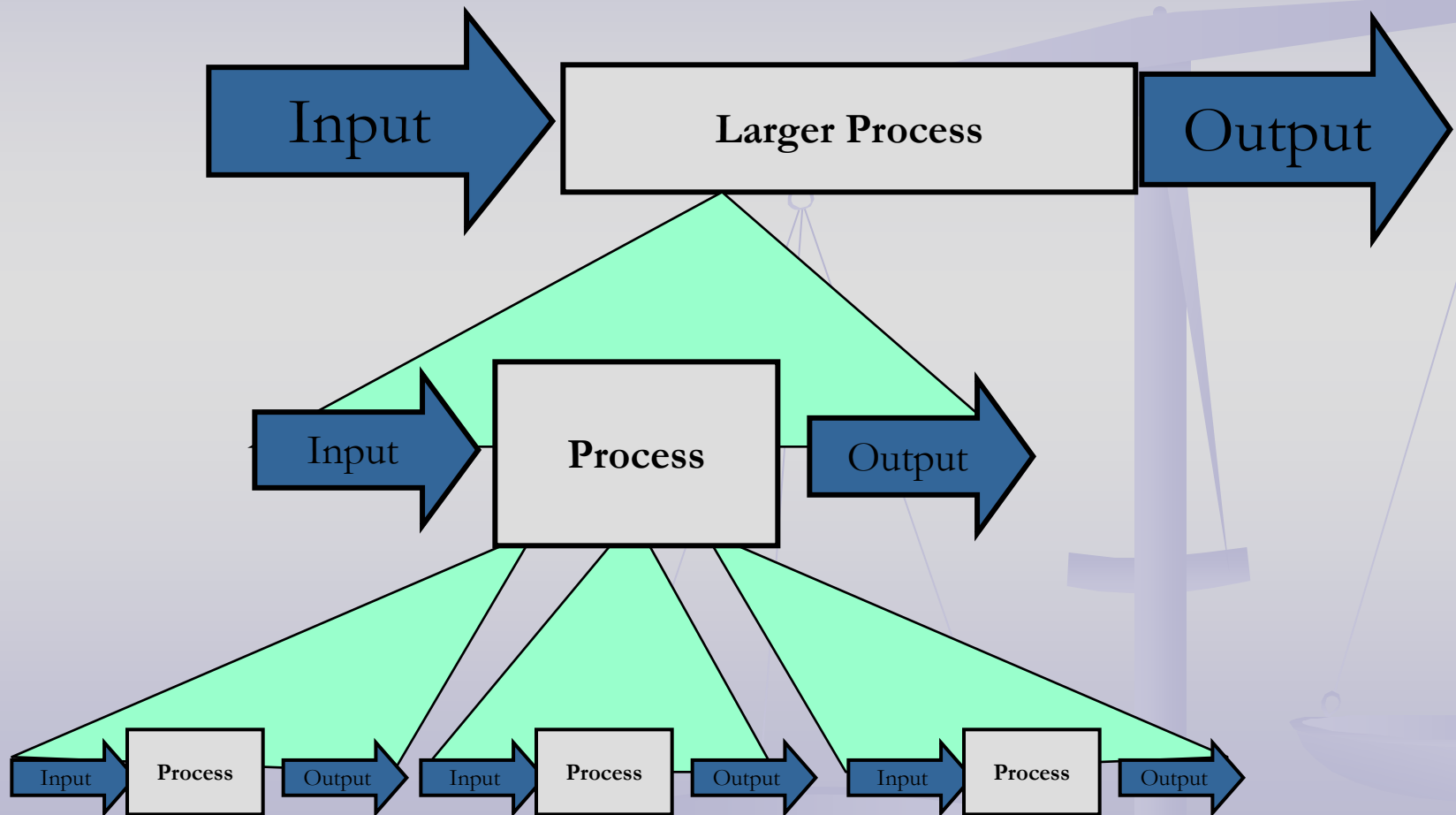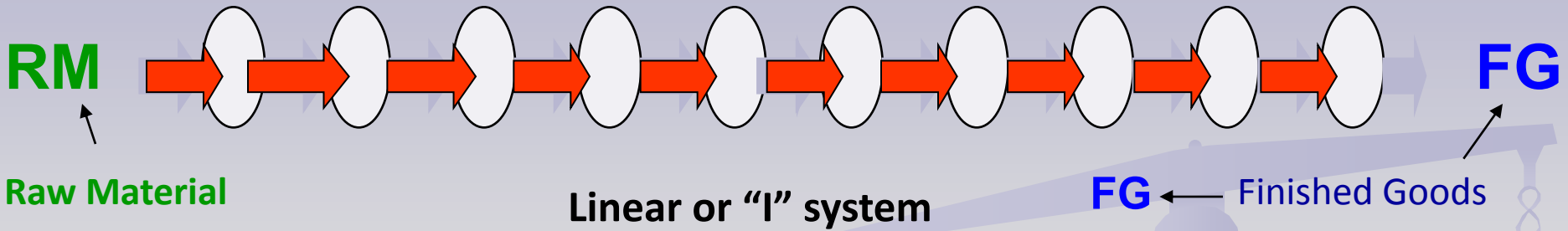
Aircraft assembly is more of an "A" Plant

RM
RM
RM
RM
RM
RM
RM
RM
RM
RM
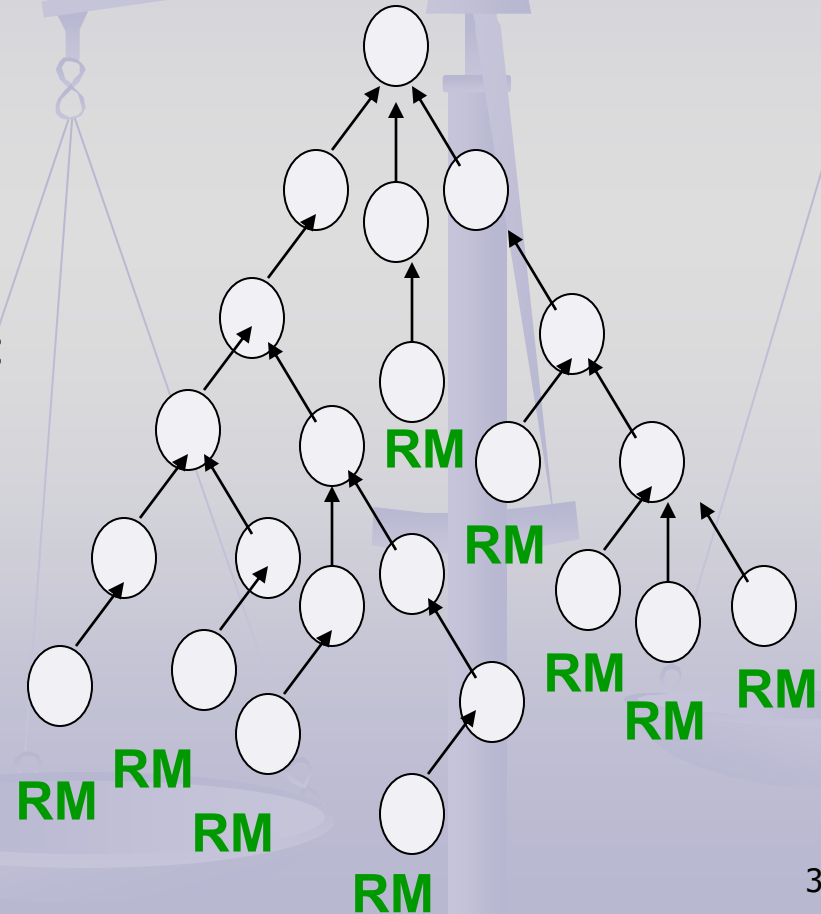
Types of the plants
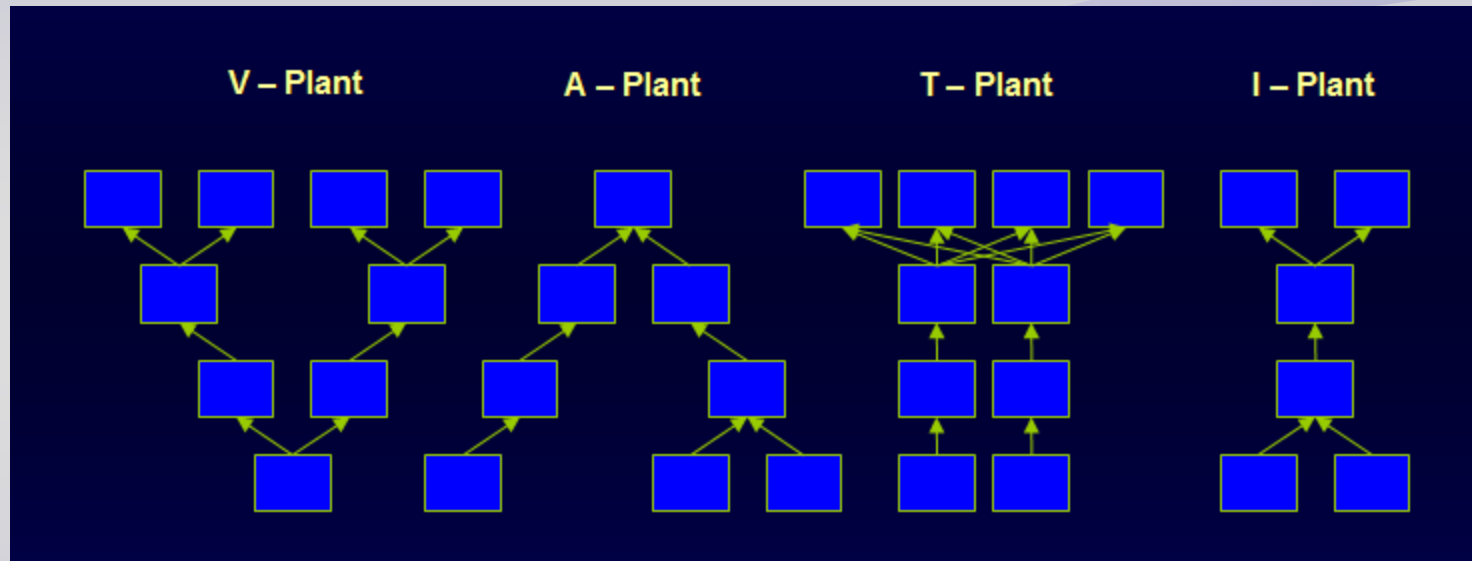
TOC – system approach

- Organizations / Systems exist for a purpose

- That purpose is better achieved by cooperation of multiple, independent elements linked together

- Purpose - Better Bottom Line

- Each Inter-linked event depends in some detail upon the other links

- The system owner determines purpose of the system

TOC (home study)

- Most real systems could be seen in such a way, that there are only a few or better **only one element** (factor), which is the **key point**, where and only there all possible managerial methods have to be focused in order to control whole system

- „Every system is based on basic simplicity".

- This element in TOC is called **Constraint of the system =** bottleneck

- Bottleneck: Any resource whose capacity is equal to or **less than** the demand placed upon it.

www.jamesfrancis.net

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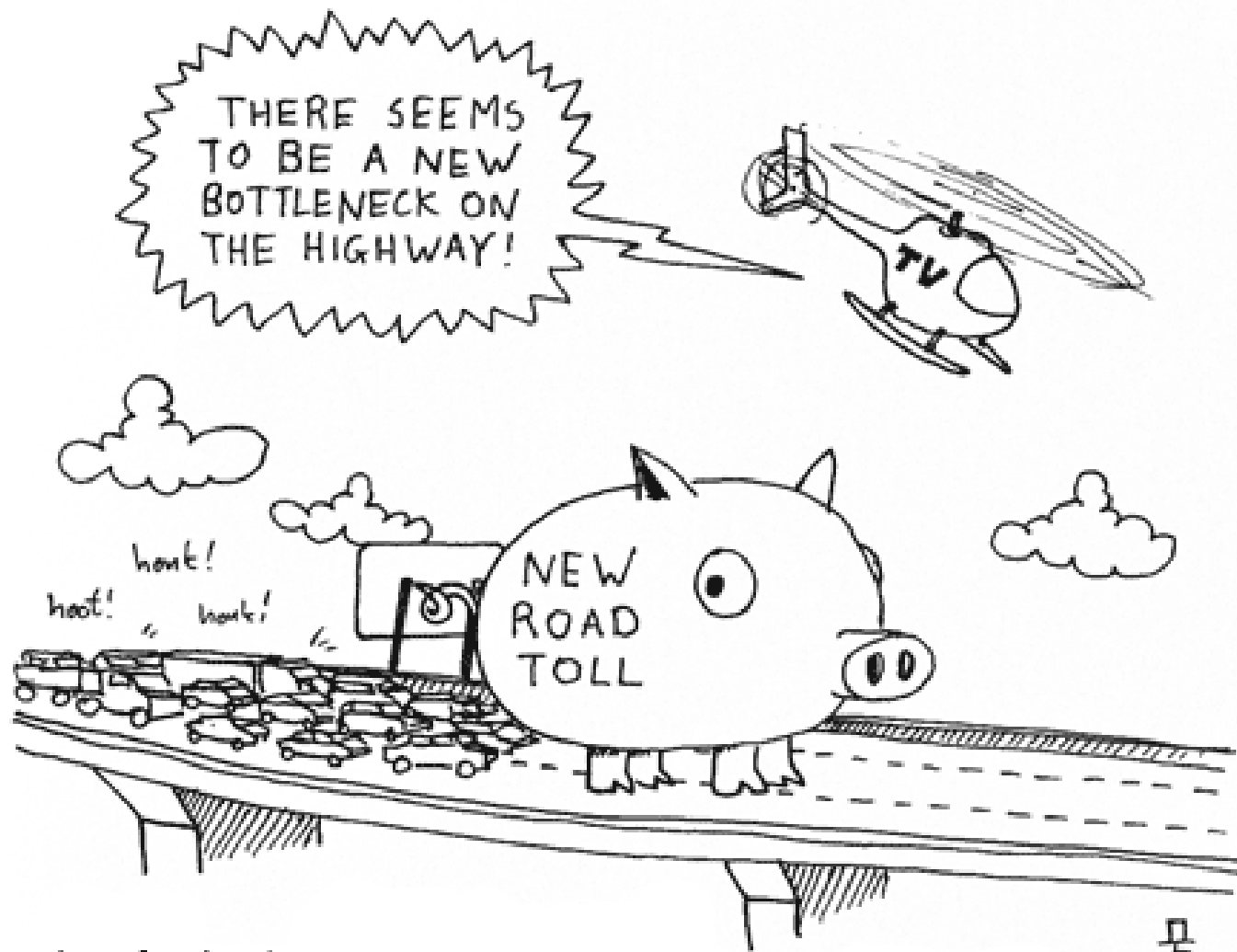
Scout Troop – Initial Condition

Scout Troop - Problem

Scout Troop - Solution

Army Solution

Mass Production Solution

Just-In-Time Solution

Drum-Buffer-Rope Solution

Time Synchron

MY NEXT NUMBER WILL BE PLAYED ALLEGRO VIGOROSO.
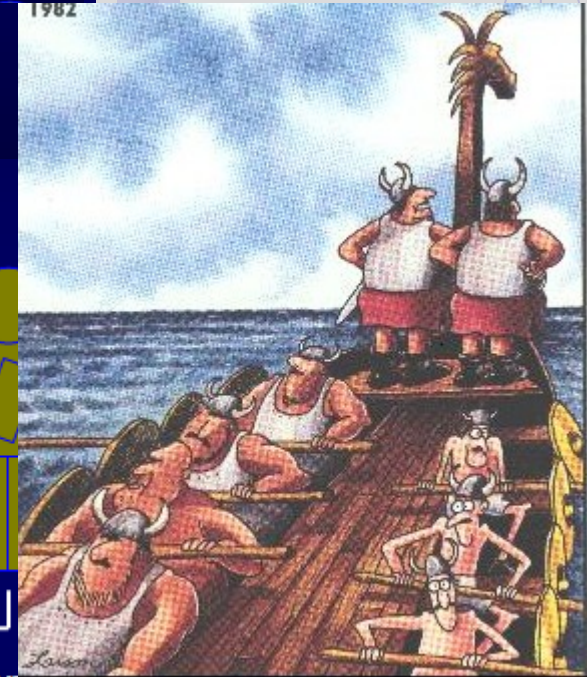
"I've got it, too, Omar … a strange feeling like we've just been going in circles."

TOC- bottleneck I

- Different link capabilities, normal variation
  and changing workload make it impossible to balance everything.

- One element of the system is more limited than another.

TOC- bottleneck II

- When the whole system is dependent upon the cooperation of all elements, **the weakest link determines the strength of the chain.**

- An exactly balanced chain (system) is stronger than a non-homogeneous chain, but when close to the **breaking point**, all links must be managed

TOC on K2

THE SNOWFIELD, SUMMIT

BALCONY SERAC

TRAVERSE

BOTTLENECK

Image courtesy of Pemba Gyalje

TOC

- Why constraint ?

- Constraint prevents to reach the goal (make money now and in the future)

- **The TOC goal** : „Make money now and in the future"

- Every system has at least one such a constraint.
  The system without such a bottlenecks would reach the predefined business plans in infinite volumes.

