



TOCICO

TOC Fundamentals Exam

Review Session

Written and Presented by: C. Grant Lindsay and Richard Reid

Date: Nov 2006

Note: Some slides in this presentation have been used or adapted, with permission, from a presentation developed by Alan Barnard.

Workshop Deliverables

- **TOC-ICO certification structure overview.**
- **Discuss fundamental TOC concepts.**
- **Suggestions for successfully completing the exam.**
- **Review of some sample exam questions.**
- **Provide an opportunity to answer and discuss some illustrative exam questions.**
- **Answer your questions.**





TOCICO CERTIFICATION ROADMAP

TOCICO Certification for “Practitioners”

**TOCICO Certified
PRACTITIONER**

Step 2 - Pass Application Exam
*Demonstrate expert level analysis & **APPLICATION**
ability in specific TOC application by passing
TOCICO Application Exam*

TOCICO Certification for “Implementers”

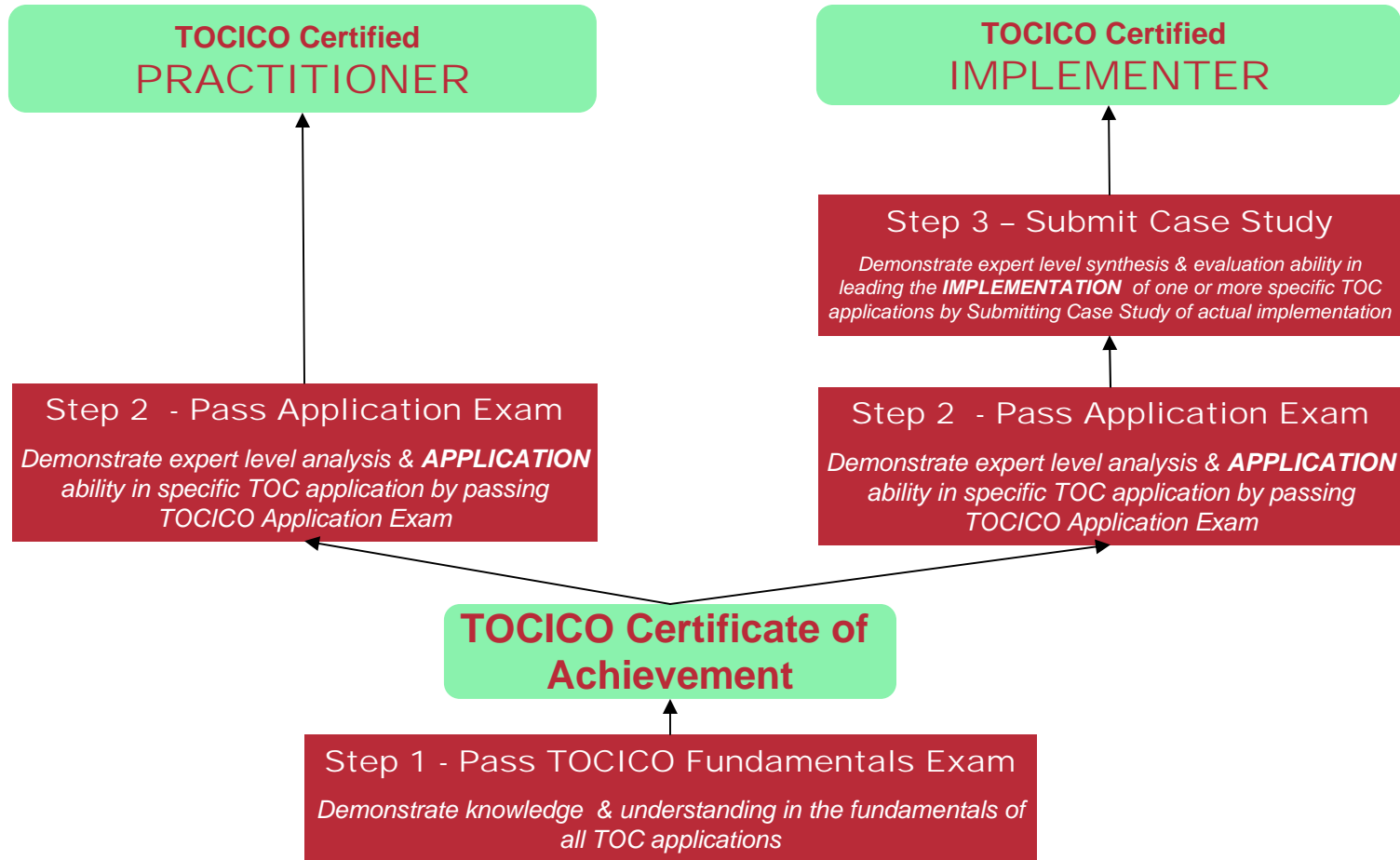
**TOCICO Certified
IMPLEMENTER**

Step 3 - Submit Case Study
*Demonstrate expert level synthesis & evaluation ability in
leading the **IMPLEMENTATION** of one or more specific TOC
applications by Submitting Case Study of actual implementation*

Step 2 - Pass Application Exam
*Demonstrate expert level analysis & **APPLICATION**
ability in specific TOC application by passing
TOCICO Application Exam*

**TOCICO Certificate of
Achievement**

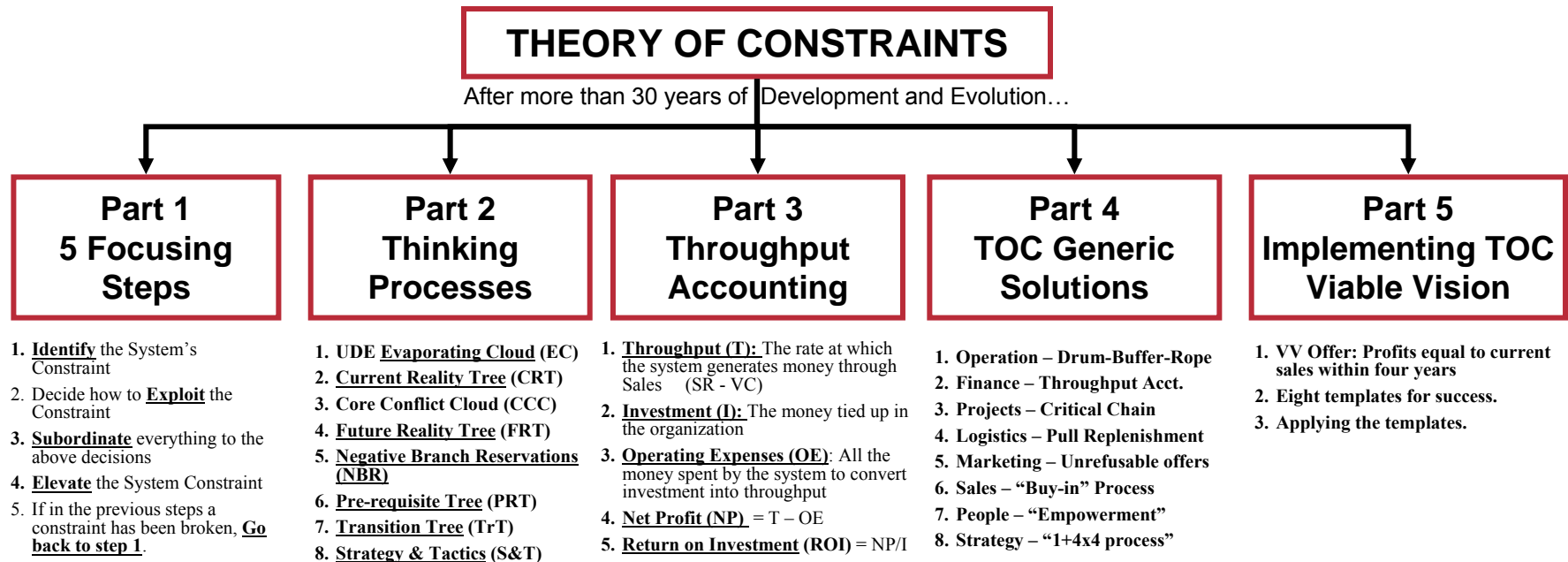
Step 1 - Pass TOCICO Fundamentals Exam
*Demonstrate knowledge & understanding in the fundamentals of
all TOC applications*



TOC Fundamentals

What is Theory of Constraints?