TOC : **of the costs**

- Traditional approach – world of where the aim of any endeavour is to optimize locally every segment of the chain, meaning balancing **the capacity** of every element and **not the flow** through the chain

Maximization of the efforts

Marketing

Orders

Purchase

Production

Packaging

Shipment
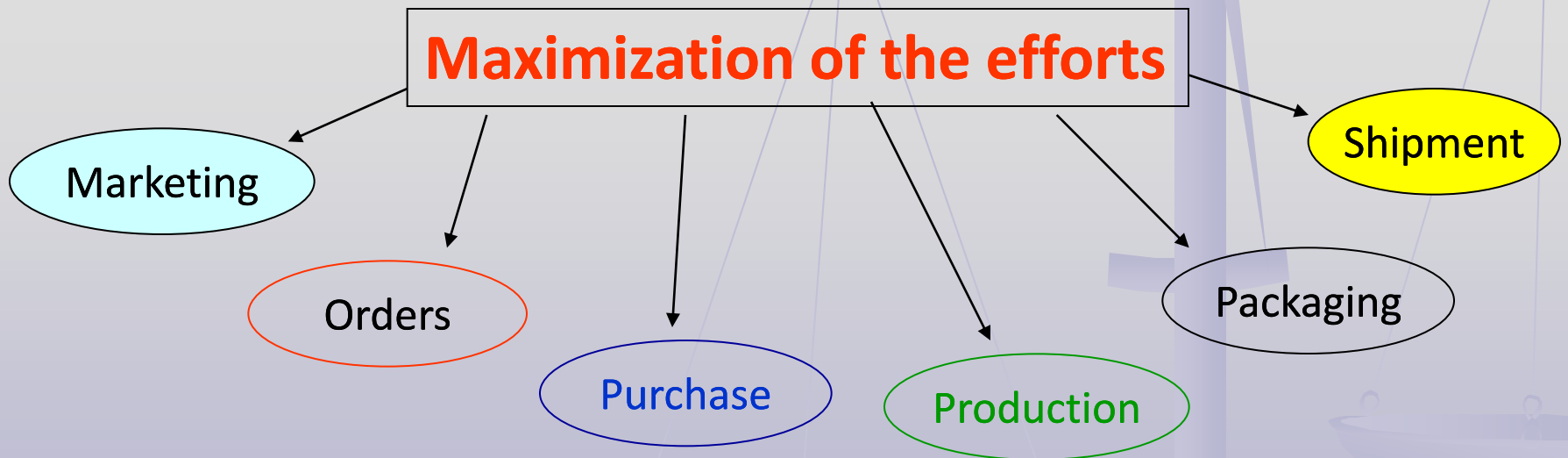
TOC : of the throughput

- Use of : „common sense"
- The consistent focus of the bottleneck-
  – global optimization

Maximization of the efforts

Marketing Orders Purchase Production Packaging Shipment

TOC

TOC

World of costs:	World of throughput:
■ **main metric** – the weight of the chain (every decrease of the weight of any components will result in better efficiency (performance)	■ **main metric** –the compactness of the chain
	■ Only improvement of bottleneck will improve performance of the whole chain
■ **Total improvement** = sum of local improvements	■ **Total improvement** = improvement of the bottleneck

Cost Model vs. Constraint Model (Home-study)

The cost accounting model—the norm in most organizations—is a financial model that was never designed to run the business. The cost model focuses on price per unit, while the constraint model focuses on price per unit of time spent at the constraint, a measure known as 'product octane'. Both the cost and constraint accounting models are necessary, but many organizations use the cost model for both purposes.

As the constraint in any business operation limits the flow of throughput, maximizing the octane is the goal of constraint accounting. The throughput model yields a dramatically different view of the relative profitability of different products. It provides a new perspective regarding the appropriate product mix and target markets.

Adopting a 'constraints' approach to profit maximization can easily lead to a 25% increase in operating profits, with significant additional cash flow benefits. Moreover, you'll reduce inventories and work-in-progress, and make smarter—and less costly—sales and marketing decisions.

Resource : https://ensembleconsultinggroup.com/method/operations-toc-overview/management-accounting/

Life show (first hypertext link)

- https://www.youtube.com/watch?v=UYZ6NC1JHfI
- http://www.tocca.com.au/

TOC

Five steps process - CONTINUOUS IMPROVEMENT:

Step 0.   Identify the Goal of the System/Organization
Step 0.5 Establish a way to measure progress to Goal

- **Step 1. *Identify*** the system's constraint.

- **Step 2. *Exploit*** the system's constraint**.**

- **Step 3. *Subordinate*** everything else to the above decision.

- **Step 4. *Elevate*** the system's constraint**.**

- **Step 5.** If a constraint is broken (that is, relieved or improved), go back to Step 1. But don't allow ***inertia*** to become a constraint**.**

http://www.leadingagile.com/2014/01/theory-constraints-brooks-law/

Brooks´law !!!

Adding manpower to a late software project makes it later !

TOC

- „Cost Accounting is enemy number one of productivity". *

- Impact on the behaviour of the people and they habits of finding and improvements of local elements having reason in optimising of these particles.

- New metrics were introduced – already presented

* Eric Noreen, Debra Smith and James t. Mackey

Definition (TOC metrics) - summary

- Throughput (T): The rate at which the system generates **money** through sales.

    - Note that the money is generated through sales and not production because if you produce something and don't sell it, you have not really had throughput. (You've just put it into inventory).

- Inventory (I): All the **money** that the system has invested in purchasing things, which it intends to sell.

- Operational Expense (OE): All the **money** the system spends in order to turn Inventory into Throughput. See classification of OE later in this show

TOC metrics more in detail (T)

- **Throughput** is the rate at which a system achieves its goal. Often this is monetary revenue and is in contrast to **output**, which is inventory that may be sold or stored in a warehouse. In this case **throughput** is measured by revenue received (or not) at the point of sale— exactly the right

TOC metrics more in detail (OE)

- **Operating expenses includes e.g. :**
- accounting expenses
- [license](#) fees
- maintenance and repairs, such as snow removal, trash removal, janitorial service, pest control, and lawn care
- advertising
- office expenses
- supplies
- attorney fees and legal fees
- utilities, such as telephone

Repetition of a topic that has already been reported on TOC

- TOC as a managerial paradigm (holistic approach)
- Literature /resources
- TOC and Business Process Reengineering (pessimistic and optimistic approach)
- Chain of processes
- Bottleneck and its definition and impacts
- DBR (Drum-Buffer-Rope) – first approach
- Cost world and Throughput world
- -the weight of the chain (every decrease of the weight of any components will result in better efficiency (performance)
- - the compactness of the chain (only improvement of bottleneck will improve performance of the whole chain)
- Basic metrics (T,OE, Inventory)
- Five focusing steps (Find, Exploit, Subordinate, Elevate , go back to 1)

-

Holistic approach

First formulated by Jan Smuts, holism has been traditionally defined as a philosophical theory that states that the determining factors in **nature** are wholes which are irreducible to the sum of their parts and that the **evolution** of the universe is the record of the activity and making of such wholes. More generally, it is the concept that wholes cannot be analyzed into parts or reduced to discrete elements without unexplainable residuals.

Measuring the goal (TOC metric)

- **Net profit** (NP=T-OE) : (T, I and OE was already explained in this course) -> T=Net Sales – TVC =S-TVC, where TVC=Total Variable Costs
- **Cash**
- **Return on Investment** (ROI=NP/I)

- Throughput =T
- Inventory = Investment =I
- Operating Expenses =OE

Metrics and their relationships-trends
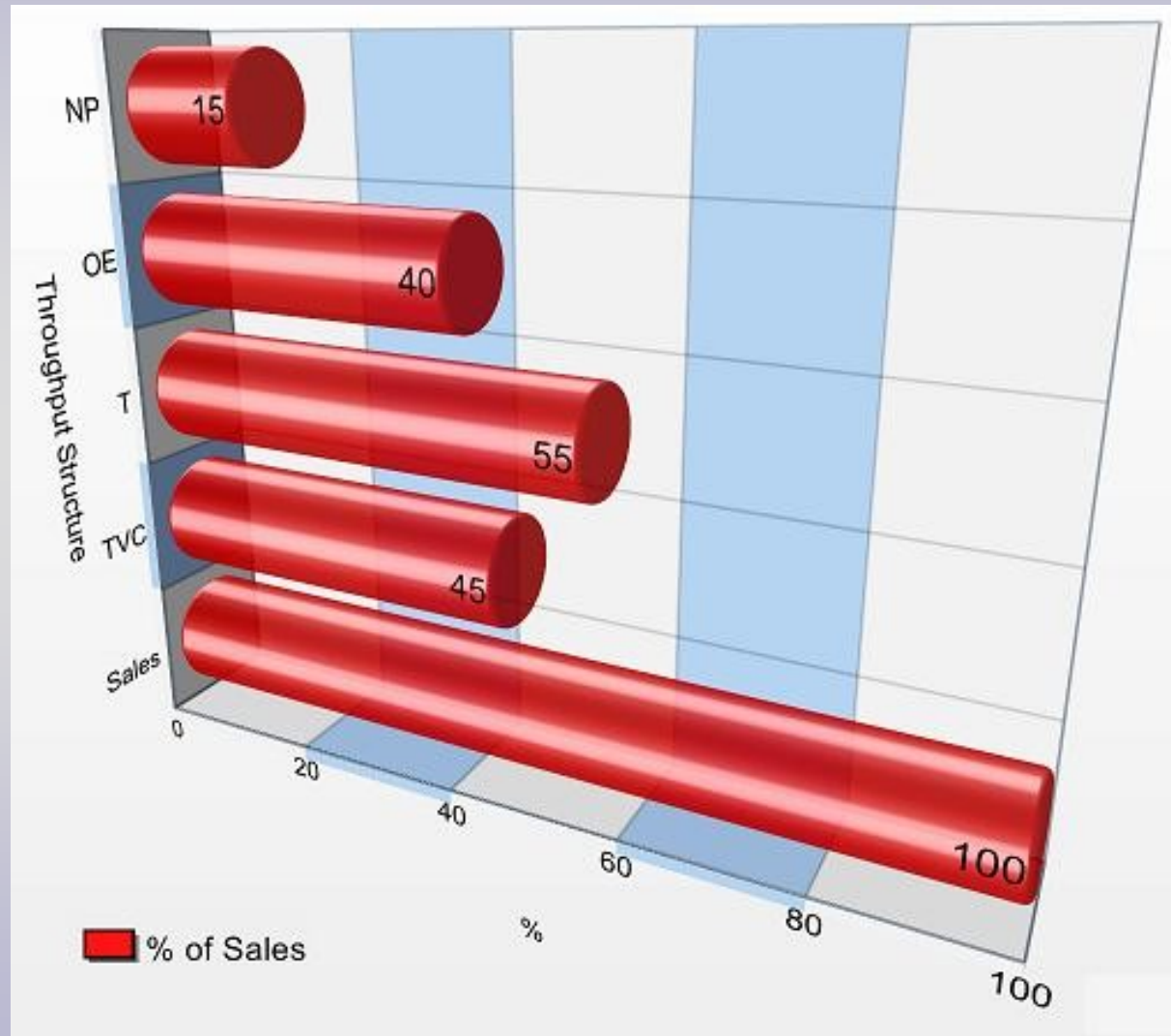
TOC –required trends
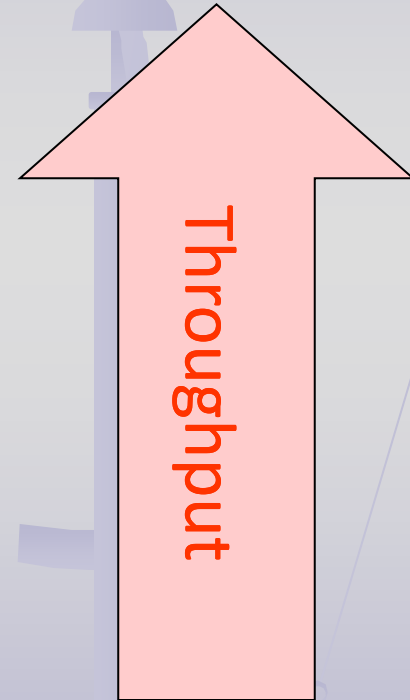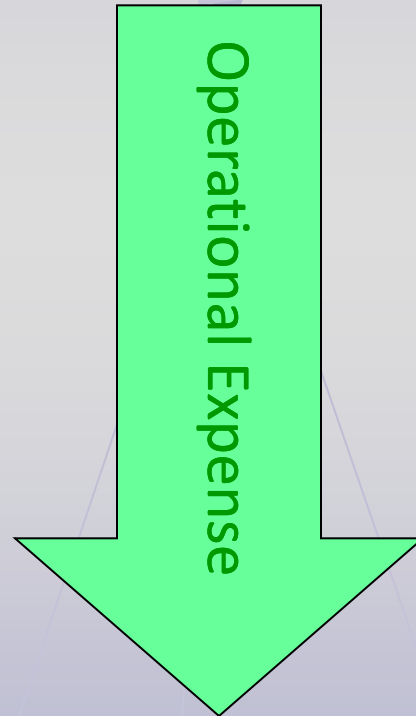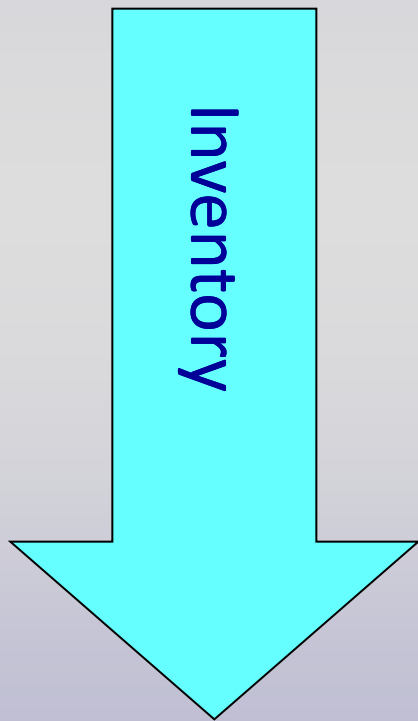
T,I,OE,NP and ROI example (home study)

- NP=**T**-OE = $(S-TVC) - OE$; where **TVC**=Total Variable Costs and **S**=Unit Price

- ROI=(T-OE)/I=NP/I, where **NP**=Net Profit

- where T=total throughput (pcs/unit of time)

A   B   C   D   E

| 10 | → | 13 | → | 7 | → | 9 | → | **11** |
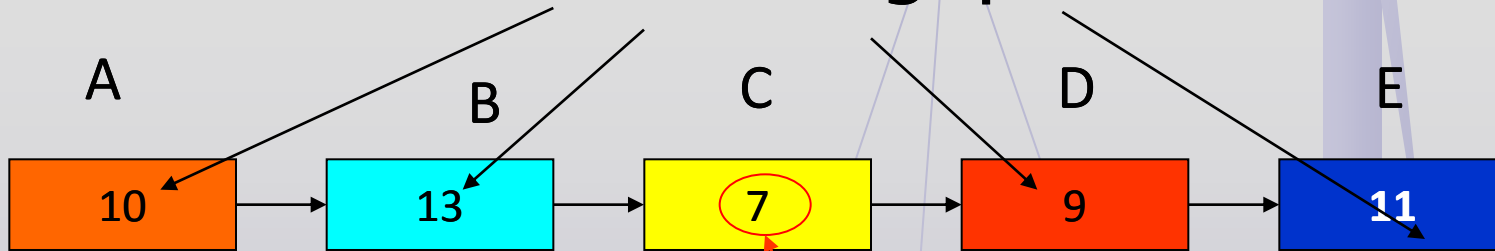
1. Only one product !!! In our example **TVC**=0
2. Unit Price (Selling price) = **100 USD = S**
3. Raw material /one product =**35** USD =**OE**
4. **NP**/product=(**T**-**OE**)=**100**-**35**=**65**
5. 176 hours/month (constraint of the company)
6. T=176 * 7 = **1232** parts/month
7. Monthly **NP** =**1232** * **65** USD = **80 080** USD

CCR=Capacity Constraint Resource=
=weakest link of the chain= **bottleneck**

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T,I,OE,NP and ROI example (home study)

- 1st suggestion is to optimize B from 13->14 parts per hour

- T will not increase ->**You cannot produce more than 7 !!!!**

- Investment to optimize B=5000 USD with depreciation 10 %

- OE(month) =(5000 USD * 0,1)/12= 41,67 -> 42 USD (when rounded)

A	B	C	D	E
10	13->14	7	9	11

CCR=Capacity
Constraint Resource=weakest link
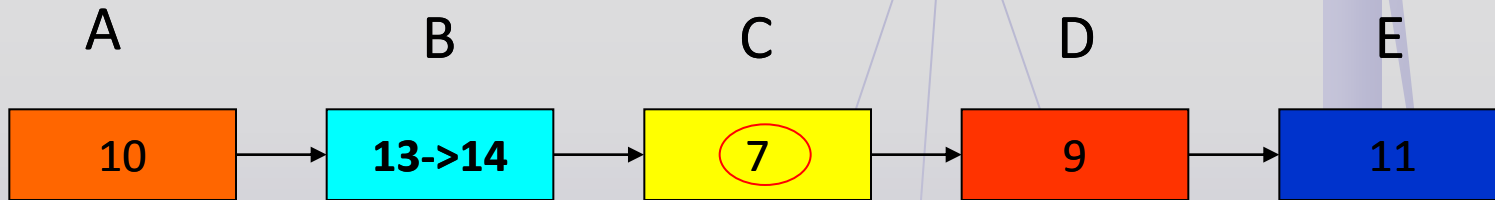
1. Only one product
2. Unit Price (Selling price) = **100 USD**
3. Raw material /one product =**35** USD =**OE**
4. **NP**/product=**100**-(**35+42**)=**23**
5. 176 hours/month (constraint of the company)
6. T=176 * 7 = **1232** parts/month
7. Monthly **NP** =**1232** * **23** USD = **28 336** USD

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T,I,OE,NP and ROI example (home study)

- **T** = **throughput** will not increase
- NP (Net Profit) will decrease based on increased OE **(41,67 USD /month)**
- Based on NP decrease ROI is negative
- **Bad suggestion !!!!!!**

A	B	C	D	E
10	13	7	9	11
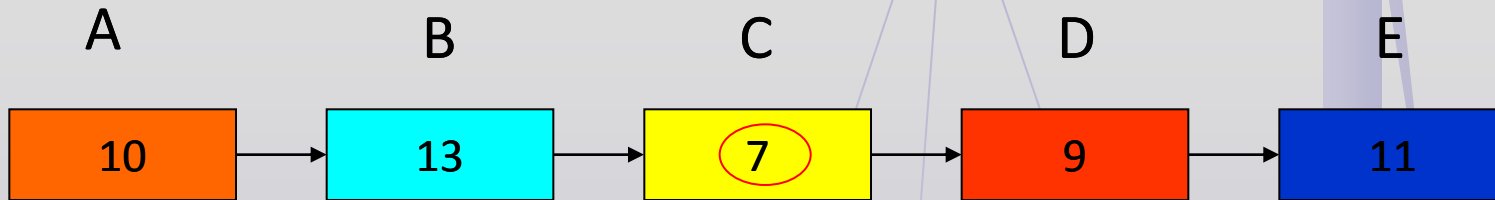
CCR=Capacity Constraint Resource=
=weakest link

T,I,OE,NP and ROI example (home study)

- 2nd suggestion is to optimize C from 7->7,1 parts/hour

- part of the 2nd suggestion is an extra load of E so it goes from 11->10

- Necessary investment is 5000 USD (remains the same)

- Increase of the T=production/month = 0,1*176=17,6 parts

- Increase of the company NP= 17,6*23 USD= 404,8 USD/month

A	B	C	D	E
10	13	7->7,1	9	11->10
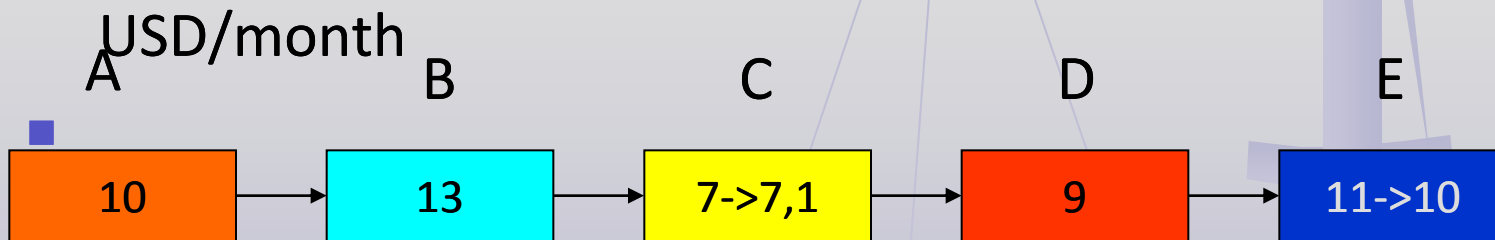
T,I,OE,NP and ROI example (home study)

- Necessary investment is **5000** USD = I =Inventory= Investment
- Increase of the T= production/month = 0,1*176=17,6 parts
- Increase of the company/month NP= 17,6***23** USD= **404,8** USD
- OE/month =(5000 * 0,1)/12= 41,67 -> **42** USD
- OE will be increased by **42** USD/month
- Annual increase of the NP = **404,8***12=4848,8 USD
- ROI=NP/I = (28336*12+4848,8)/**5000** = 69 % !!!
- **T** does not measure local efficiencies, except at the constraint- see next slide

A	B	C	D	E
10	13	7->7,1	9	11->10
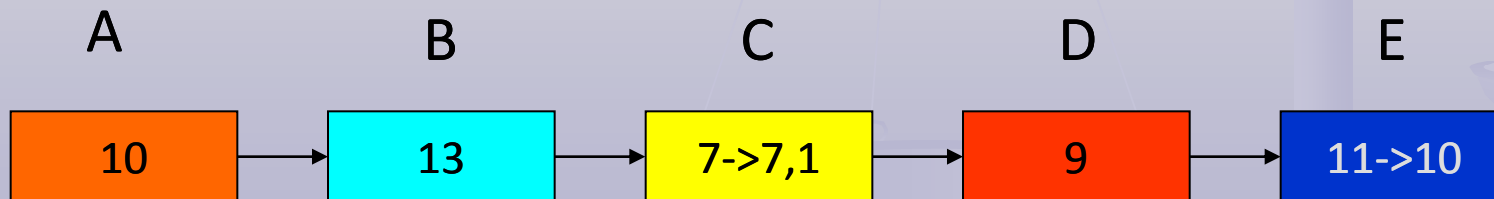
Throughput

1. T=176 * 7,1 = **1249,6**

2. parts/month (not rounded)

3. Monthly **NP** =**1249,6** * **23** USD = **28 740,8** USD

4. Originally :

   1. T=176 * 7   = **1232** parts/month

   2. Monthly **NP** =**1232** * **23** USD = **28 336** USD

   3. **28740,8**-28336=**404,8**

Implementation of TOC is complicated **switchover process**

- it represents challenging adventure, where the invested efforts are often **not predictable**

- it requires cooperation, coordination and use of well informed and trained teams on both sides.

- you will certainly overcame natural resistance against changes and persuade distressed and indolent people

- no one is willing to change anything

Implementation of TOC is complicated switchover process

- try to find somebody who could accept changes !!!

- you must persuade these guys, that the suggesting changes are in fact their idea and without their creativity TOC would be only toothless beast !

- but how to achieve it ??

Implementation of TOC is complicated switchover process

- **Socratic teaching** – proving the logic by use of **dialog**

- **Buy-in approach** – initiator of the changes must have interpersonal and communication talents in order to persuade the targets and squeeze from the people their best ideas.

Socratic teaching

Review of last 63 slides

- Cause->Effect relations
- Bottleneck specification-problem identification
- Cost world and Throughput world
- 5 TOC steps
- TOC metrics (T,I,OE) – basics of throughput accounting

Throughput accounting (home study)

- **Throughput accounting** (TA) is principle-based and simplified management that provides managers with decision-support information for enterprise profitability improvement. TA is relatively new in management accounting. It is an approach that identifies factors that limit an organization from reaching its goal and then focuses on simple measures that drive behavior in key areas towards achieving organizational goals. Goldratt proposed TA as an alternative to traditional cost accounting. **Throughput Accounting** is neither **cost accounting** because it is cash focused and does not allocate all costs (variable and fixed expenses, including overheads) to products and services sold or provided by an enterprise

Cost accounting I.

- In accounting, the term cost refers to the monetary value of expenditures for raw materials, equipment, supplies, services, labor, products, etc. It is an amount that is recorded as an expense in bookkeeping records.

Cost accounting I.

Cost Accounting

↓

Set Up Cost Types, Cost Centers, and Cost Objects

↓

Transfer Costs from General Ledger   Post Costs in Cost Journals

↓

Allocate Costs from Cost Centers to Cost objects

↓

Create Cost Reports

Implementation of TOC is complicated switchover process

We have to find out the answers to these questions:

1. What to change?
2. To what to change to ?
3. How to make the change happen?

Implementation of TOC is complicated switchover process

What to change?

- Objectives : **Situation assessment,** description of **"current reality,"** and identification of the core problem or conflict and assumptions that sustain it. **Diagnosis and systemic root cause analysis.**

- **But at any time you will meet enemies – the ones who hate any changes**
  You have a lot of people wishing to do the same, a lot o people doing exactly the opposite and immense quantity of people which would like to do nothing !

- Layers of resistance: **Lack of agreement on the problem**

RESISTANCE

Implementation of TOC is complicated switchover process

To what to change?

- Objectives : **Verbalization of vision/solution->process diagram, description of strategy to attain the desired state, and avoidance of undesirable side effects. Prescription, decision-making, and solution development.**

- Layers of resistance:
    - **Lack of agreement on a possible direction for a solution**
    - **Lack of agreement that the solution will truly address the problem**
    - **Concern that the solution will lead to new undesirable side effects ("Yes, but…")**
    - **Or you will get even worse reaction ("NO, because…")**

Process diagram
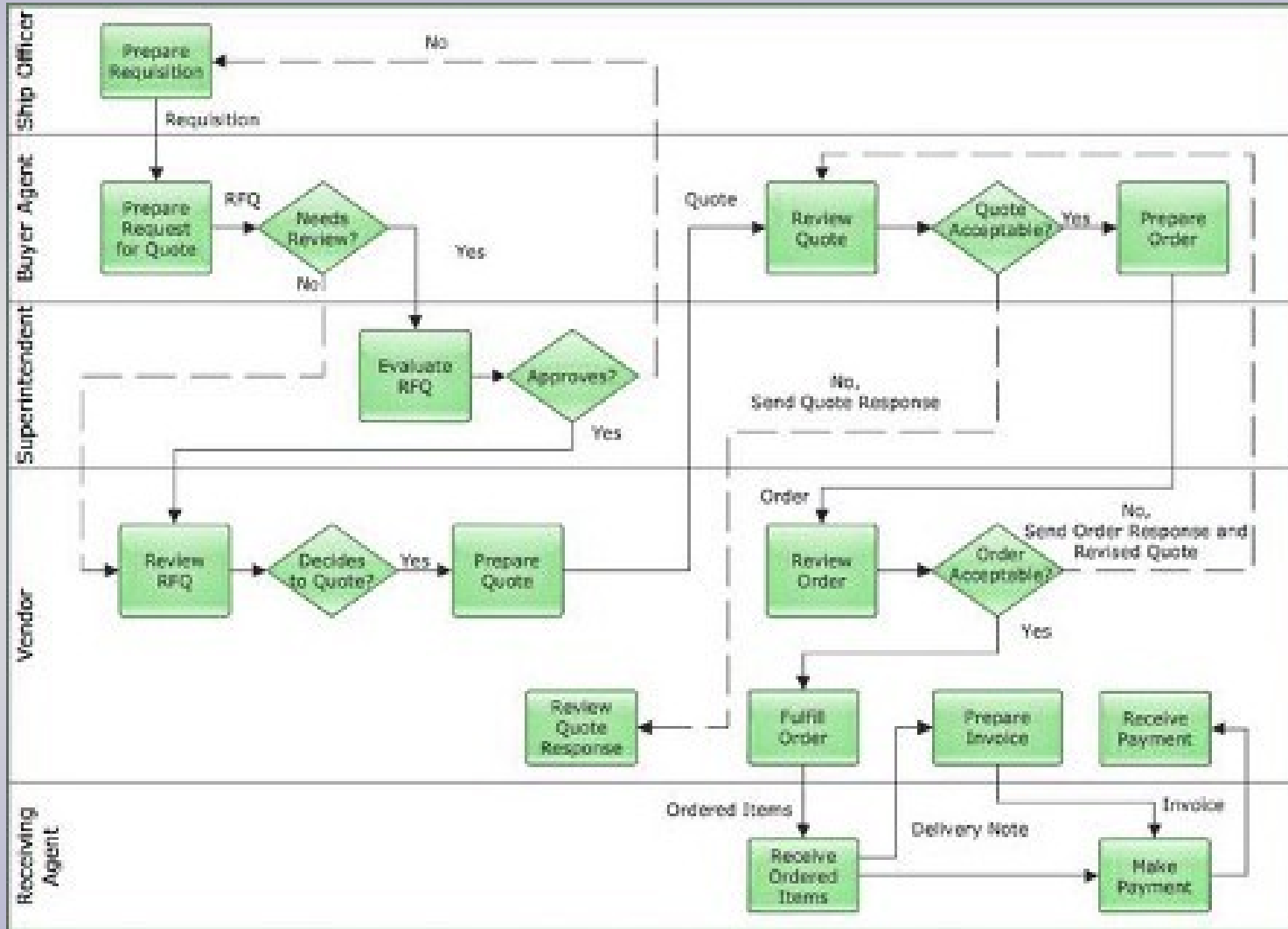
Thinking Process Tools

- offer the answers to three TOC questions about changes

- help to **clear away** every layers of resistance

- visualisation of the thinking process

- verbalization of the thinking process

- use of **casual logic** (cause ->effect)

- use of **sufficiency logic** – „**IF - AND - THEN**"

- use of necessity logic – „**IN ORDER TO - THEN - BECAUSE**"

Thinking Tools (home study)

Thinking Tools

- Sufficient cause is the thought pattern of effect-cause-effect. When we assume that something, only because it exists, causes something else to live, we use enough cause thinking. Another point of view is using sufficient cause thinking when we assume that something is the inevitable result of the mere existence of something else" (Scheinkopf, c1999 p. 31).

- It is essential to care about hidden assumptions because they are the "source of disagreements and best-laid plans gone awry" (Scheinkopf, c1999 p. 34).

- The primary benefit of the Thinking Tools diagrams is in the relationships they are capable of showing.

- The thinking process related to finding plausible causes is related to the assumption that the existence of one element causes the presence of another.

- Another reasoning when using plausible cause is the assumption that one element is the inevitable consequence of another (Scheinkopf, c1999 p. 31).

Basics relationships

Cause A ──── Assumption ────▶ Effect B

Auto battery is empty ────────▶ The engine do not start

The engine do not
start because battery is flat (empty)

I drink a lot of Czech bier ────────▶ My belly looks like Zeppelin

The bier is an energy drink

My belly looks like Zeppelin ────────▶ I cannot find a girl !!!!

The girls like slim athletes !!!
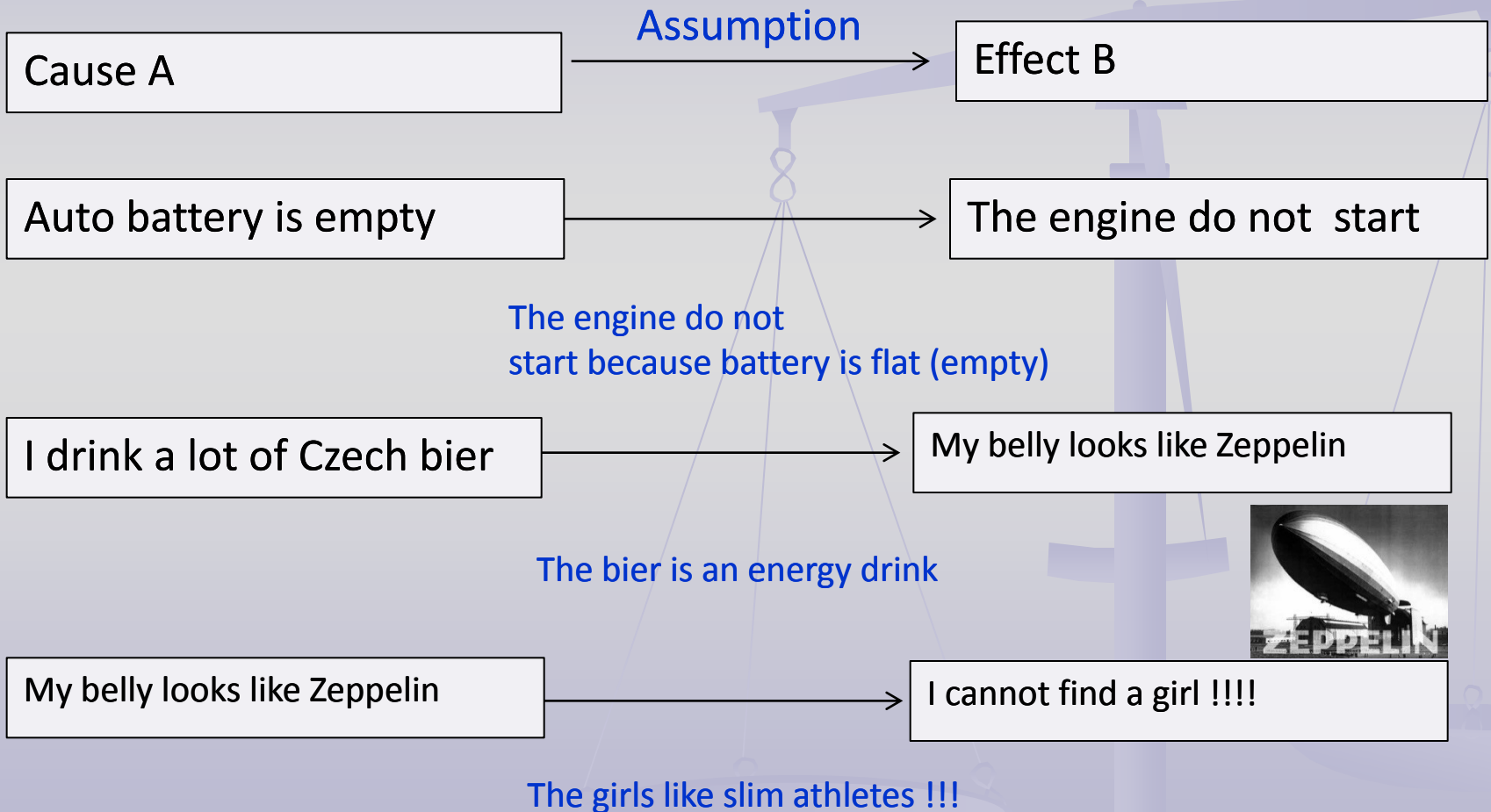
Cause-effect simplified structure

I drink more bier !!

↑

I am alone and frustrated

↑

I cannot find a girl !!!!