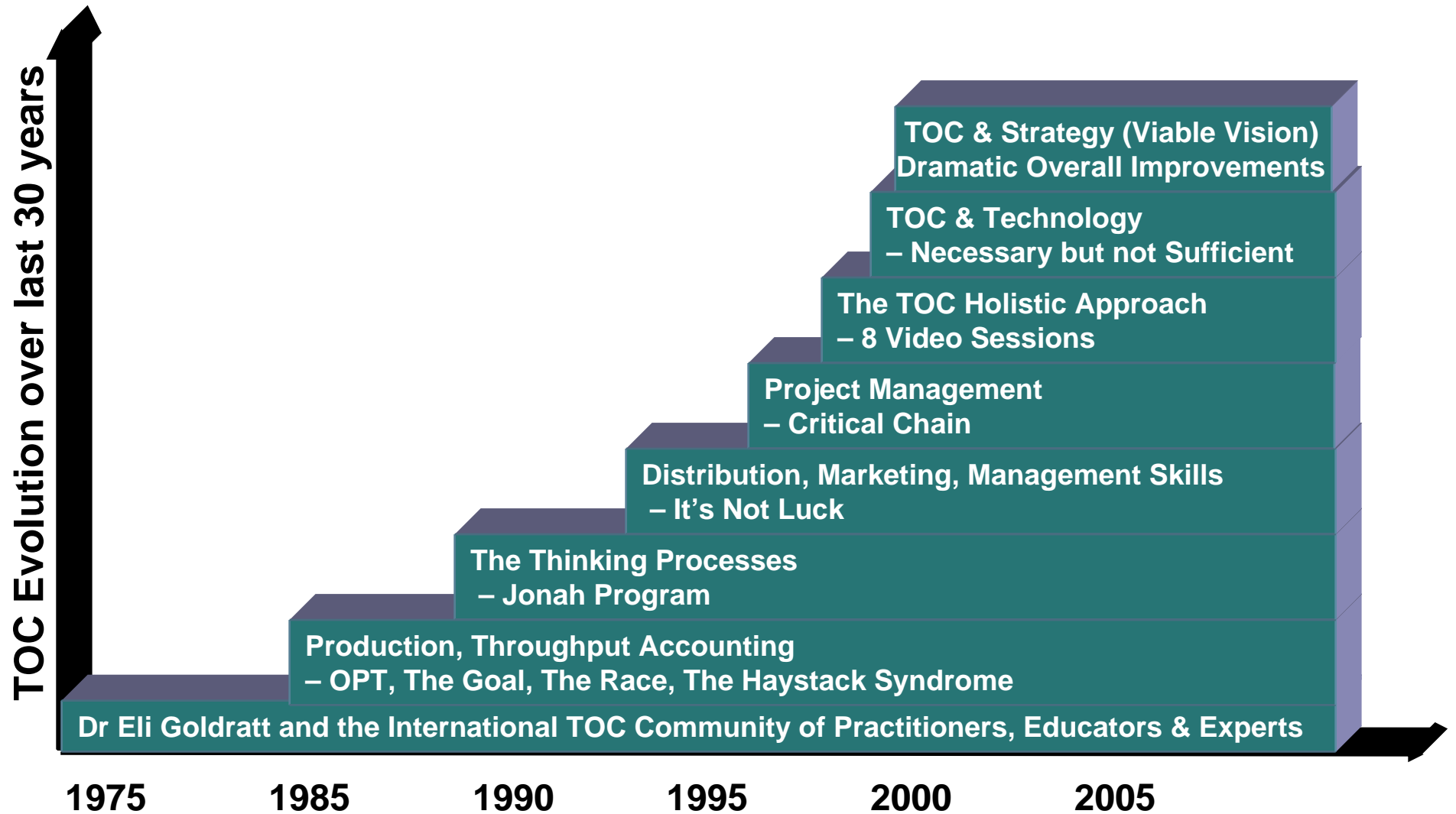
Theory of Constraints provides a set of Holistic processes and rules, all based on a Holistic/Systems approach, that **simplifies the complexity** of improving and managing complex organizations through **FOCUSING** on the **FEW** physical & logical constraining **“LEVERAGE POINT(S)”** and building the necessary & sufficient **“LEVERS”** (holistic rules) that will **SYNCHRONIZE** the parts to achieve an ongoing & step change improvement in the performance of the system as a whole...



TOC Fundamentals

The Evolution of TOC over 30 years

TOC Fundamentals



Keys to Writing a Successful Exam

The Fundamentals Exam (FE) is structured to ascertain your knowledge and understanding of basic TOC tools and concepts.

Some requirements for successfully completing the FE include:

- 1. Knowledge** of the steps in TOC improvement approaches.
- 2. Understanding** of basic TOC principles concepts and tools.
- 3. Application** of TOC improvement approaches and tools to specific scenarios.

Some Suggestions for Writing a Good Exam

- **Carefully read and understand the question**
- **Ask yourself what is given and what is being requested**
- **If question seems unclear, then record relevant assumptions before writing your answer**
- **Answer all parts of the question**
- **Relate the question to your answer**
- **Show your work where applicable**
- **Do not provide excessive information that has not been requested**

TOCICO Fundamentals Exam Outline

Part A – TOC Fundamentals

- **Simple vs. Complex Systems**
- **Global vs. Local Improvement**
- **The Five Focusing Steps**

Part B – TOC Thinking Processes

- **The Change Sequence: Answering Three Questions**
- **UDEs, Conflicts and Injections**
- **Negative Branch Reservations**
- **Resistance to Change**

Part C – TOC Applications

- **Supply Chain and Operations**
- **Finance and Measurement**
- **Project Management**

Part A – TOC Fundamentals

Achieving a Process of Ongoing Improvement

“Every Improvement is a Change, but not every Change is an improvement...”

1. How can we know whether a planned “change will result in an improvement for the system as a whole”?
2. How can we achieving a process of ongoing improvement?

Strengthening the “Weakest Link”...

The Theory of Constraints (TOC) make the case that a change will only be a **total system improvement** if the change improves or protects the performance of the **System Constraint (the weakest link)**.

Therefore, to measure the impact of our recommended change, we should **identify the expected impact on the System Constraint** and therefore on increasing the flow of goal units through the system.

In TOC, we use the **Five Focusing Steps** and the **measure progress with the 3 Global Performance Metrics: (1) Throughput (Sales – Variable Cost), (2) Investment/Inventory and (3) Operating Expense** to drive and enable a Process of Ongoing Improvement.

A Focused Process for Breakthrough and Continuous Improvement

5 Focusing Steps of the Process of Ongoing Improvement (POOGI)

Step 0: Agree on the **System GOAL** (& to define "constraint" and goal metrics)