↑

My belly looks like Zeppelin

↑

I drink a lot of bier
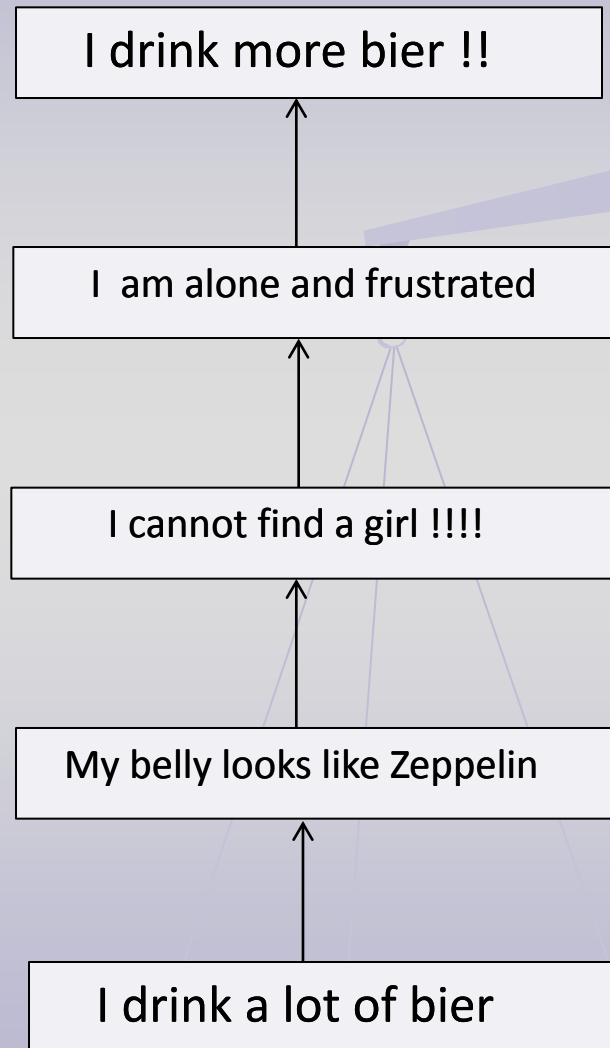
Thinking Process Tools

Necessity logic

IN ORDER TO - THEN - BECAUSE

In order to survive and to be strong as Hercules I must eat fatback

I will survive and I will date girls every day

I am eating fatback every day

Thinking Process Tools

Sufficiency logic

IF - AND - THEN

I have in my room a lot of light

AND

I have one good bulb in my castle hall

The chandelier is connected to the electric network

Switch is on
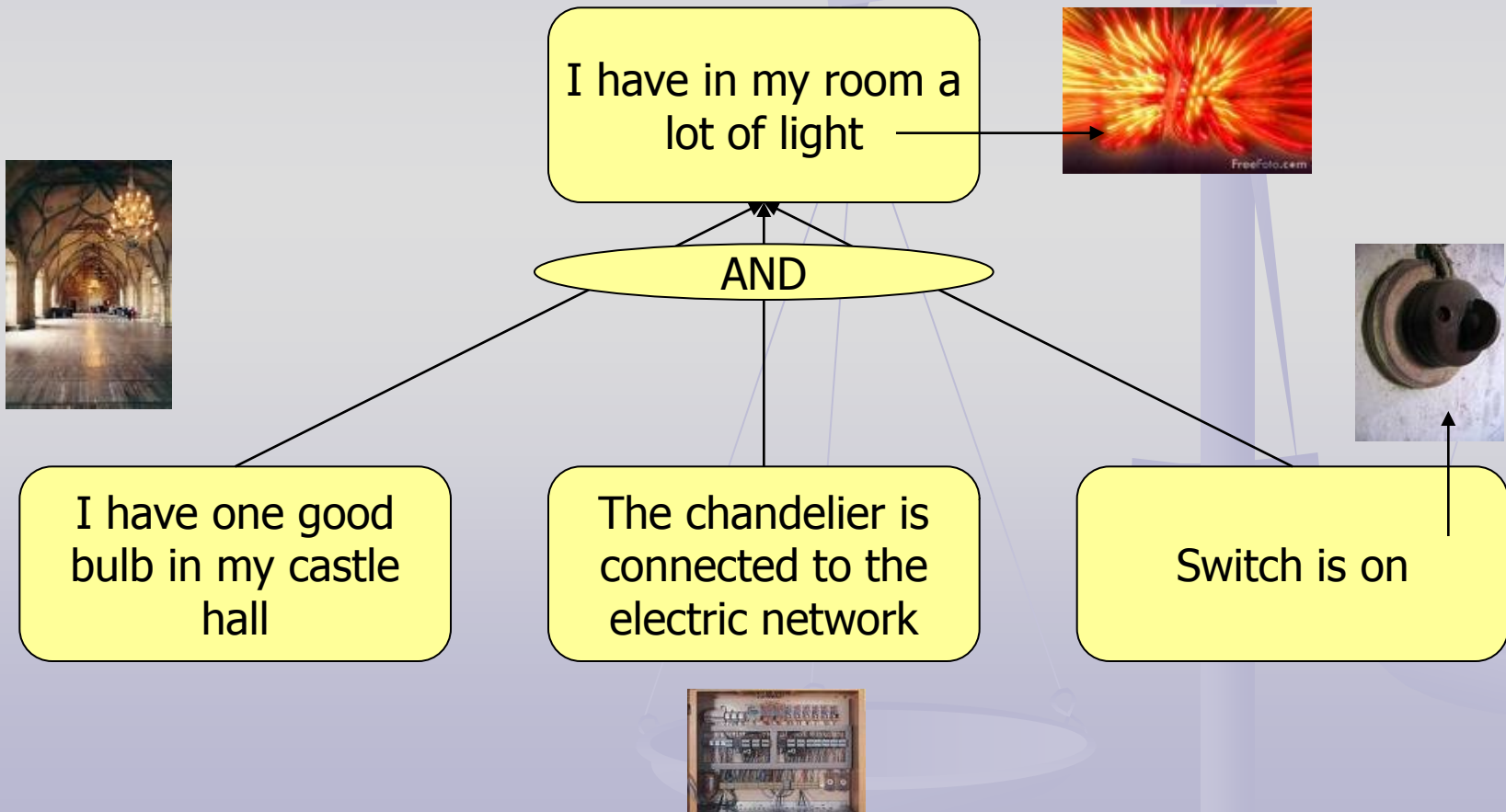
We have to solve the crucial question: what is a core problem (what should be changed)

A tool for solving such a task : Current Reality Tree

➢ Why to change something and what is something (core problem=constraint, bottleneck)

➢ Summary of all **U**ndesirable **E**ffects (**UDE**) and their layout based on **casual logic** - **sufficiency logic**

➢ **Core Problem** – common cause of all **UDE**

UDE examples

- **From the book "[It's Not Luck](#)", some examples of the UDEs are:**
- Production and distribution do not improve fast/significantly enough
- Engineering is unable to deliver new products fast and reliably enough.
- Companies do not come up with good innovative ideas in marketing.
- In more and more cases, the price with the market price is willing to pay does not leave enough margin.
- There is unprecedented pressure to take actions that will increase sales
- Competition is fiercer than ever.
- In advanced material industries, there is a need to launch new products at an unprecedented rate.
- In advanced material industries, the constant introduction of new products confuses and spoils the market.
- Salespeople are overloaded.
- There is increasing pressure to reduce prices.

We have to solve the crucial question: what is a core problem (what should be changed)
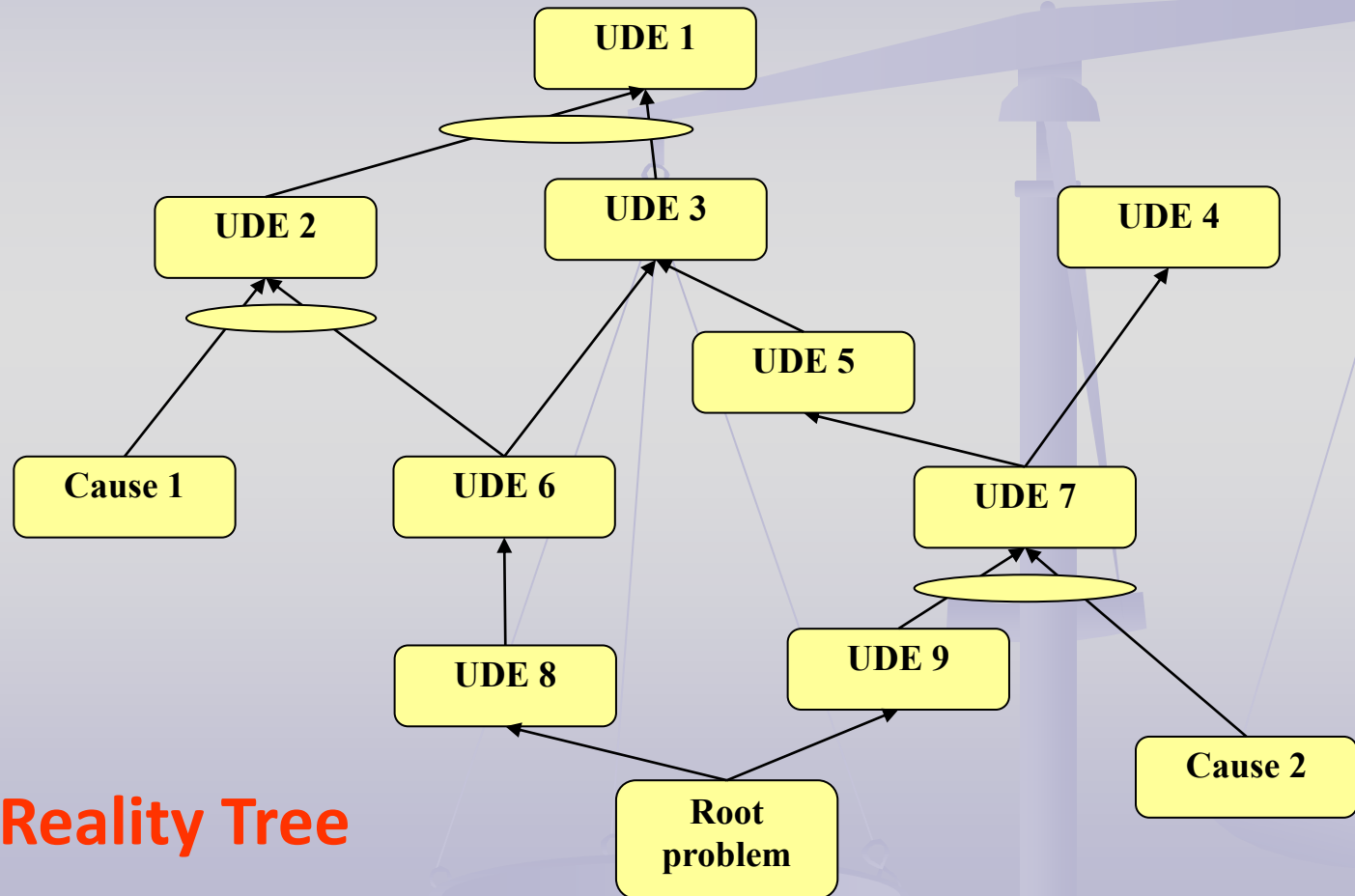
Current Reality Tree

CRT (home study)

- A **CRT** is a cause-effect logic diagram constructed with "sufficient cause" reasoning that is used to establish a stream of logical relationships that link the core conflict with the UDEs (Ronen, c2005 p. 29).

- The **CRT** is used to pinpoint the core driver – a common cause for many effects. The most common use is to identify a core problem, which can be thought of as the invisible constraint responsible for many of the system's current problems.

- Constructing the tree is a process that leads to the recognition of the behavioral patterns of the conditions existing in the reality of the system.

- **CRT** is a tool that allows to see order even in the midst of chaos" (Scheinkopf, c1999 p. 144). Before creating the diagrams, any and all possible information is collected; what issues the inspected company deals with, what its pains are, and what the corporate goals are. These topics can be described with the as-is model, and the information is therefore transcribed into the CRT.

CRT (home study)

■ **CRT** diagram does not represent any reality, but as is the case with the other diagrams, shows relationships based on the cause-consequence paradigm, where undesirable effects in unison create the final problem being addressed by the diagram.

■ Backtracking these consequences to their cause, the single core problem, or the bottleneck, is determined. The CRT construction process contains the following steps:

1. Determine the scope of the analysis

2. List between 5 to 10 pertinent entities

3. Diagram the effect-cause-effect relationships that exist among the entities.

4. Review and revise for clarity and completeness

5. Apply the "so what" test. 6. Identify the core cause(s) (Scheinkopf, c1999 p. 144).

6. Identify the core cause(s) (Scheinkopf, c1999 p. 144).

How to create CRT (home study)

The CRT construction process contains the following steps:
(it was already mentioned on the previous slide)

1. Determine the scope of the analysis
2. List between 5 to 10 pertinent entities
3. Diagram the effect-cause-effect relationships that exist among the entities.
4. Review and revise for clarity and completeness
5. Apply the "so what" test.
6. Identify the core cause(s) (Scheinkopf, c1999 p. 144).

We have to solve the crucial question: what is a core problem (what should be discovered and changed)

Causality:

IF a lot of snow AND snowboarding in restricted area THEN avalanche

I will burn
my hand

I touch a hot
cook stove

I will not burn
my hand

AND

I touch a hot
cook stove

I will use
"**pot holder**"
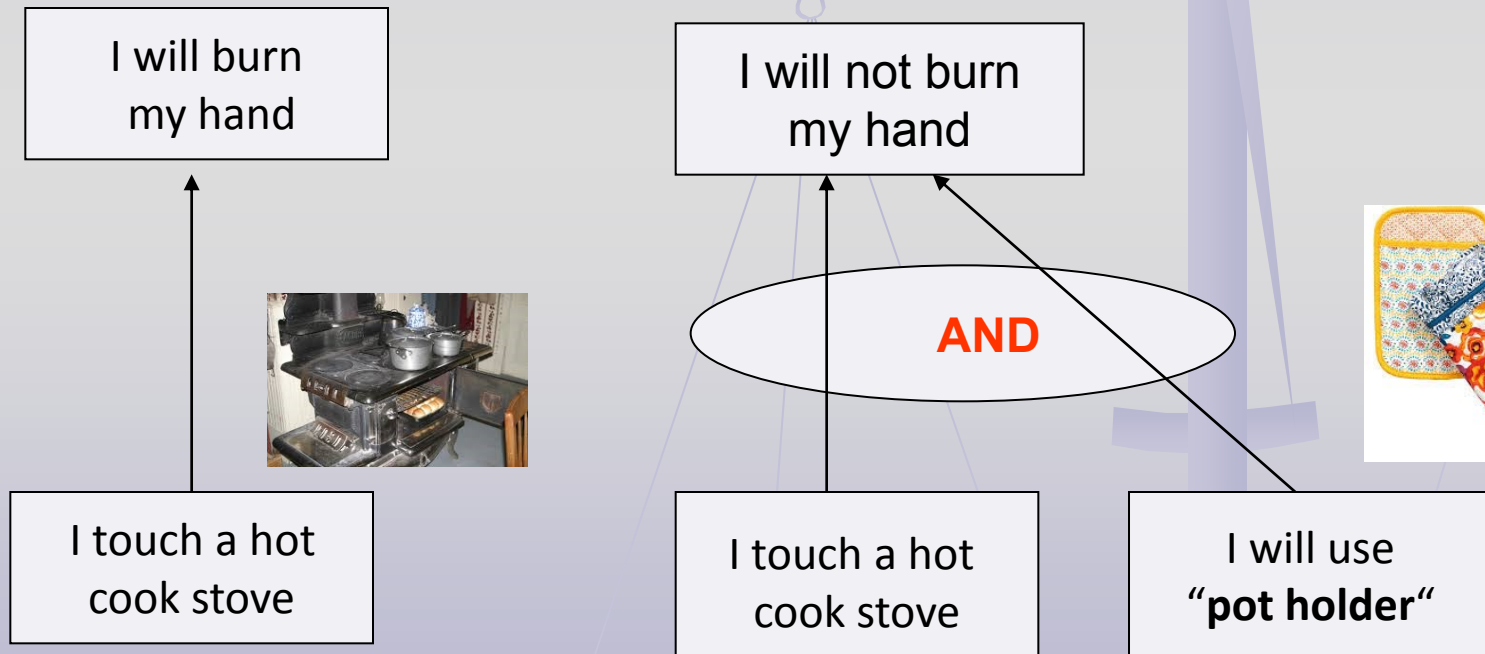
We have to solve the crucial question: what is a core problem (what should be changed)

Necessity logic:

IN ORDER to avoid something I HAVE TO do this

BECAUSE IF I will touch
the hot cook I will be singed (wounded)

IN ORDER
to avoid to be singed

I may not touch a hot cook stove

Current Reality Three

I am alone

I am obese (overweight)

No rendezvous → No girl

I am very shy to negotiate dating

No time for rendezvous

I am very shy because of my figure

I visit often fast food

Oversupply of calories

I am very busy (no time) → No sporting

I am surfing on internet to much

I am killing anxiety having reason in solitude by eating and drinking liquors

I cannot manage my time

Current reality three (home study)

List of UDE´s :

- **UDE1 :** lack of financial consultants (FC)
- **UDE2 :** late hand-over of required services during implementation and support
- **UDE3 :** a modern design of ERP is not easily understood by rigid customer´s accountants
- **UDE4 :** the customer´s accountants tend to use old fashioned methods and processes which are difficult to manage by using a modern ERP
- **UDE5 :** rigid remuneration does not allow to pay more FC than the others
- **UDE6 :** high level of fluctuation and job-hopping
- **UDE7 :** overburdened FC as a consequence of bad multitasking (will be explained later in Critical Chain PWP)
- UDE8 : FC are fed up by permanent repetitive explanation to the customer´s accountants who do no want to understand
- UDE9 : bad multitasking
- UDE10 : FC are unhappy because of a salary, which is much more lower then their expectations
- UDE11 : The management sticks to Cost world and tends to decrease costs by minimising payroll and having all resources as a CCR (Critical Constraint Resources)
- UDE12 : Customer is unhappy

Current reality three (home study)