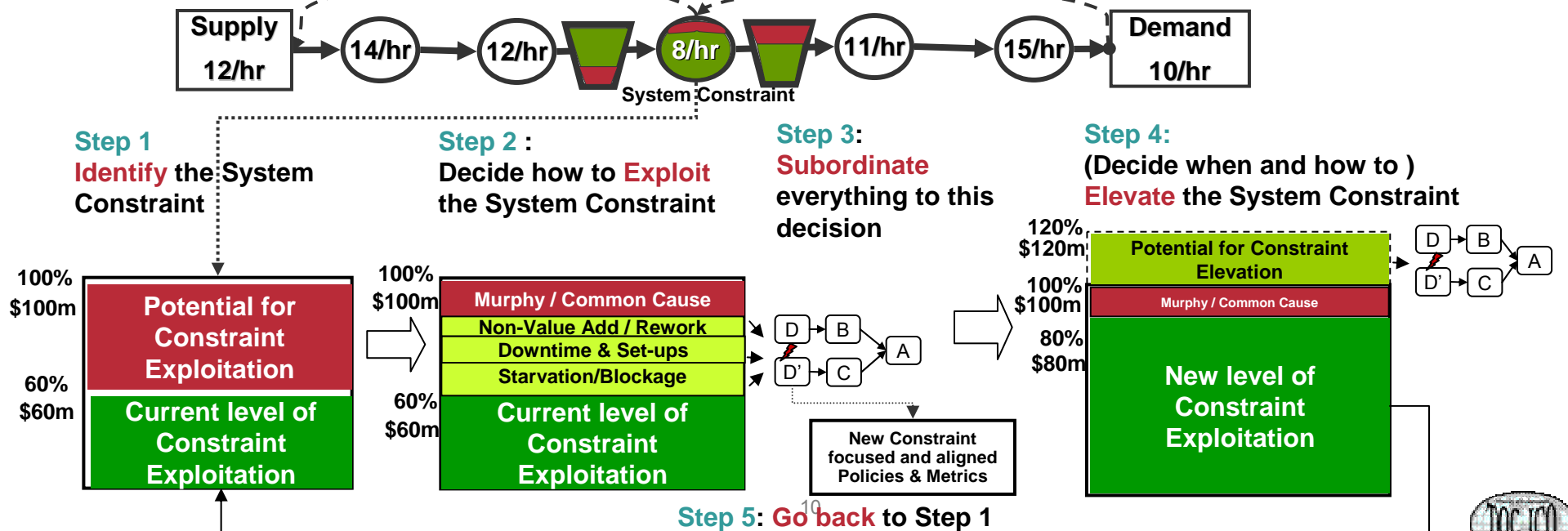
Step 1: **IDENTIFY** the System Constraint (the Weakest Link)

Step 2: Decide how to **EXPLOIT** (i.e. not Waste) the System Constraint

Step 3: **SUBORDINATE** everything to the above decision

Step 4: **ELEVATE** the System Constraint

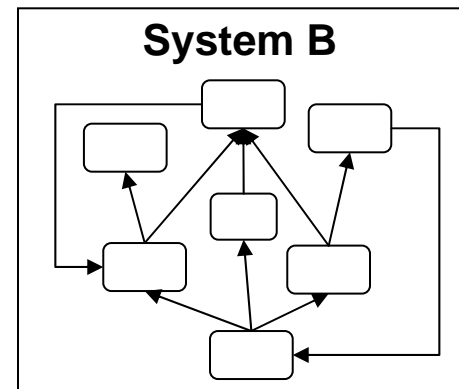
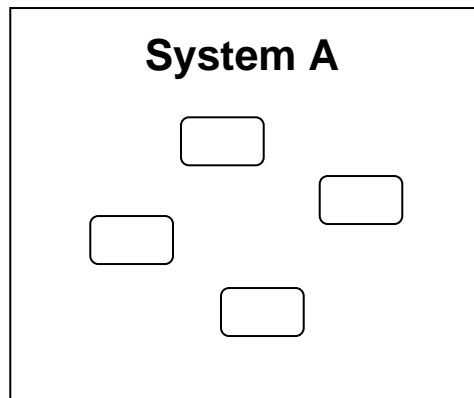
Step 5: If the constraint was removed in previous steps, **GO BACK** to Step 1



Part A – TOC Fundamentals

Problem A1

- a) Which is more complex: System A or System B?
- b) Explain why you claim this to be true?



Please indicate your answer using a "X" next to the statement you believe is correct:	
a)	System A is more Complex <input type="checkbox"/>
b)	System B is more Complex <input type="checkbox"/>
Explain the reason for your above answer in the space provided below:	

Part A – TOC Fundamentals

Problem A2

- a. What is the implication of the TOC definition of a “complex system” on the way TOC experts analyze, manage and improve complex systems?
- b. True or False – Explain your answer: Any complex system is based on “inherent simplicity” and capitalizing on this fact is what enables incredible performance improvements within a short time.

Answer to A2a:

Answer to A2b:

Part A – TOC Fundamentals

Problem A3

- a. What are the 5 focusing Steps we use in TOC to achieve a Process of Ongoing Improvement?
- b. Explain how the 5 Focusing Steps specifically applied to managing a specific scenario:

Answer to A3a:

Answer to A3b:

Part A: Concept Review

- **TOC is a systemic-based management approach**
- **Simple vs. Complex Systems**
- **Global vs. Local Improvement**
- **The Five Focusing Steps in POOGI – Be able to:**
 1. **Understand this improvement process**
 2. **Apply this focusing process**

Section B

TOC

Thinking Processes

Part B – TOC Thinking Processes

What to Change?

- Identifying **UnDesirable Effects** (UDEs) within a System.
- Defining the **Conflict** that blocks us from removing the UDEs.

To What to Change?

- Finding **Injections** that can resolve the Conflict.
- Identifying potential **Negative Effects** of a new Solution.
- Constructing the “Cause-Effect” or **Negative Branches** between the Solution and Predicted UDE.
- Finding **Injections** that can prevent or minimize the risk of the Negative Branch Reservation (NBR).

How to Cause the Change?

- Identifying Implementation **Obstacles** for the new Injections.
- Determining the sequence of **Intermediate Objectives** (IOs) to be achieved to overcome these obstacles with a **Prerequisite Tree** (PRT)
- Construct a **Detailed Roadmap** via a **Transition Tree** (TRT) showing actions needed to overcome dependencies between successive IOs.

Part B – TOC Thinking Processes

System Evaluation & Overcoming Resistance to Change

TOC uses a systematic approach based on the answers to **3 questions (change sequence)** to analyze systems and overcome each of **6 layers of resistance** using a set of logical thinking processes to get the buy-in and active collaboration from all the key stakeholders.

WHAT TO CHANGE?

Layer 1: Agree on the **Core Problem and Constraint** causing the Undesirable Effects.

TO WHAT TO CHANGE?

Layer 2: Agree on the **Direction of the Solution** to remove the Core Problem & better exploit and or elevate the physical system “constraint”.

Layer 3: Agree the **Proposed Solution** will achieve the Desirable Effects and Strategic Objectives.

Layer 4: Ensure that all significant **Negative side-effects (1st Yes, Buts...)** have been surfaced and addressed.

HOW TO CAUSE THE CHANGE?

Layer 5: Ensure that all **Obstacles (2nd Yes, Buts...)** to implementation have been surfaced and addressed in a **detailed action plan**.

Layer 6: Overcome any **Unforeseen inertia or unidentified obstacles**, that will limit or prevent the change from occurring (Un-verbalized fear).

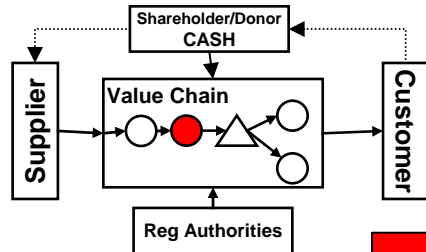
Part B – TOC Thinking Processes

System Evaluation TP Tools

TOC Fundamentals

Step 0. System Goal & Definition Process

Improvement Objective: ↑NP and ↑ROI
Improvement Metrics: T, I, OE, CF

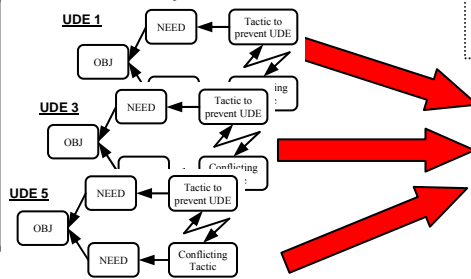
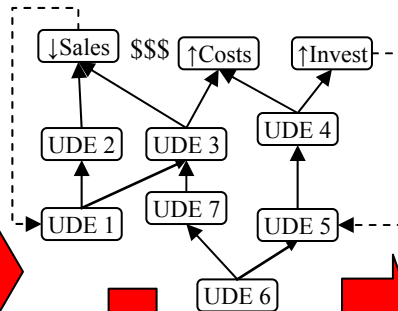


Step 1. List of Undesirable Effects and Desirable Effects

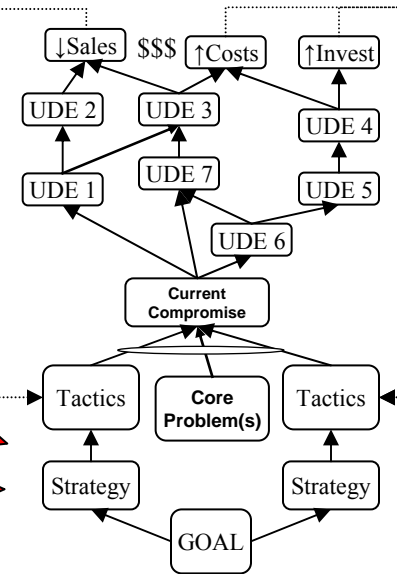
AREA	UDE	IMPACT	DE
Sales	UDE1	Reduced Sales	DE1
Finance	UDE2	Increased Costs	DE2
Logistics	UDE3	Increased Inventory & reduced cash	DE3
R&D	UDE4	Increased Time to Market Lead Time	DE4
Marketing	UDE5	Reduced Sales	DE5

Step 2. UDE Map & 3 UDE Conflict Cloud Process

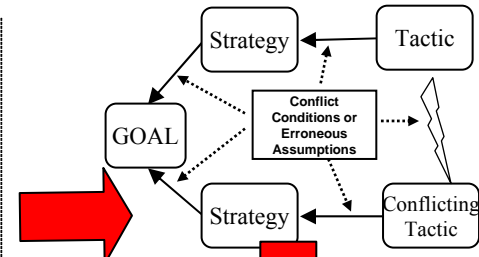
Conflict Cloud Process



Step 3. Current Reality Tree & Core Conflict for Company

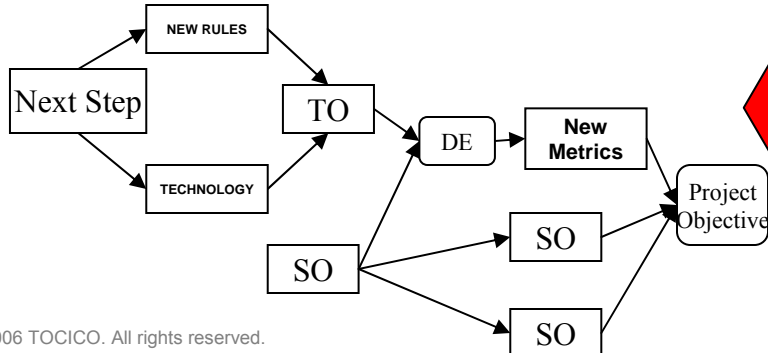


Step 4. Identifying & Challenging the Core Conflict Conditions for Company

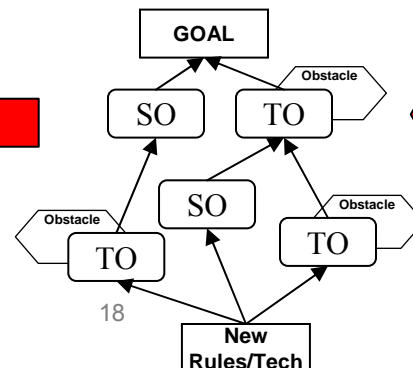


AREA	UDE	OLD RULE	DE	NEW RULE
Sales/	UDE1	Old Rule 1	DE1	New Rule 1
Finance	UDE2	Old Rule 2	DE2	New Rule 2
Logistics	UDE3	Old Rule 3	DE3	New Rule 3
R&D	UDE4	Old Rule 4	DE4	New Rule 4
Marketing	UDE5	Old Rule 5	DE5	New Rule 5

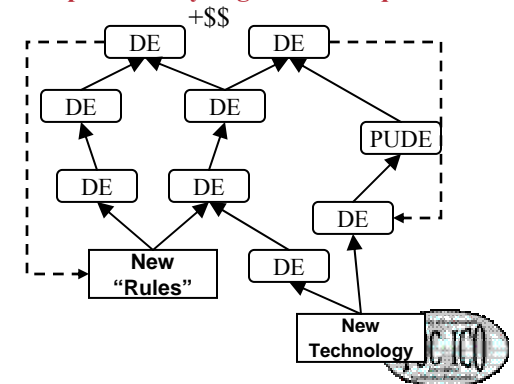
Step 7. Strategic & Tactical Project Plan & Metrics for Company & Departments



Step 6. PreRequisite Tree to overcome Implementation Obstacles



Step 5. Future Reality Tree to achieve DE's and NBR's to prevent any negative consequences



Section B

Why Change?

Defining the UDEs

Identifying Undesirable Effects (UDEs) of the System

UnDesirable Effects (UDEs) are **symptoms or negative effects** that you and other stakeholders (e.g. your customers, shareholders etc) are currently experiencing.

These effects are “undesirable” in relation to the goal of your defined system and its vision.

Usually, people have very good intuition. When dealing with a system whose performance we want to improve, we engage our thinking about what can be done to make it better. As such, we tend to collect observations or “complaints”, from our own thoughts or what others say, that we believe are the major problems of the system.

“The best way (to analyze project management) is to ask people ‘what is the problem?’ in the field of project management or ‘what makes managing projects so difficult’. Well... people who are deeply involved in projects are experts in bitching and moaning. And they have good reasons for it. So ask them what really bothers them.. For example, let me show you a list that I got from a friend of mine, who had a lot of experience in projects: Original due dates are not met...there are too many changes...too often resources are not available when needed...there are fights about priorities between projects...there are budget over-runs... there is too much re-work.”

Eli Goldratt, Goldratt Satellite Program, Session 3 - Project Management

Verbalizing the Undesirable Effects (UDEs) of the System

Criteria for a “Good” UDE

1. It is a **complete statement**. (written in present tense)
2. It **exists in current reality** – it is not a Predicted Undesirable Effect.
3. It is an **“effect”, not a presumed “cause”**, absence of “solution” or obstacle to implementing a solution.
4. A **single effect**, without an **“and,” “because”** or **“as a result of.”**
5. It is **negative in its own right** and can be quantified or at least qualified.
6. There is agreement that it is very important to **neutralize or remove it** (because it has a significant negative impact on Goal Units, necessary conditions, and global metrics – T, I, and OE).
7. It **does not blame anybody directly**, but describes the undesirable effect being experienced.

Examples of "UDEs" that are NOT "good enough"

No	UDE Statement	Good or Bad UDE?	Why? (List criteria)	Recommended Correction in UDE
1	Our Production manager is too strict.			
2	We don't have the budget to buy more machines.			
3	Last year's bad weather lost us money.			
4	Our management meetings are too long.			
5	We have a bad project management process.			
6	The no. of safety incidents have been increasing year-on-year.			

Part B – TOC Thinking Processes

Problem B1

- From the text below [*Some of our customers are truly crazy!*] identify at least three Undesirable Effects [UDEs] and the impact on the company (in terms of T, I and OE)
- For ONE of these UDEs, verbalize the associate conflict the person responsible for dealing with the UDE, is facing. Use your answer to Complete the Conflict Cloud template below.
- Identify at least 3 possible erroneous assumptions on any of the logical arrows
- Identify the injections that could invalidate these assumptions.

“Some of our customers are truly crazy!”

This quite surprising quote belongs to G.G. Gerald, the CEO of Remedy, a medium size manufacturer of drugs. Mr. Gerald referred to the increasing number of customer complaints. He said one of the complaints claimed that the company’s sleeping pills caused some disturbing nightmares to the 70 years old woman who sent the complaint. As a result of the increase number of complaints, the company had to increase the number of people who took care of the complaints to meet the company’s publicized “one-week-at-most” response time promise to every complaint.

The company suffered a decrease in sales last year, but the CEO said that the sales are picking up due to the global reduction of 12% off the list price on all the products. The increasing sales helped, to some degree, the severe cash situation of the company. Mr. Gerald also explained the recent move to outsource the logistics of distributing the products to the drug stores to an external logistics service company. According to him managing the detailed transportations became quite difficult because the stores demanded too frequent replenishments and even demanded that the exact arriving time to the store be arranged and agreed one day ahead. “There is no way for a truck driver to predict when he will arrive to a certain store. You all know the state of the traffic and how unpredictable it can be.