Customer is unhappy

| 1 |
| 12 |
| 6 |
| 2 |
| 10 |
| 8 |
| 7 |
| 4 |
| 9 |
| 5 |
| 3 |
| 11 |

ROOT PROBLEM
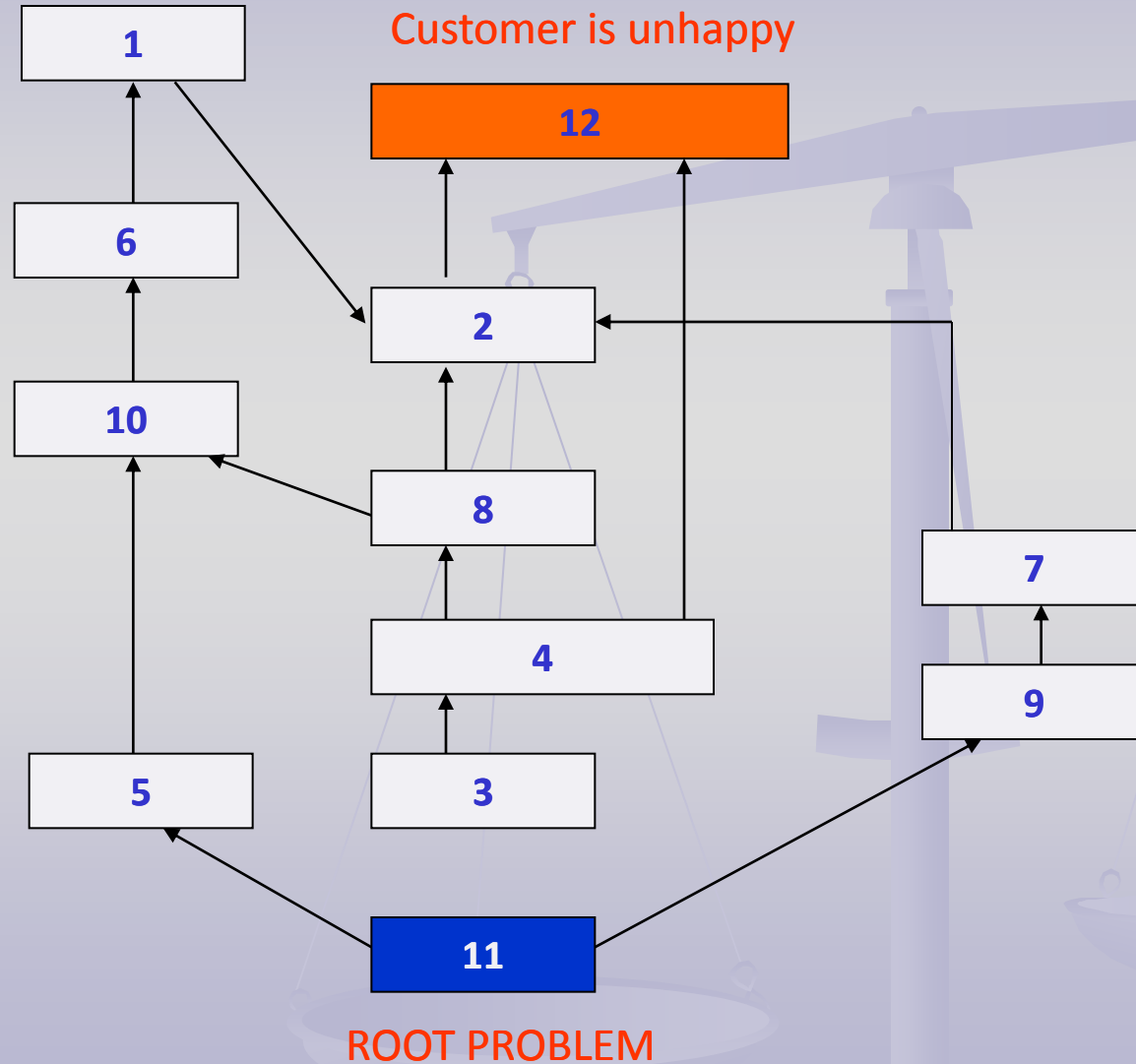
CRT – Bad structure of the code
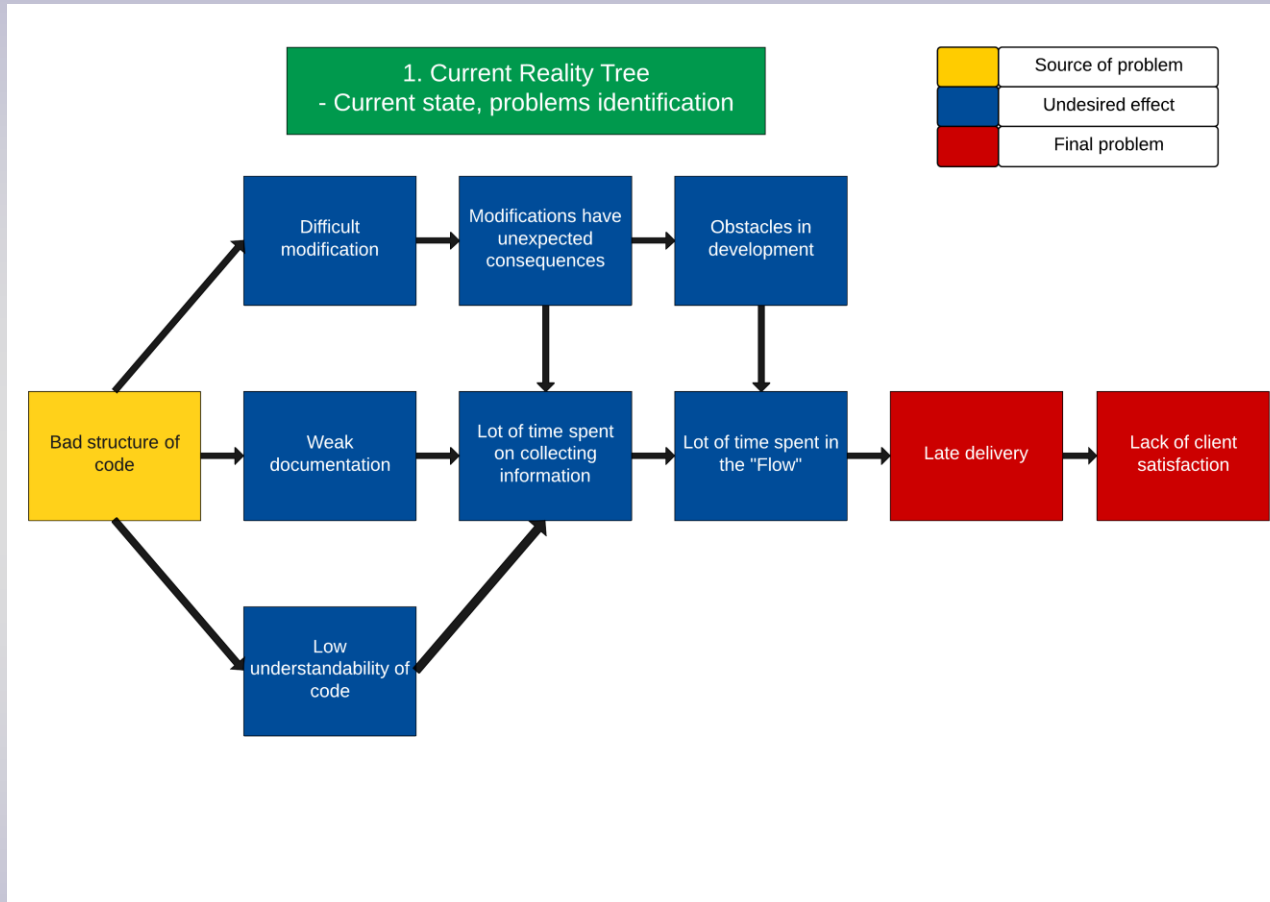
Resouce: BW, ing,Martin Lofaj, 2014

We have to solve another crucial question:
the direction of solving a core problem

What is the main reason (injection) supporting the change !

Evaporating Cloud Tree

➢ the change without any compromise - basic and starting impulse for the change

➢ use of „**necessity logic**" – common goal, necessary condition to reach this goals, what have to be done and where is a conflict

➢ „**how to get out from the scratch**" of the problem, disclosure (findings)and verbal definition of hidden assumptions

➢ **Win-Win** solution of the whole conflict = **injection !!!**

EC –definition (home study)

- The Evaporating Cloud (**EC**) is "by far the most often used of the thinking processes. This may be due to the fact that it is the easiest of the tools to learn.

- The cloud only has five entities, and it takes just a few minutes from start to finish.

- The tool is used for conflict resolution, and one thing we humans are not short on is conflict" (Scheinkopf, c1999 p. 171). The **EC** is responsible for a majority of the identified UDEs (Ronen, c2005 p. 27).

- The second diagram, the **EC**, shows different approaches to solving a problem. Each approach eliminates the other, while both attempt to reach the same goal.

- The first diagram, **CRT**, shows the current state, while the **EC** requires commitment to the path that management chooses and based on which consequences justifies its success.

EC creation (home study)

The process of EC creation is:

1. Articulate the problem and diagram the cloud.

2. For each arrow, uncover assumptions and identify potential solutions, using the necessary condition thinking process.

3. Choose an injection to implement (Scheinkopf, c1999 p. 173).

We have to solve another crucial question: the direction of solving a core problem

Requirement

Prerequisite

Objective

Necessary condition B to get A

Activity D

Goal **A**
(negation of the root problem)

Conflict

Necessary condition C to get A

Activity D´

Requirement
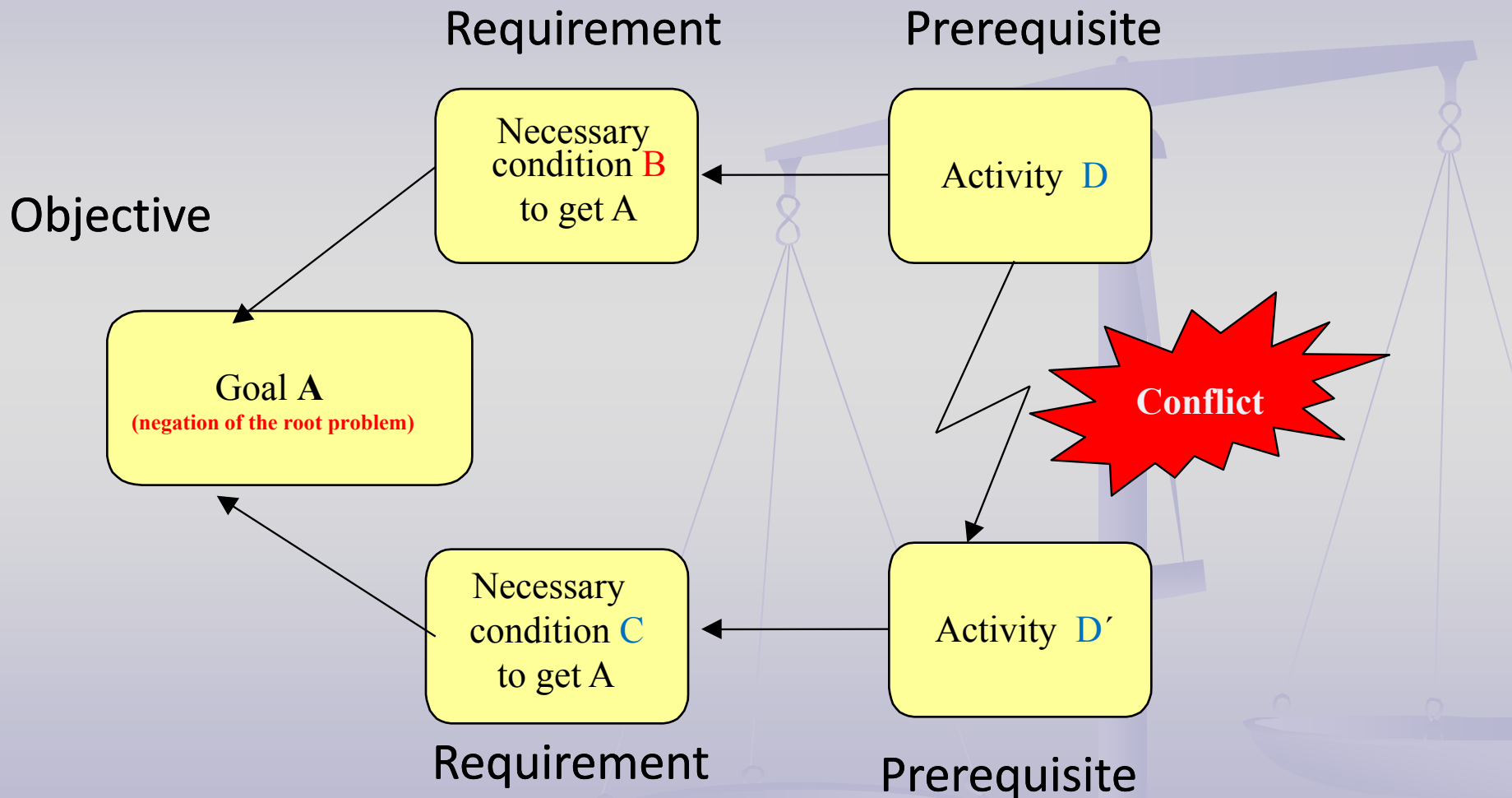
Prerequisite

Evaporating Cloud Tree (a conflict tree, a conflict resolution diagram)

How to read this Evaporation tree

In order to have objective A, we must have requirement B..

In order to have requirement B, we must have prerequisite D...

In order to have objective A, we must have requirement C...

In order to have requirement C, we must have prerequisite D'...

But prerequisites D and D' are in conflict... Like Fire and Water or **Night and Day**

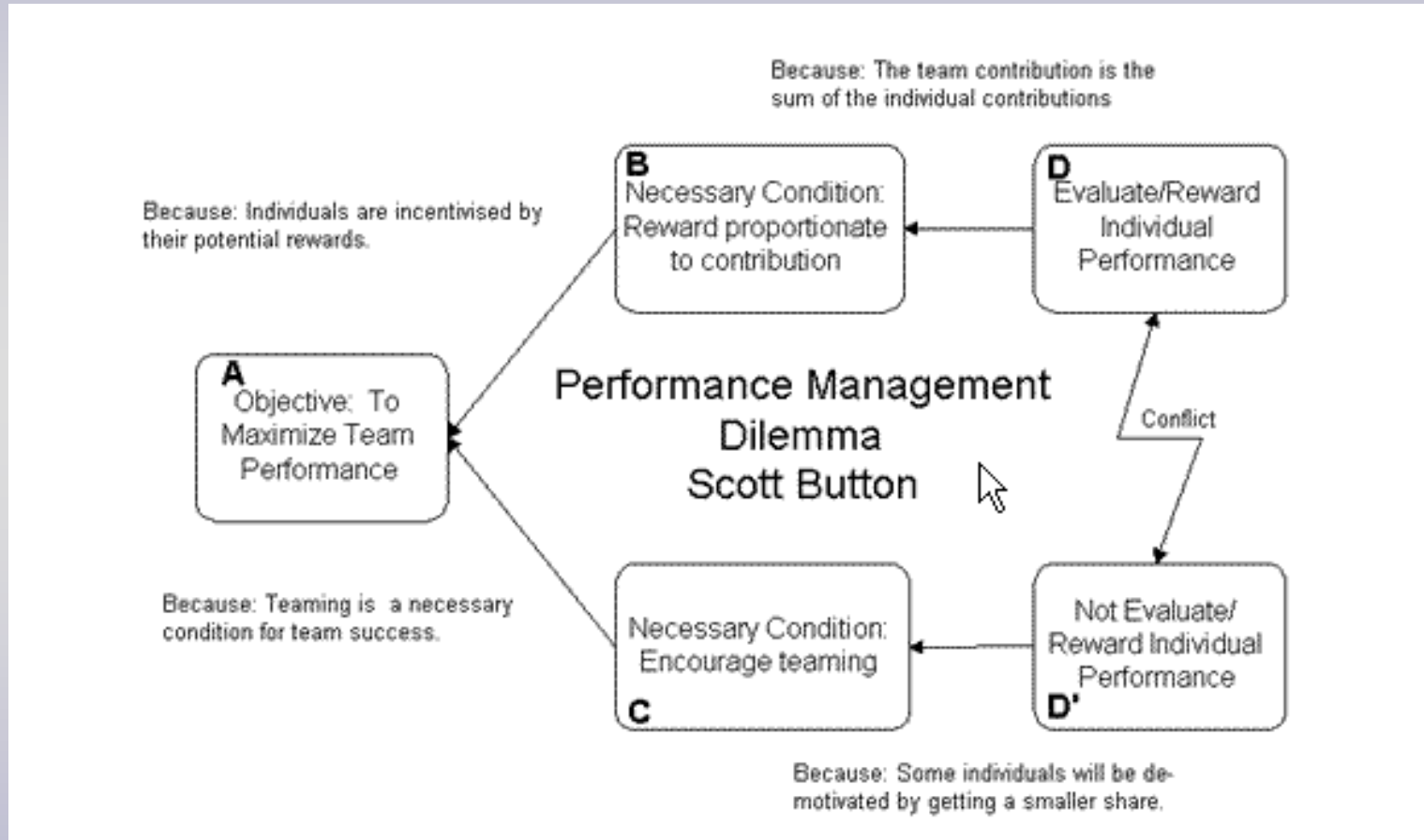# Evaporation cloud tree- example 1

Because: The team contribution is the sum of the individual contributions

Because: Individuals are incentivised by their potential rewards.

B
Necessary Condition: Reward proportionate to contribution

D
Evaluate/Reward Individual Performance

A
Objective: To Maximize Team Performance

Performance Management Dilemma
Scott Button

Conflict

Because: Teaming is a necessary condition for team success.

C
Necessary Condition: Encourage teaming

Not Evaluate/ Reward Individual Performance
D'

Because: Some individuals will be de-motivated by getting a smaller share.

Performance Management

Evaporation cloud tree- example 2

In order to fulfill B, I must D

B Necessary Condition: Understand the System

D Use Effect-Cause-Effect Logic

Read the cloud as follows: In order to fulfill A, I must have B

A Objective: To Manage (or Engineer) Well

TOC Implementation Dilemma
Scott Button

Conflict

On the other hand In order to fulfill A, I must have C

Necessary Condition: Use that which is familiar, comfortable, and has succeeded in **C** the past

Use Data, Intuition and Assumptions

D'

In order to fulfill C, I must D'
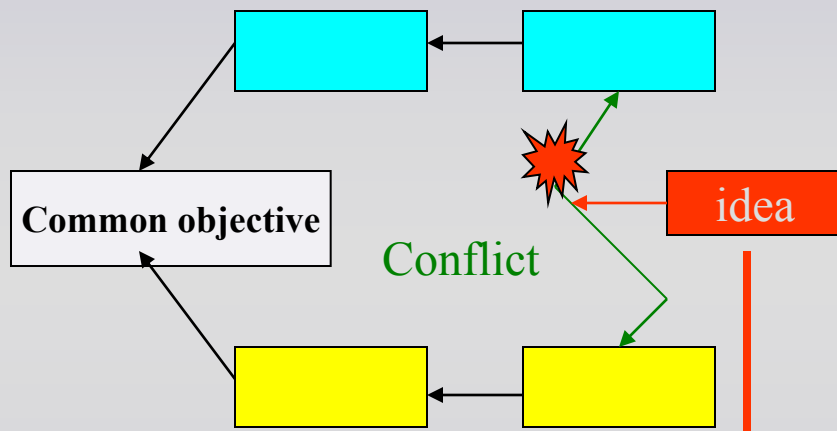
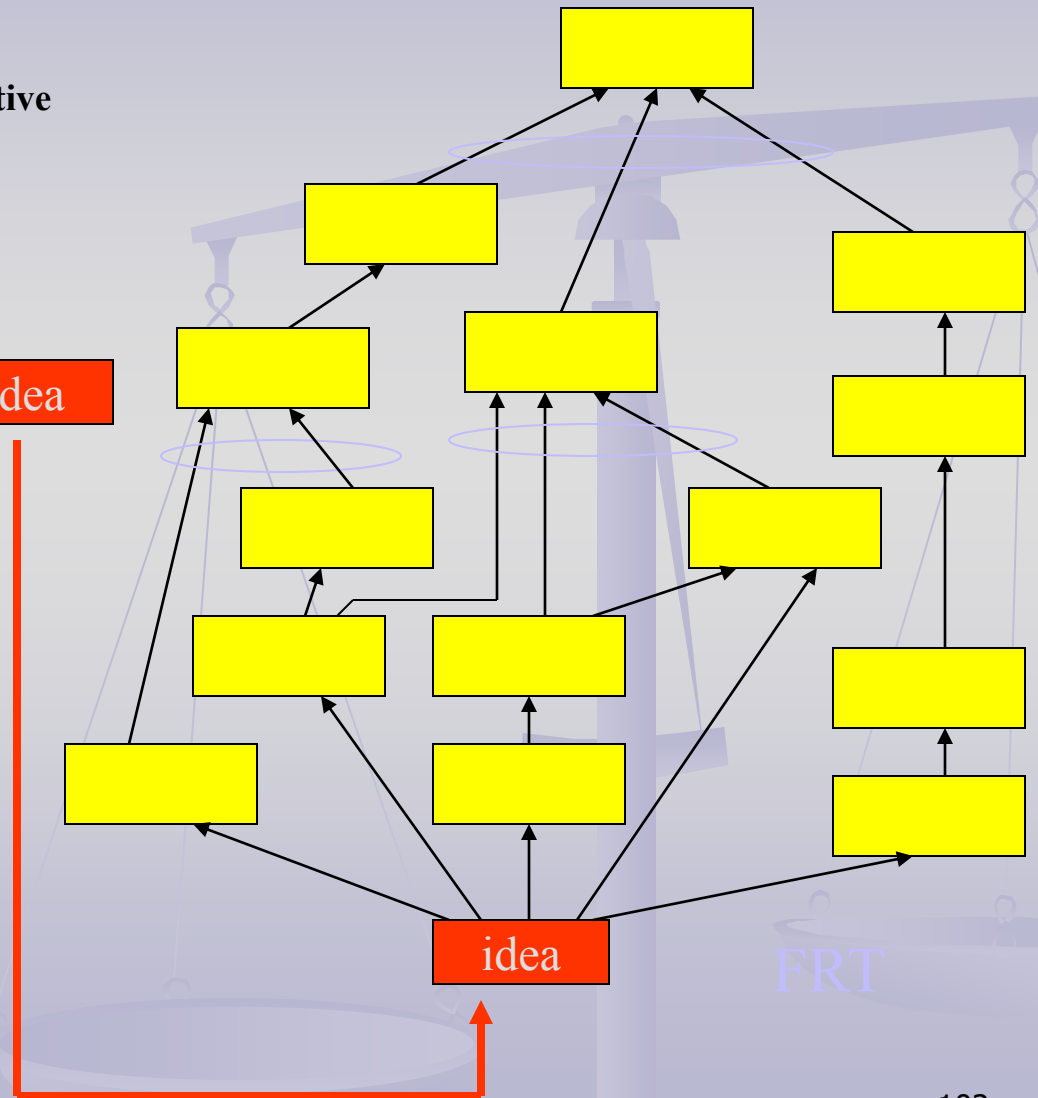## Implementation of TOC

Evaporation cloud tree- example 3
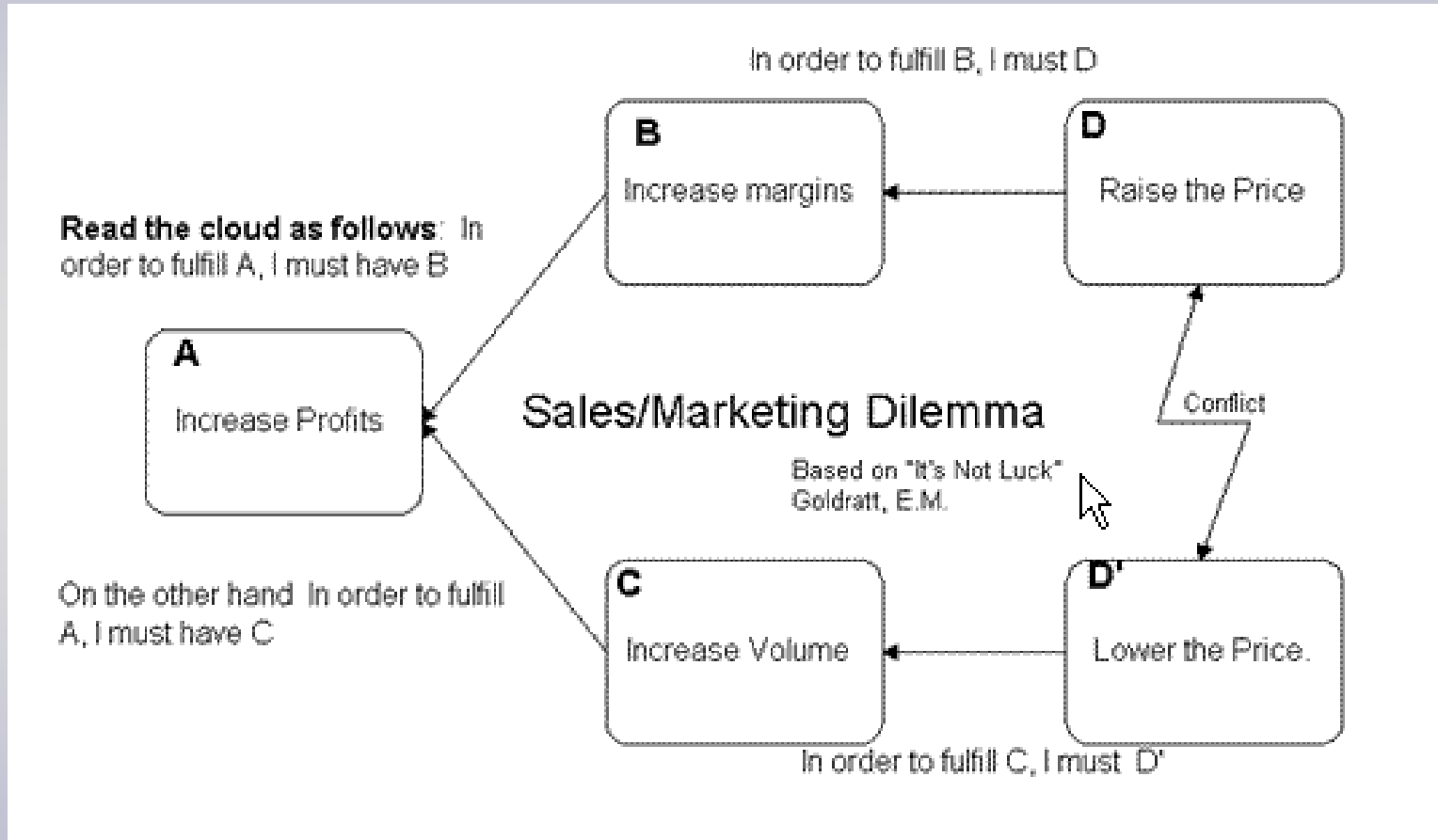
Sales and prices

Transition Evaporation Cloud Tree ➡ Future Reality Tree (FRT)
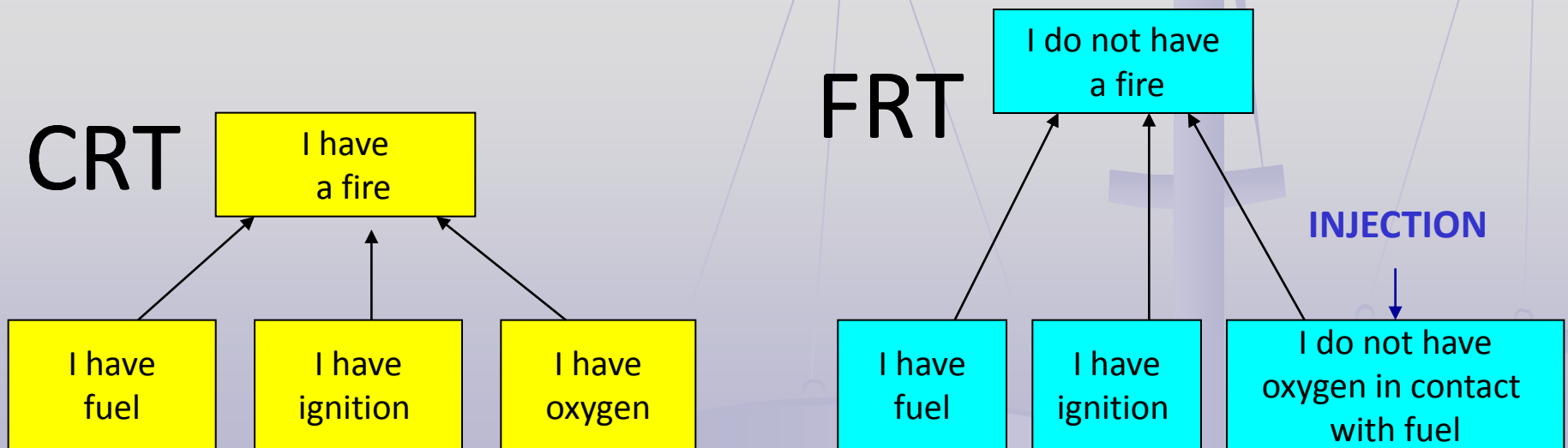
The opposite of root problem = Common objective

Conflict

Common objective

idea

Evaporation Cloud Tree

idea

FRT

Future Reality Tree (FRT)

- The FRT **is very similar** to the **CRT** in structure, but with new proposed actions, policies, and behaviour injected into it tocreate a new vision of the future reality of the system.

- The power of the logical "**if-then**" construction is that if any one of the lower-level causes are removed or mitigated, everything that is above it is subject to change.

- If any one of the three „IFs" are removed or modified, the „THEN" may be removed from consideration as a problem

CRT

I have
a fire

I have
fuel

I have
ignition

I have
oxygen

FRT

I do not have
a fire

INJECTION

I have
fuel

I have
ignition

I do not have
oxygen in contact
with fuel

FRT (home study)

- The Future Reality Tree (**FRT**) is a tool for logically visualizing the future through systematic transformation of the CRT.

- It presents the results from the planned implementation of healing injections that will eliminate the core conflict (Ronen, c2005 p. 33).

- The third diagram shows the future state and how it can be achieved. Based on the chosen strategy in EC, "healing injections" are used to enable processes causing the shift towards the desired state, achieved at the top of the FRT.

- FRTdiagram also heavily relies on the logical relationships of individual elements as well as their causality. The approach is purely theoretical, on higher levels of abstraction and assumes an ideal context. As a model, it however perfectly translates the situation, needs, and progress to the stakeholders.

- Every single decision we make, every single action we take, will change something in the future. The FRT is a tool for visualizing and predicting the future.

-

FRT (home study)

The FRT contains four parts:

1.   **Injections** are always entry points to the tree. They are entities that do not exist in the system's current reality and are distinguished from other entities by their squared corners.

2.   Entities that do currently exist in the system´s reality. In FRT, this type of entity will usually be entry points and is typically not found in the body of the tree.

3.   Entities that do not yet exist in the system. When entities that currently exist (2.) are combined with injections (1.), the (3.) entities will exist in the future.

4.   Reinforcing loops are often placed in future reality trees, as a means to create patterns of sustained and continuous improvement (Scheinkopf, c1999 p. 110).

How to create FRT (home study)

The steps to making a FRT are:

1. **Define the basis for the tree.**
   - a. Identify an injection (idea).
   - b. List the objectives (pro's) of the injection.
   - c. List potential undesirable consequences (con's) of the injection.
2. **Describe the effect-cause-effect relationships.**
   - a. Using sufficient cause thinking, connect the injection to the objectives.
   - b. Seek and block potential undesirable consequences of the injection.
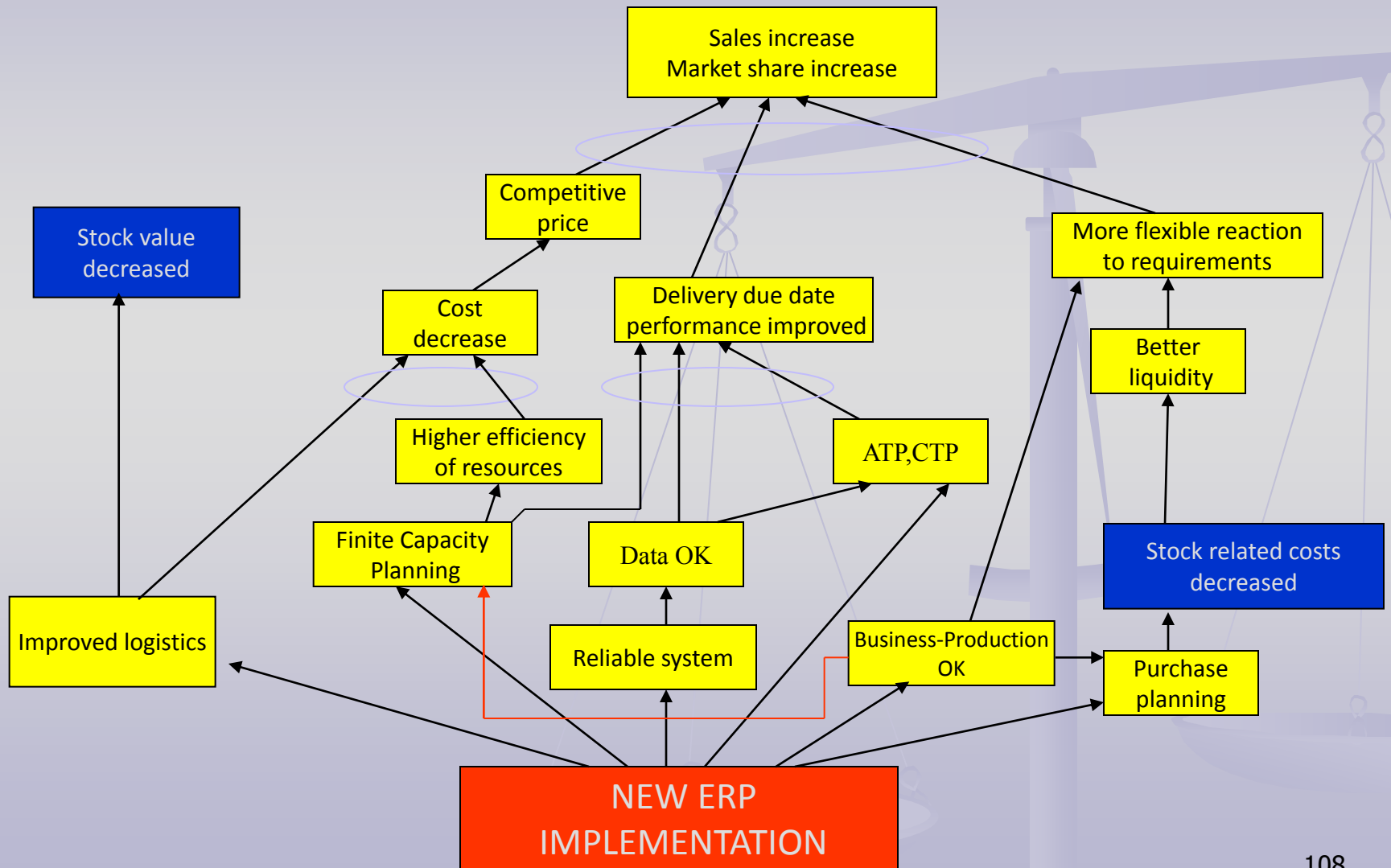3. **Enhance the solution.**
   - a. Predict additional effects.
   - b. Add reinforcing loops (Scheinkopf, c1999 p. 112).

Future Reality Tree (FRT)

- The objective of the FRT is to communicate a vision of how to change the undesirable effects found in the CRT to desirable effects.