This is an illogical request. From now on the stores would deal with our logistics service supplier that is large and strong and also transport many more products to the same stores and let’s see whether they will request such stupid demands. I’m truly sorry for our 25 or so employees who lost their job due to the outsourcing. I’m aware that other employees feel uncomfortable about it and even concerned about their own job, but I had to take that difficult decision for the benefit of my company.”

Part B – TOC Thinking Processes

Problem B1

a) From the text on previous slide (#23) [*Some of our customers are truly crazy!*], identify at least three Undesirable Effects [UDEs] and their impact on the company (in terms of change in T, I and OE)

No	Three Undesirable Effects from the Text	Impact on Company (in T, I and OE)
1		
2		
3		

Section B

What to Change?

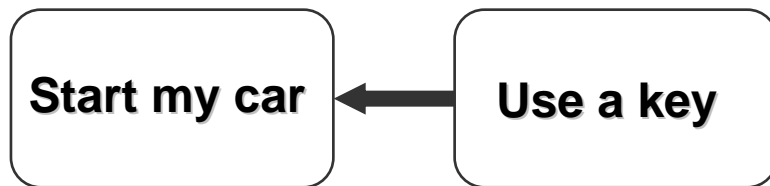
Defining & Breaking Conflicts

“Define a problem precisely and you are half way to a solution”

Part B – TOC Thinking Process Logic

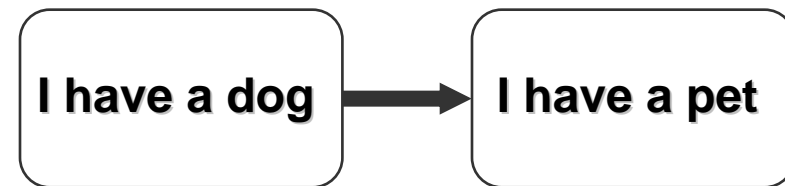
Necessary Logic

In order to...,I must... .



Sufficiency Logic

If...,Then... .



In either case reversing the order of the entities creates an illogical statement

Part B – TOC Thinking Processes

The Conflict Cloud

Defining a Problem Precisely

“Define a problem precisely and you are half way to a solution”
from “What is this thing called Theory of Constraints?” by Eli Goldratt (1990)

Let’s examine, what is the meaning of a “problem”.

- Intuitively, we understand that a problem exists whenever there is a **GAP** between our current reality and some desired objective.
- What limits us from solving this problem or closing the GAP?
- It must be that some **unresolved conflict or compromise** limits or blocks us from achieving the desired objective.
- Therefore, defining a problem precisely must start with a declaration of the **desired objective** and the **conflict** that limits or blocks us from “Solving” the problem.

Unresolved Problem = Unresolved Conflict

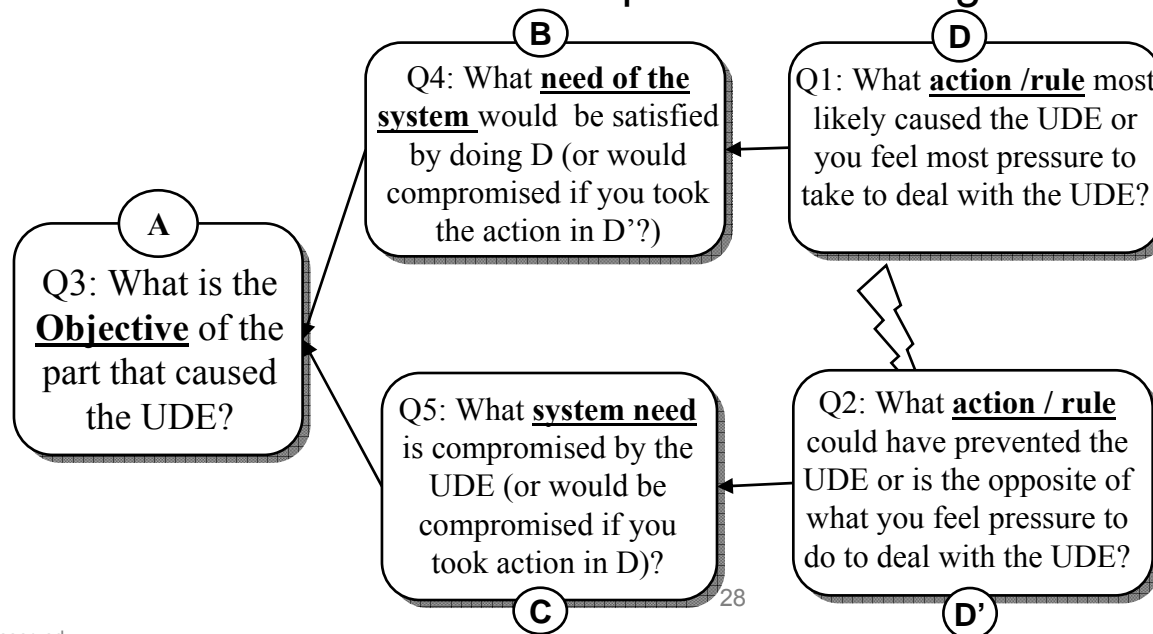
Part B – TOC Thinking Processes

The Conflict Cloud

Defining a Problem as an Unresolved Conflict

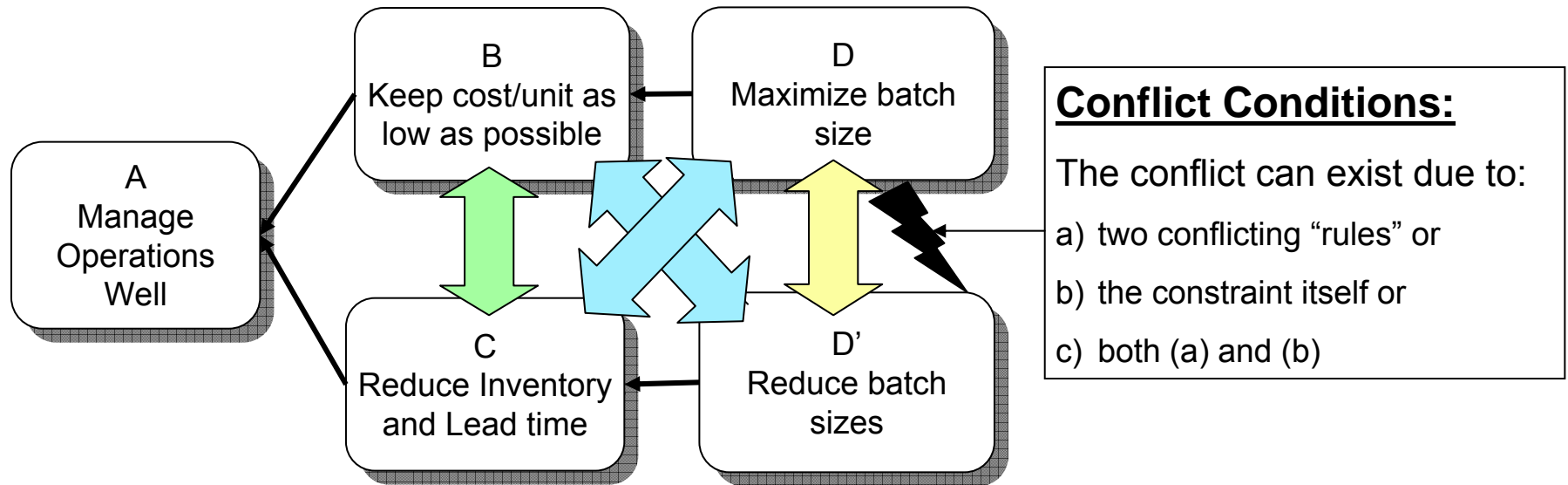
In TOC we believe that the reason you have labelled a situation as a problem or UDE (undesirable effect), is **not only because it jeopardizes the goal of the system in some way, but also because it must put you in some sort of dilemma or conflict.** Identifying this conflict not only will help us to understand the “real” problem (the unresolved conflict) but will also enable us to surface our intuition and/or assumptions about what is blocking us from dealing or removing the UDE.

To convert a Problem or UDE is as simple as answering the following 5 questions:

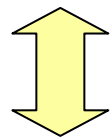


Note: You can start with any of the questions; one possibility is to begin with the one that is 'easiest' to answer and then complete the rest.

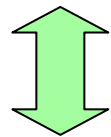
Part B – TOC Thinking Processes Validating the Conflict Cloud



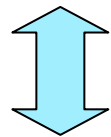
The way to **validate your conflict cloud is to answer the following questions:**



Is there a clear conflict between D and D'?



Is there no conflict between B and C?



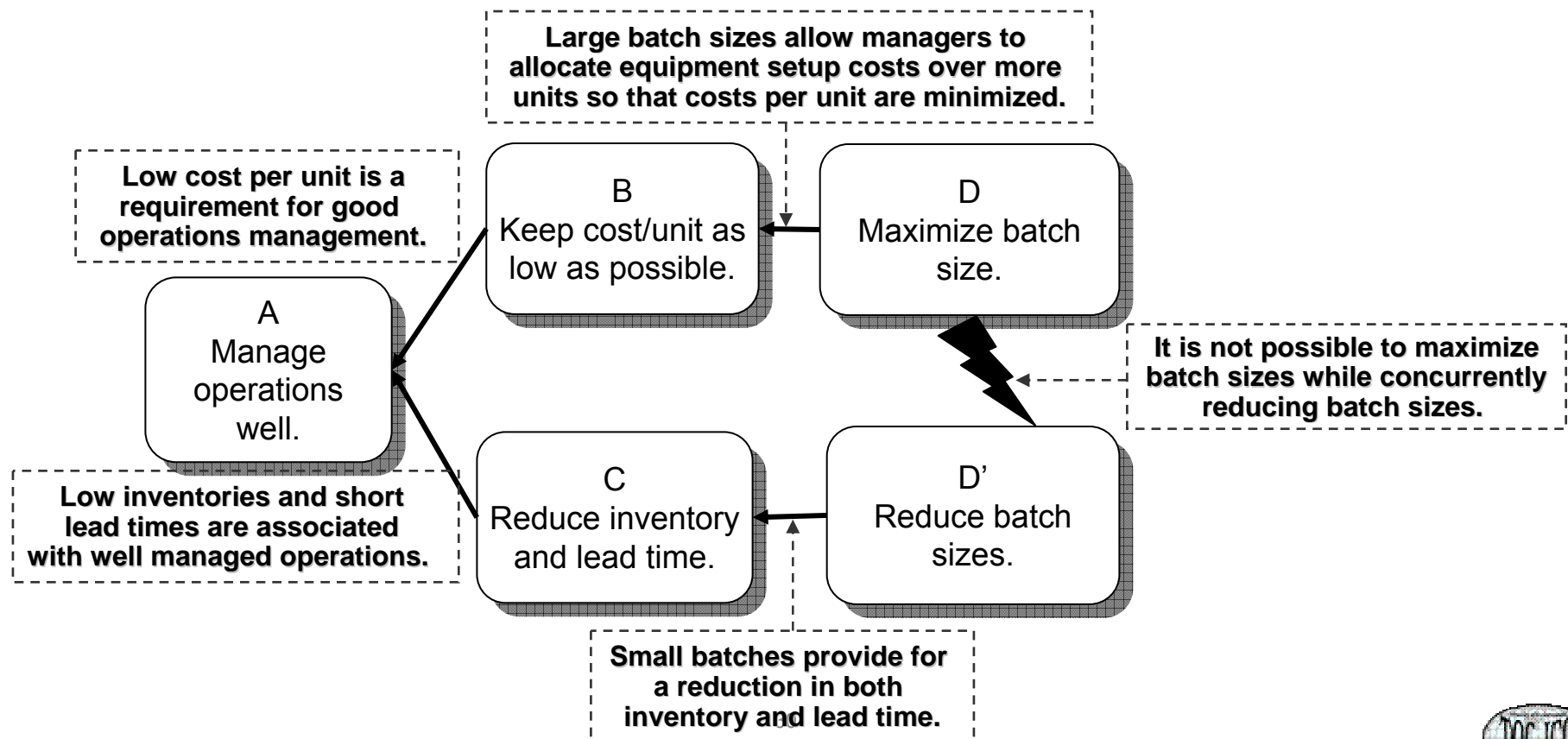
Does the existence of D Jeopardize C?

Does the existence of D' Jeopardize B?

Part B – TOC Thinking Processes Surfacing Conflict Cloud Assumptions

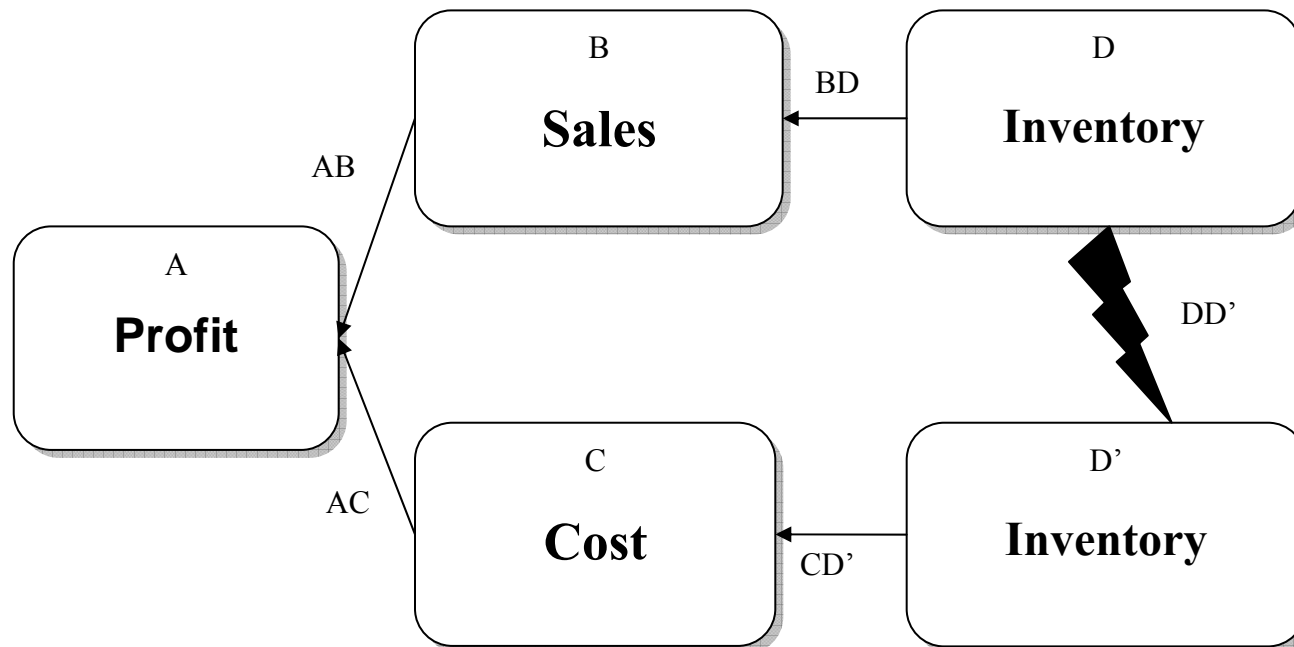
The way to **resolve/break conflicts without compromise** is by identifying the erroneous assumption or creating an injection that will invalidate a legitimate assumption underlying one or more relationships between entity-pairs.

Have any erroneous assumptions been surfaced in the dashed-lined boxes below?