DE- Desirable effect
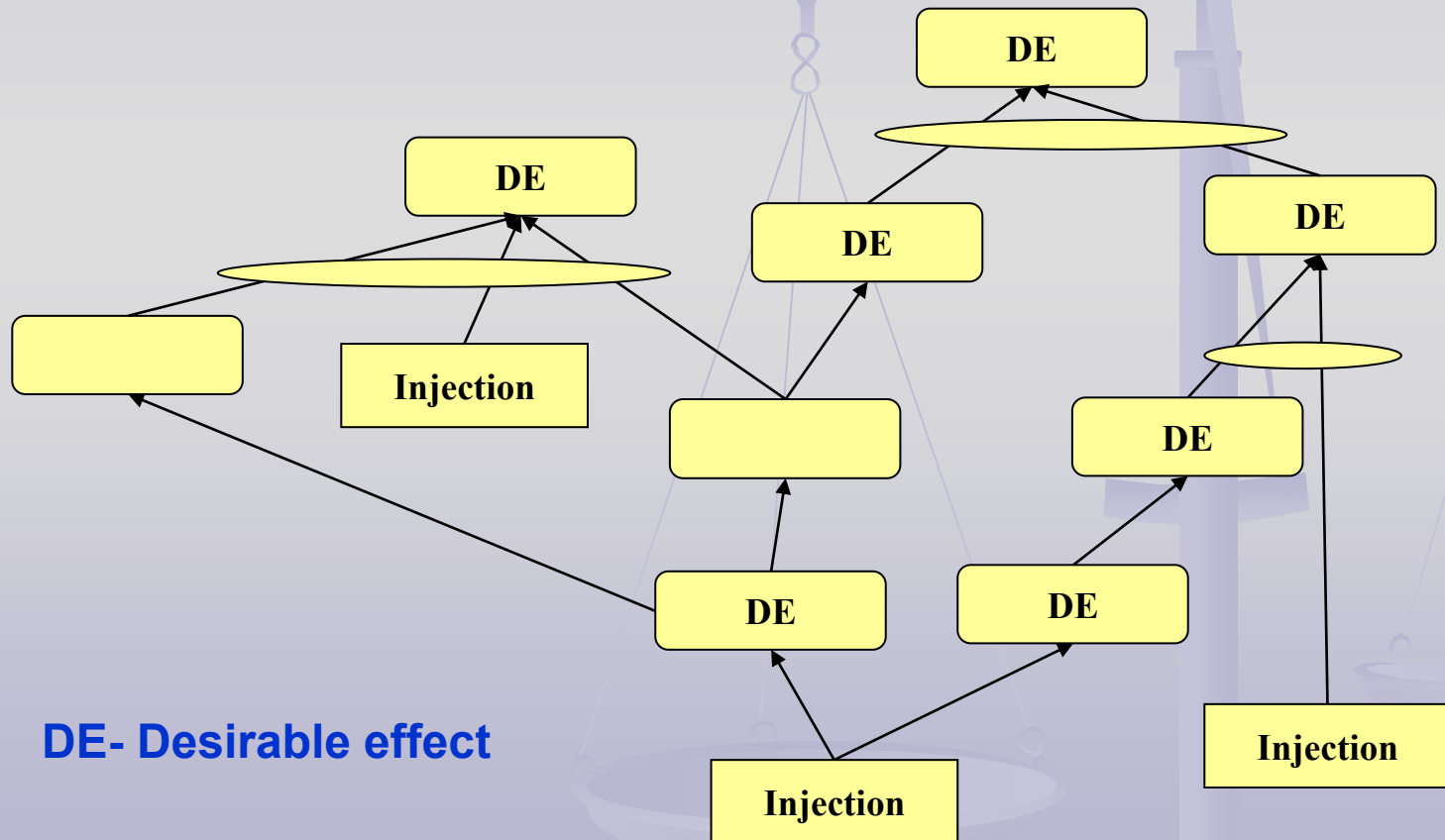
Future Reality Tree (FRT)

YES, this could be managed BUT……
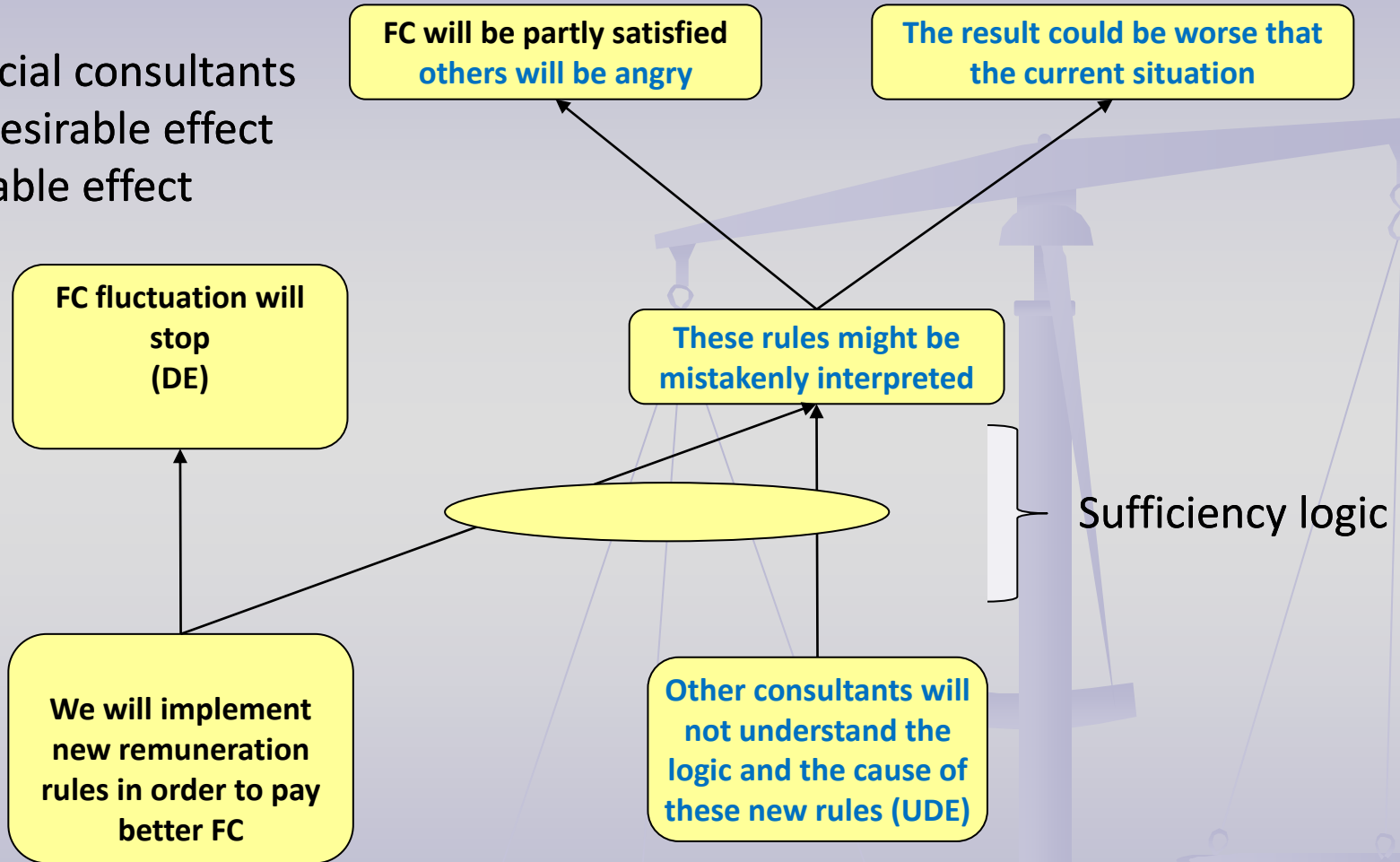
Negative Branch Reservations (NBR):

➤ use of **sufficiency logic** – by taking into consideration **objections** of other involved persons

➤ these objections were related to possible **undesirable impacts** of the injection (solution) implementation

➤ **NBR** is often a part of the **FRT** (**F**uture **R**eality **T**ree)

➤ Evaporation Cloud Tree, FRT and **NBR** enable to answer the second question : **To What To change ?**

➤ **or Where we are going ?**

Where Are We Going?

www.spousedates.com

Thinking like we always have is what got us where we are
It is not going to get us where we are going ! (A.Einstein)

YES, this could be managed BUT……

FC= financial consultants
UDE=undesirable effect
DE=desirable effect

FC will be partly satisfied others will be angry

The result could be worse that the current situation

FC fluctuation will stop (DE)

These rules might be mistakenly interpreted

Sufficiency logic

We will implement new remuneration rules in order to pay better FC

Other consultants will not understand the logic and the cause of these new rules (UDE)

Negative Branch Reservations example

We cannot implement it, because . . . . .

(Prerequisite Tree):

➤ use of **necessity logic** – identification of **obstacles**

➤ use of the human ability to invent **any reason**

   WHY IT IS NOT FEASIBLE

➤ setup of the necessary intermediate objectives

➤ setup of the schedule for change process

We cannot implement it, because. . . . .

(Prerequisite Tree):

- The pre-requisite tree ought to be considered **the most important tree** in the **Thinking Process** suite.

- It is the tree that allows us to overcome the **obstacles** that stop us from implementing our plan.

- It is also the tree that in fact becomes the **implementation plan** *(it is very, very close to project management practice !!!!)*

- And it is the tree to which timelines, responsibilities, and accountabilities can be assigned to.

- The pre-requisite tree occupies the position of "plan" amongst the Thinking Process tools.
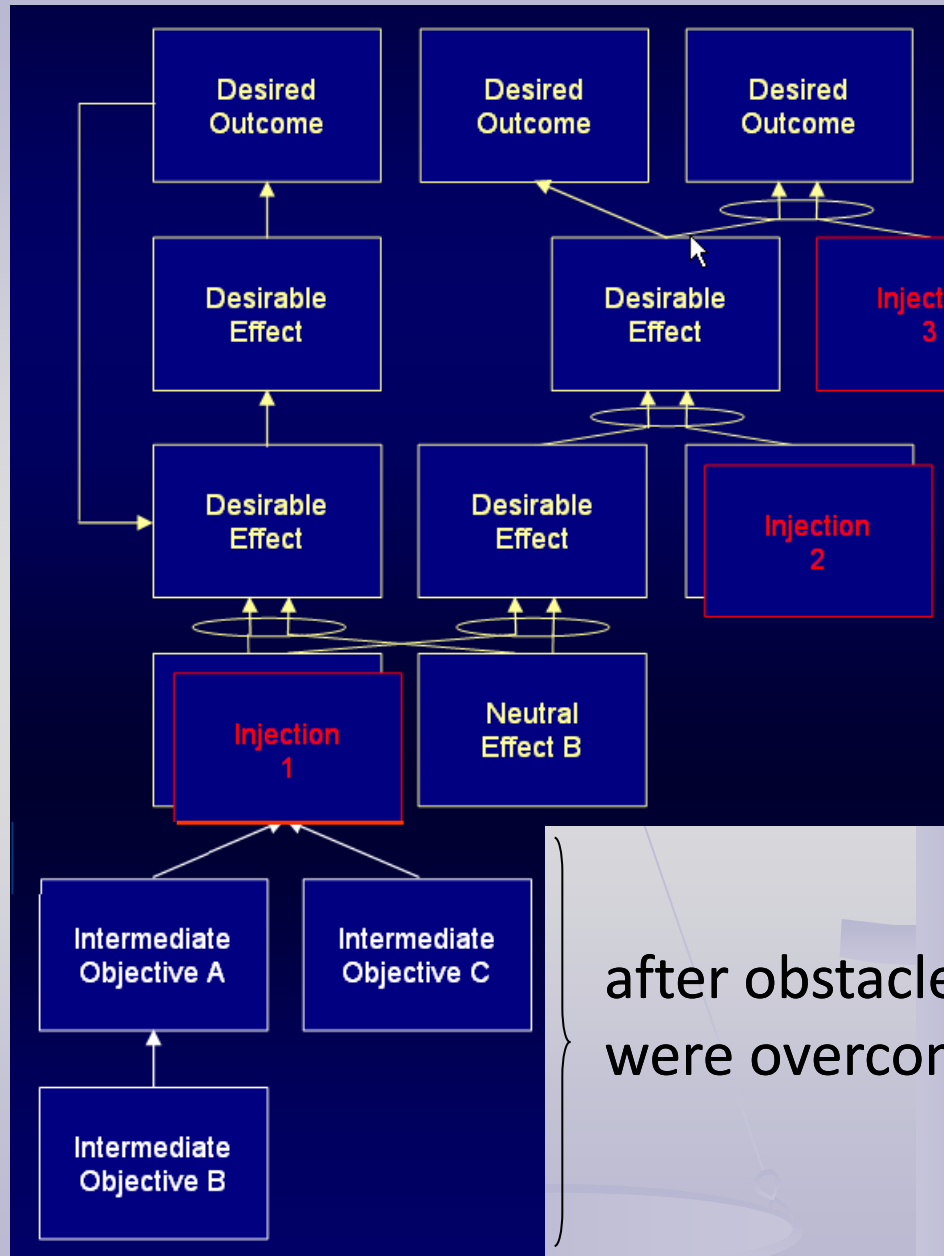
Prerequisite tree - construction

So our first step will look like this
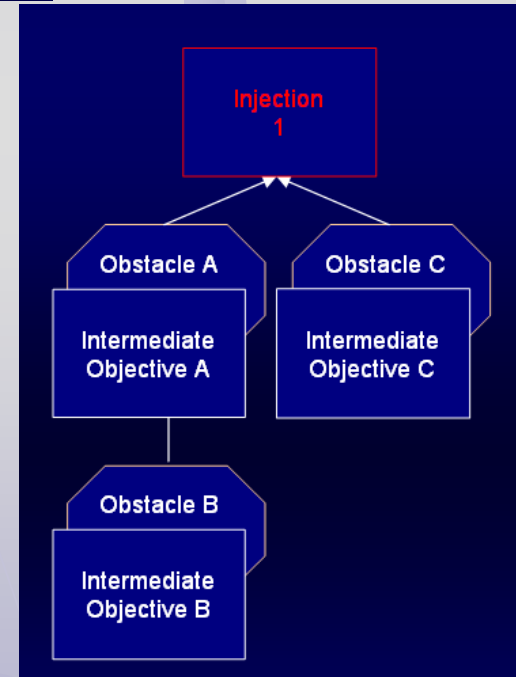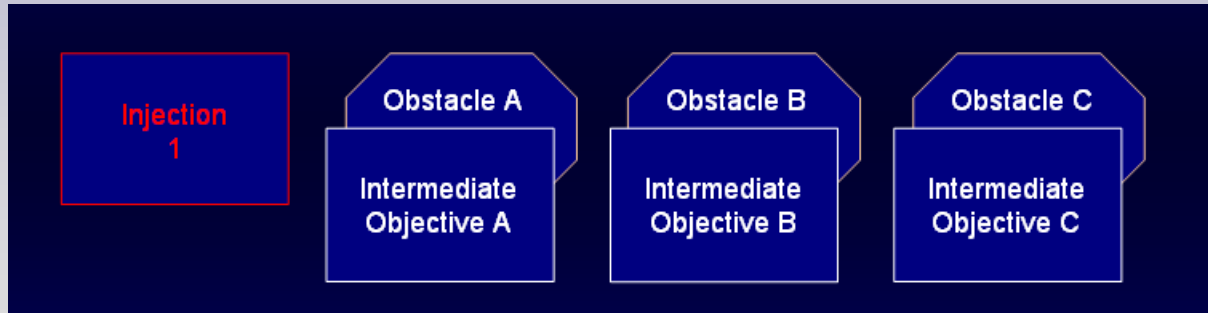
Objectives	Obstacles	Actions
Better reports	Not SW tool	Buy it
Improve liquidity	High Safety Stock	Optimization of ROP
Smart organization	Not Workflow Tool	Buy it or modify ERP

ROP=Reorder Point – see logistics theory

114

after obstacles
were overcome

Prerequisite tree - example

- **Tea Mission** (we want to have a nice cup of tea in the wilderness)

- **Obs-1** : We do not have material to burn
  Obs-2 : Collection of such material is not allowed in the wilderness.
  Obs-3 : There could be a strong wind
  Obs-4 : We do not have matches
  Obs-5 : We do not have cups
  Obs-6 : We don't have a container to boil the water

- **IO-1** : We have some pieces of wood in the trunk of the car.
  IO-3 : We have a sheltered place to light the fire
  IO-4.1 : We have a packing list for the tea activity
  IO-4.2 : The tea kit is loaded into the car