Part B - Poor Cloud Example

- **What changes are needed to make this a well structured and valid conflict cloud?**

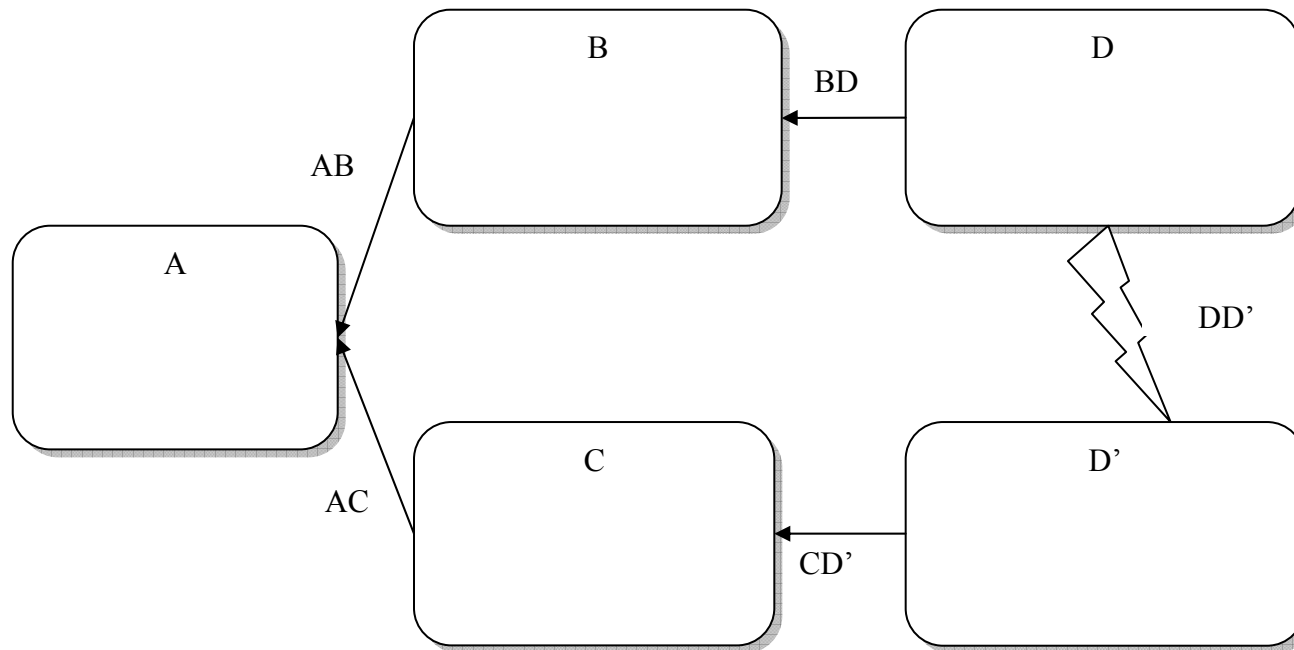


Part B – TOC Thinking Processes

The Conflict Cloud

Problem B1

b) For ONE of your UDEs (see slide #24), record the associate conflict the person responsible for dealing with the UDE is facing. Use your answer to complete the Conflict Cloud template below. Be sure to surface a major assumption underlying each entity pair relationship.



Part B – TOC Thinking Processes

The Conflict Cloud

Problem B1

- c) List all major assumptions and indicate whether erroneous (E) or valid (V).
- d) Identify 1 injection that could invalidate at least one of the valid assumptions.

Arrow	(c) List all 5 major assumptions; Specify if erroneous (E) or valid (V)	(d) Identify injection to overcome valid assumption or if erroneous, explain why.



Section B

To What to Change ?

Negative Branch Reservations

“Every systemic solution has potential negative side-effects”.

Part B – TOC Thinking Processes

The Negative Branch Reservation (NBR)

The inventor of an new idea or solution also has the responsibility to ensure that the solution **does not create new UnDesirable Effects** (UDEs). This responsibility is manifested through two channels:

1. Preparation - thinking about and **asking others for potential negative outcomes** of the proposed solution.
2. Being capable of **handling feedback from relevant Stakeholders** and recognizing that their collaboration and buy-in is critical for the implementation of the solution. When these people raise their concerns and reservations (normally expressed as “**yes, BUTS**”), the inventor should be technically capable of converting the input into a process that addresses the concerns which TOC calls the **Negative Branch Reservation**.

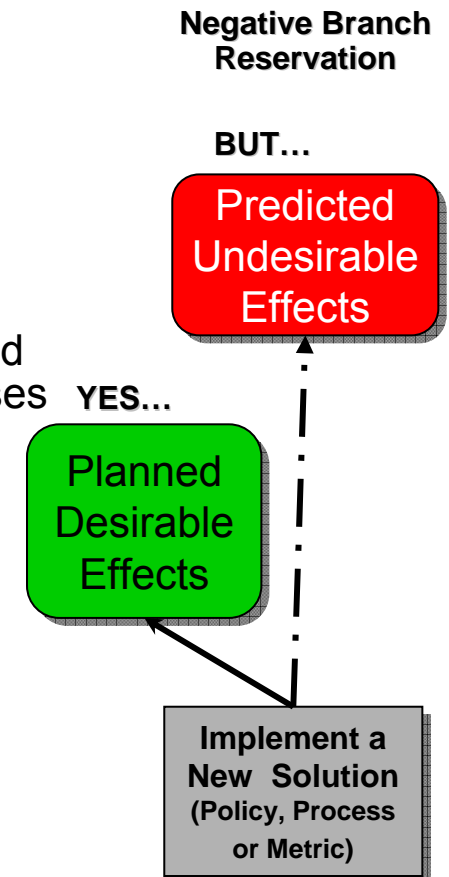
The NBR process is described below:

Step 1: Use your own and others’ experience and intuition potential to identify undesirable effects of the new injections by answering “**what can go wrong?**”

Step 2: Construct the detailed cause-effect relationships between the injection and the Potential UDE (PUDE) to validate the sufficiency logic

Step 3: Identify **how to “trim the NBR”** by identifying where in the logic it turns the positive injection into a potential negative outcome.

Step 4: Identify a potential **additional injection** to prevent or minimize the risk of this PUDE by preventing the condition that can cause the PUDE...



Part B – TOC Thinking Processes

The Negative Branch Reservation (NBR)

Detailed process for creating a NBR

1. Write the injection in the bottom box
2. Use the space on the left to build a logical tree of why the injection will lead to the predicted negatives. Use the 'If...then...because...' logic
3. Write the possible negative outcome or Potential UDE (PUDE) in the top box. If you were constructing a "Positive Branch" for a FRT, then write the Desirable Effect or Strategic Objective you expect the "injection" to achieve.
4. Write your reasons or logic of why you claim the change will result in a negative (or positive outcome for positive branches) in the middle box.
5. Split the entities of the middle box into two groups - those that exist in the current reality and those that do not exist in the current reality but will once the injection will be implemented
6. Use the "will-be entities" in the "back bone" on the link between the injection and the negative outcome
7. Add the supporting entities using the 'If...then...because...' logic
8. Check for clarity and sufficiency