  IO= intermediate (partial) objective
  Obs= obstacle
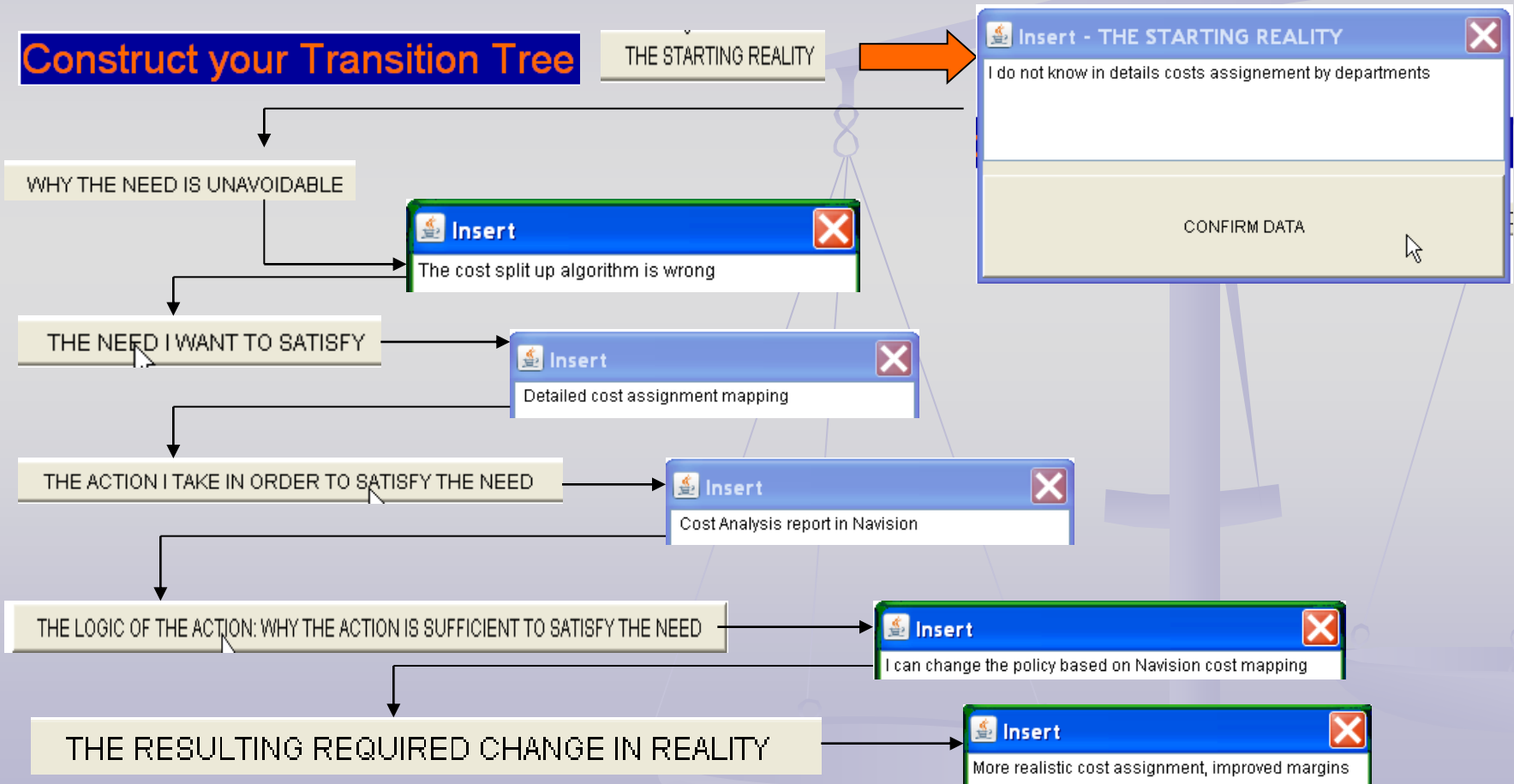
Prerequisite tree - example
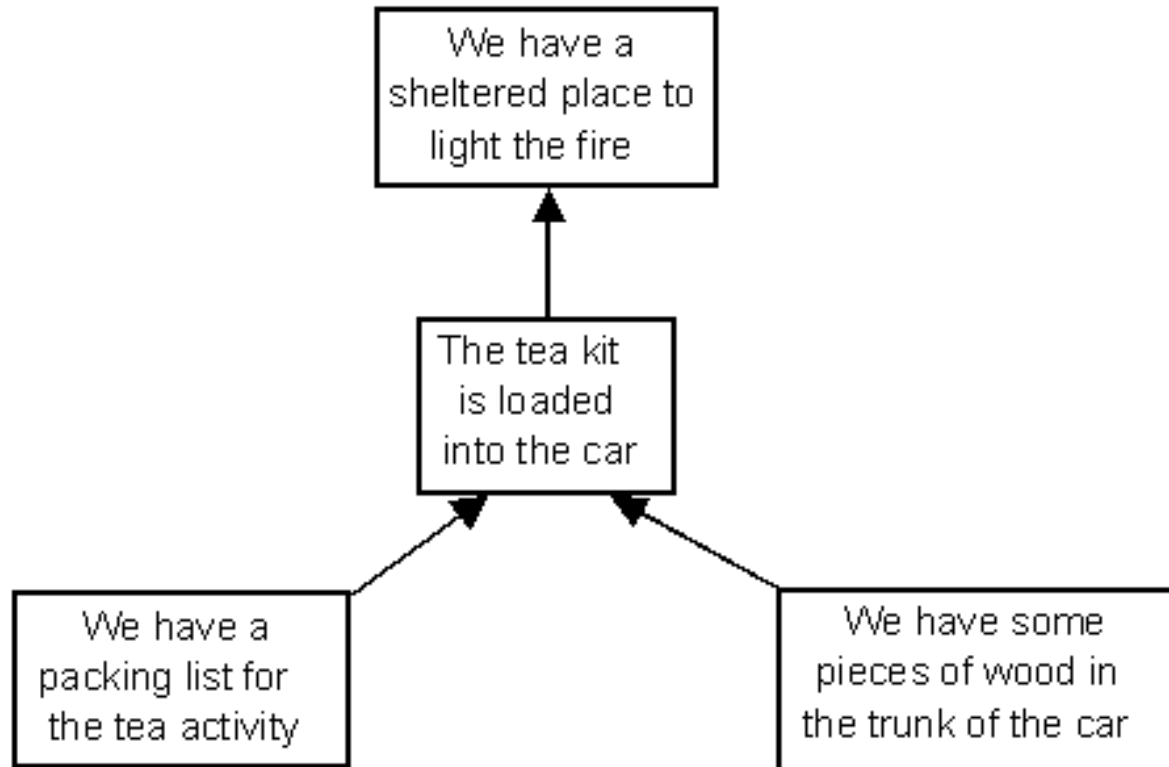
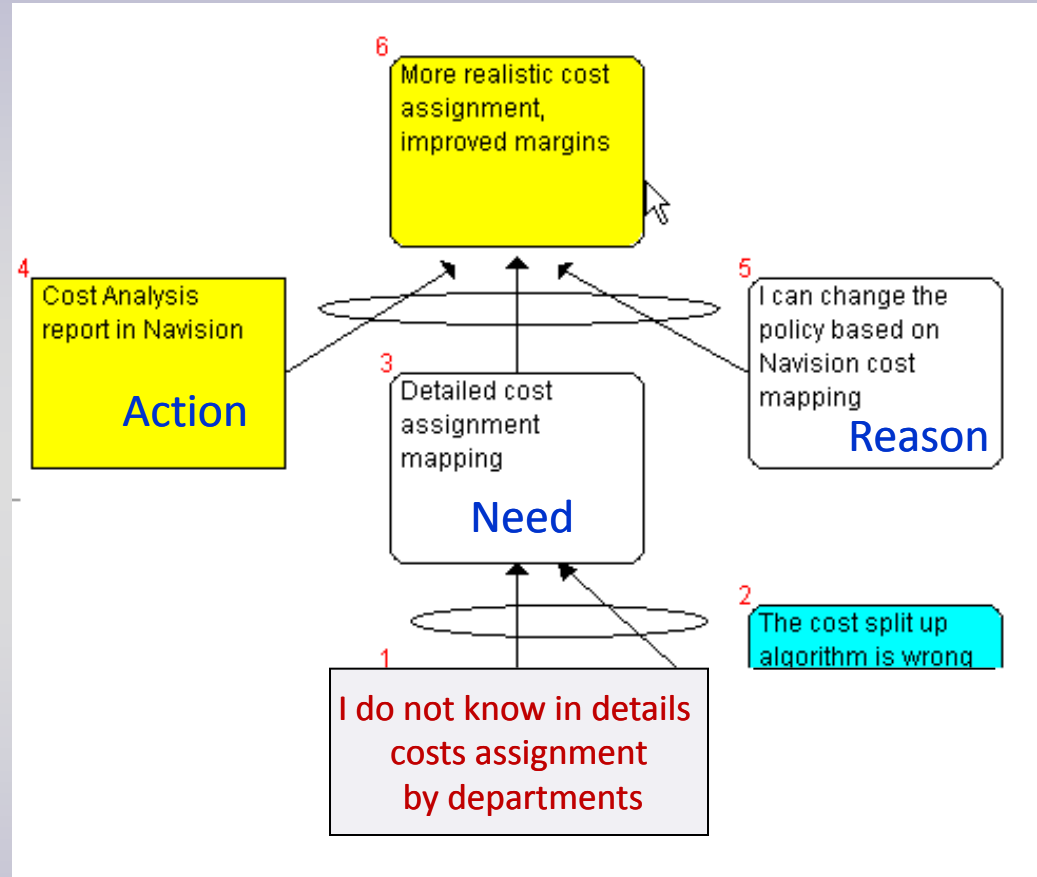## We cannot implement it, because . . . . .

(Transition Tree):

➢ detailed schedule of change implementation process

➢ what actions have to be taken in order to reach intermediate objectives using sufficiency logic (IF-THEN-ELSE)

We cannot implement it, because….. HOME study ONLY !!!!
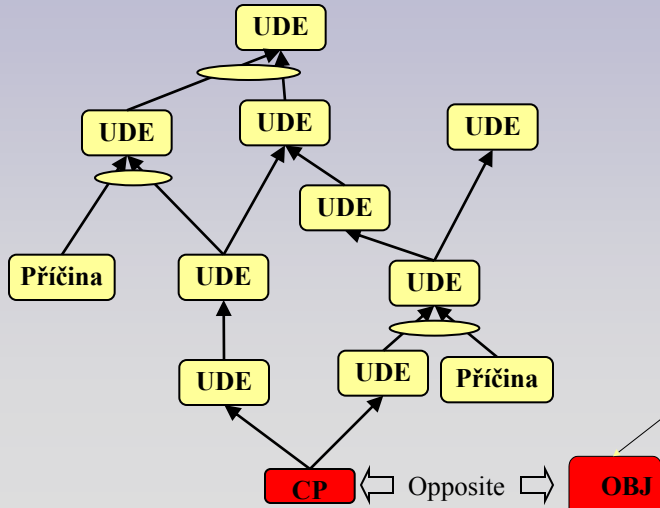
(Transition Tree) http://www.thedecalogue.com/Tools/trt/TREE.html:

We cannot implement it, because…..

Thinking Process Tools Relationships

CRT

UDE

UDE

UDE

UDE

UDE

Příčina

UDE

UDE

UDE

UDE

UDE

Příčina

CP ⇦ Opposite ⇨ OBJ

Evaporating cloud tree

FRT

DE

DE

DE

DE

Injection

DE

DE

DE

DE

DE

Injekce

Injekce

Top Objective=injection

NBR-

UDE (DE)

UDE (DE)

Injekce

Injekce

Injection

OB 5

OB 3

OB 4

IO 7

IO 6

TT

IO 2

REASON   NEED   ACTION

IO 1

REASON   NEED   ACTION

IO 2

OB 1

OB 2

IO 4

IO 5

Prerequisite tree

Starter

IO 3

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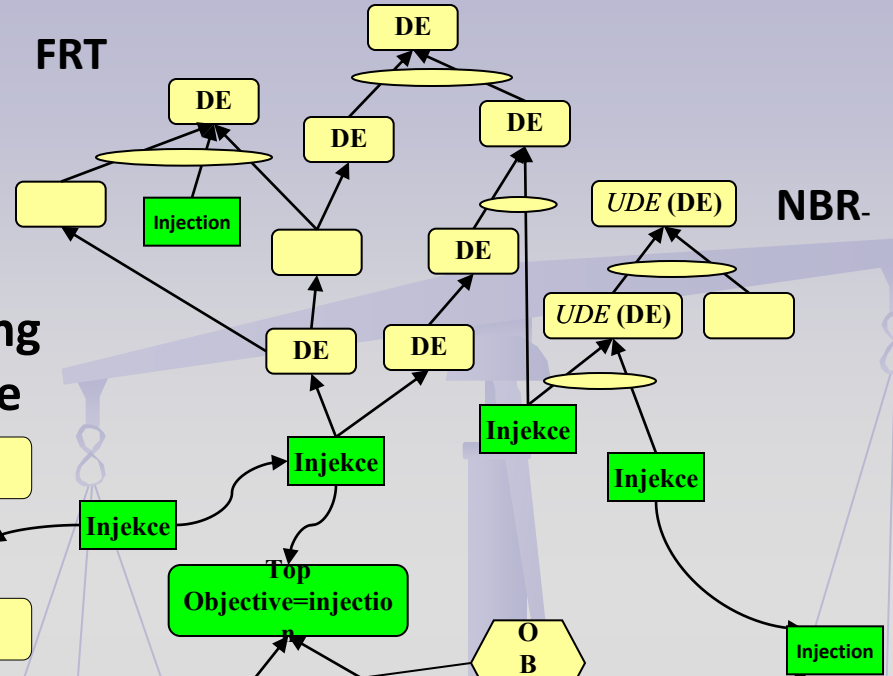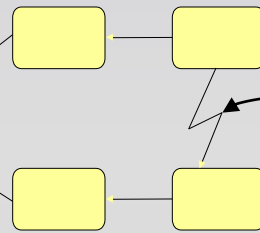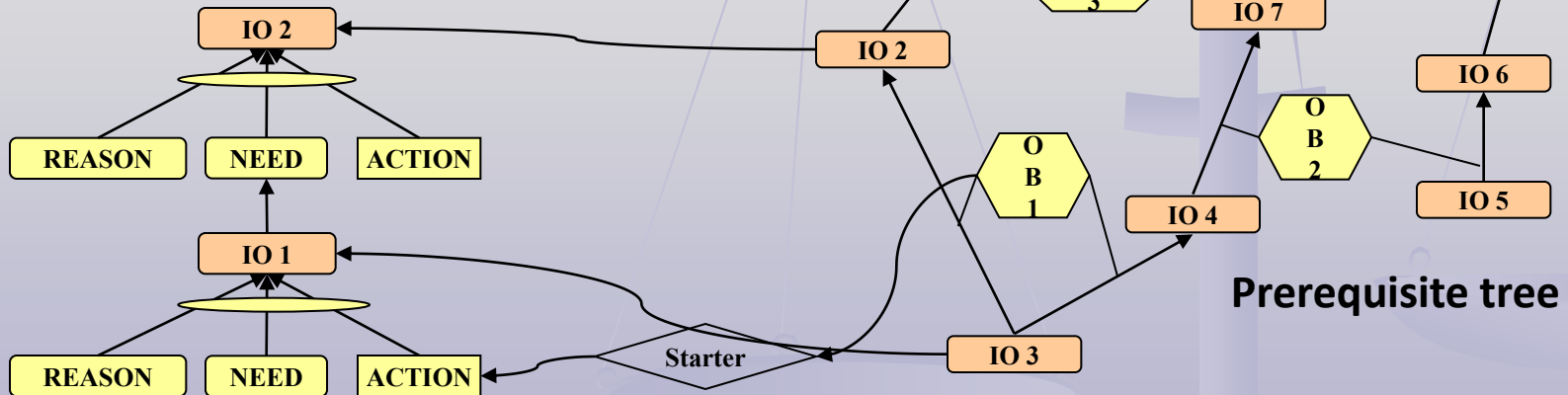
Additional metrics of TOC (appendix 1)

Inventory dollar days (IDD)

A measure of the effectiveness of a supply chain – i.e., did it do things that it shouldn't have done and as a result is the supply chain holding inventory of products the customer doesn't want? **IDD** accounts for two things:

1. the time from when a unit is placed in stock until it is actually needed by a customer and

2. the monetary value of the inventory being held. **IDD** is calculated by multiplying the monetary value of each inventory unit on hand by the number of days since that inventory entered the responsibility of that link. The system should strive for the minimum IDDs necessary to reliability maintain zero throughput dollar days.

NOTE: The resulting unit of measure is "dollar-days". It is neither monetary nor time based. Attempts to compare dollar-days to other monetary measures are invalid. IDDs can be compared only to other IDD levels.

# Additional metrics of TOC (appendix 2)

Throughput dollar days (TDD)

A measure of the reliability of a supply chain. TDD considers two things:

1.the monetary value of the things a link is committed **to deliver but does not** and

2. the number of days by which the link misses its commitment to deliver. TDD is the summation of the commitments not delivered on time during the chosen time period. The TDD value of individual missed commitments is calculated by multiplying the dollar value of the end product times the number of days the commitment is/was overdue. The system should strive for zero throughput dollar-days.

- NOTE: The unit of measure "dollar-days" is neither monetary nor time based. Attempts to compare dollar-days to other monetary measures are invalid. TDD levels can be compared only to other TDD levels.

Literature

Goldratt, E., M.:

- The Goal
- The Race
- The Critical Chain
- Necessary But Not Sufficient
- The Haystack Syndrome
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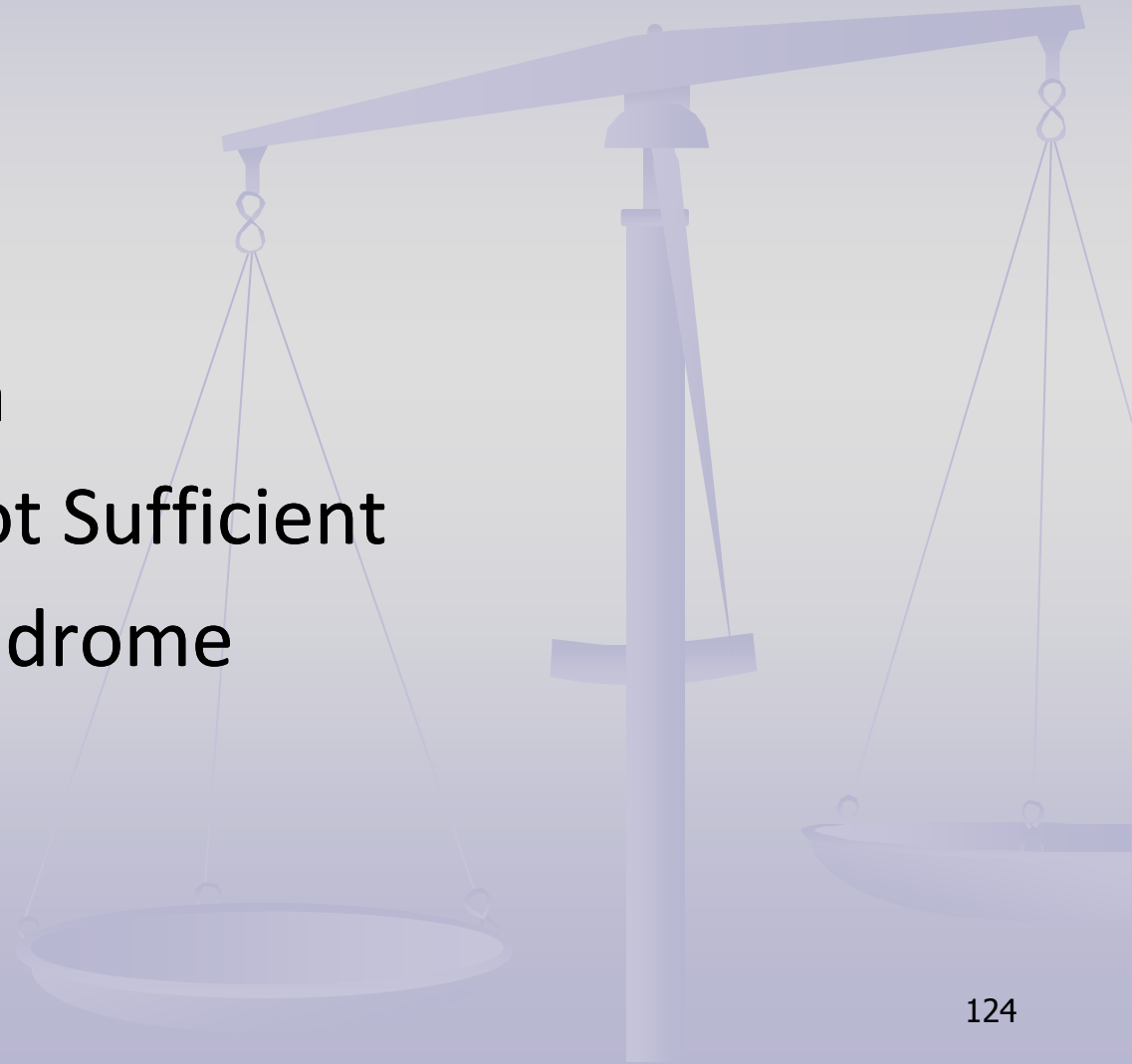
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