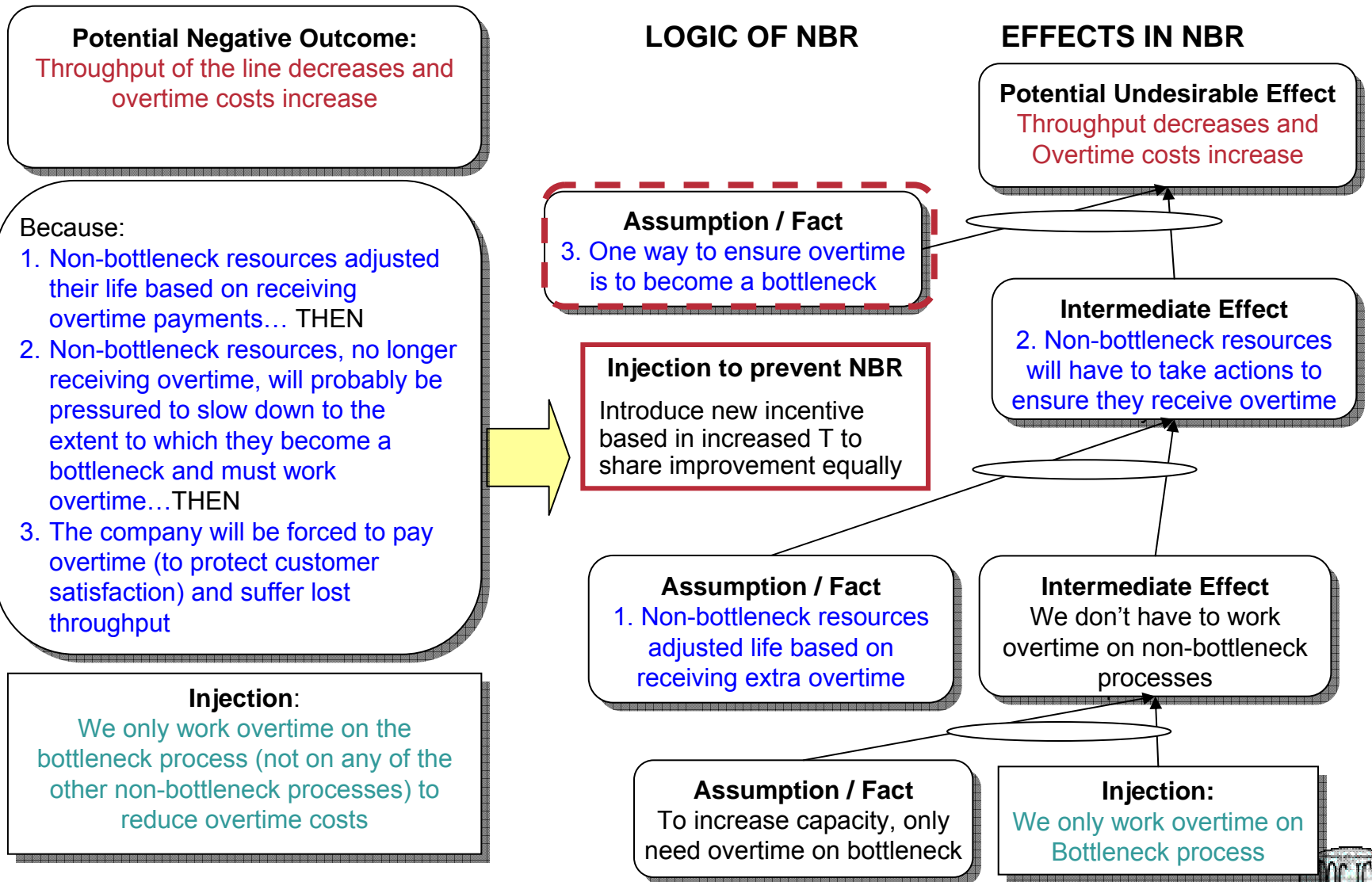
Potential Negative Outcome:

Because:

Injection:

Part B – TOC Thinking Processes

The Negative Branch Reservation



Part B – TOC Thinking Processes

The Negative Branch Reservation

Problem B2

- For the new “Solution” or Change defined below, list at least three potential negative consequences
- For the one with the largest potential negative impact on the company as a whole, construct the FULL negative branch using “if-then-because” logic
- Identify the assumption/fact [circle in red] that can be challenged and define an Injection [to be written on diagram below selected assumption that is challenged] that can prevent the negative consequence.

List of potential intermediate and overall negative consequences of:

“Laying off 10% of the employees across all the departments to achieve cost reduction”

”

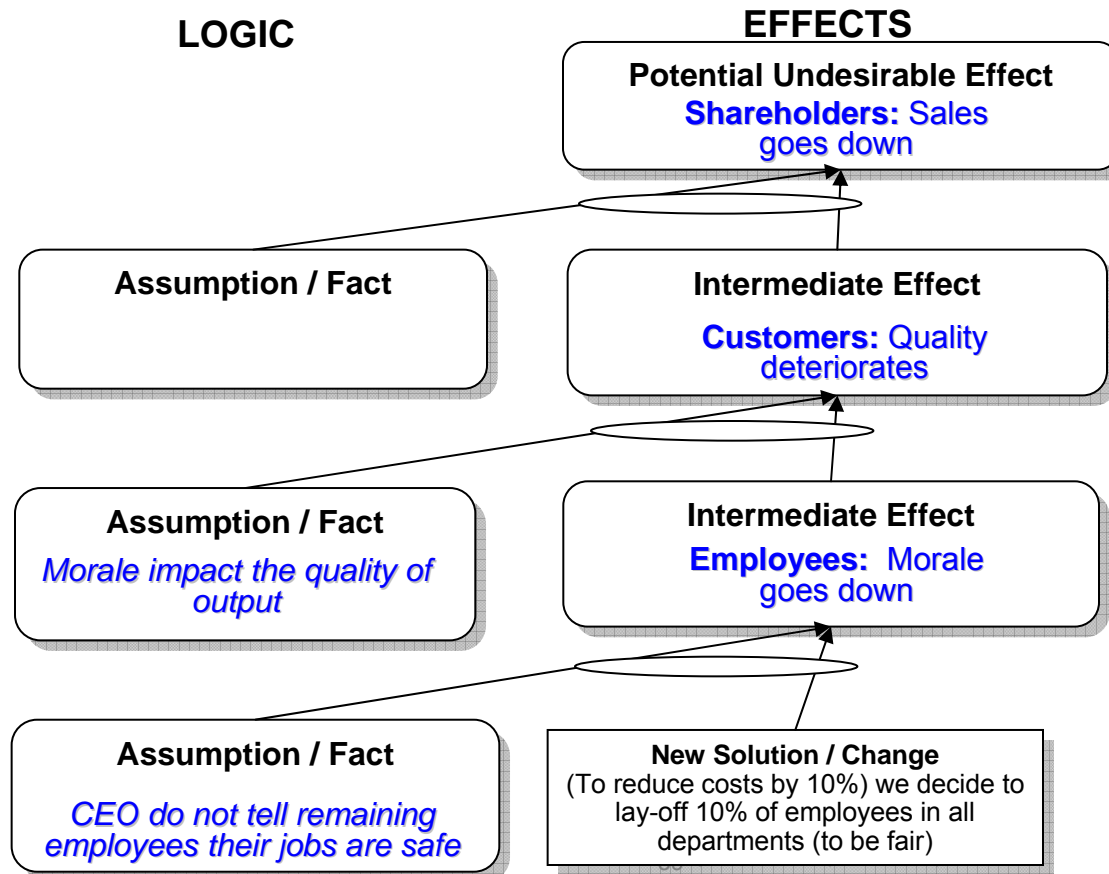
No.	(a) Possible Negative Consequences of New Idea
1	
2	
3	

Part B – TOC Thinking Processes

The Negative Branch Reservation

Problem B2

- b) For the one with the largest potential negative impact on the company as a whole, construct the FULL negative branch using “If ..., and if..., then...” logic.
- c) Identify the assumption/fact [circle in red] that can be challenged and define an Injection [written on diagram below selected assumption that is challenged] that can prevent the negative consequence.



Section B

How to Cause a Change?

The Prerequisite Tree

Part B – TOC Thinking Processes

The Prerequisite Tree

A long journey needs its milestones

implementing any new change or injection is not a trivial task. Let's not forget that typically after a TOC Analysis such as breaking a Core Conflict, at least one of the **injections is a breakthrough**, a *departure from the currently prevailing tradition* and achieving it can be considered an **“ambitious target”**. Thus, it is usually necessary to break the implementation task into smaller increments.

Why is an ambitious target “ambitious”?

...Because the path to making it happen is an obstacle course!

To prepare fully to understand and overcome this obstacle course, we use the Pre-Requisite Tree (PRT). This thinking process starts with the identification of the implementation obstacles that we expect we'll encounter (based on collective experience and intuition) and then we derive the necessary milestones – **the Intermediate Objectives (IOs)** verbalized as outcomes - each needed to **overcome the obstacles**.

To complete the process, the **Intermediate Objectives need to be sequenced**; which one is first, which ones can be accomplished in parallel, etc. The connections are provided by the fact that any time dependency is due to the need to overcome an obstacle. The power of the PRT stems from the fact that it doesn't ignore the obstacles, on the contrary, they are used as the main vehicle for *building the “sufficiency” and “sequence” of the roadmap* which will be the basis of the project network.

Part B - TOC Thinking Processes

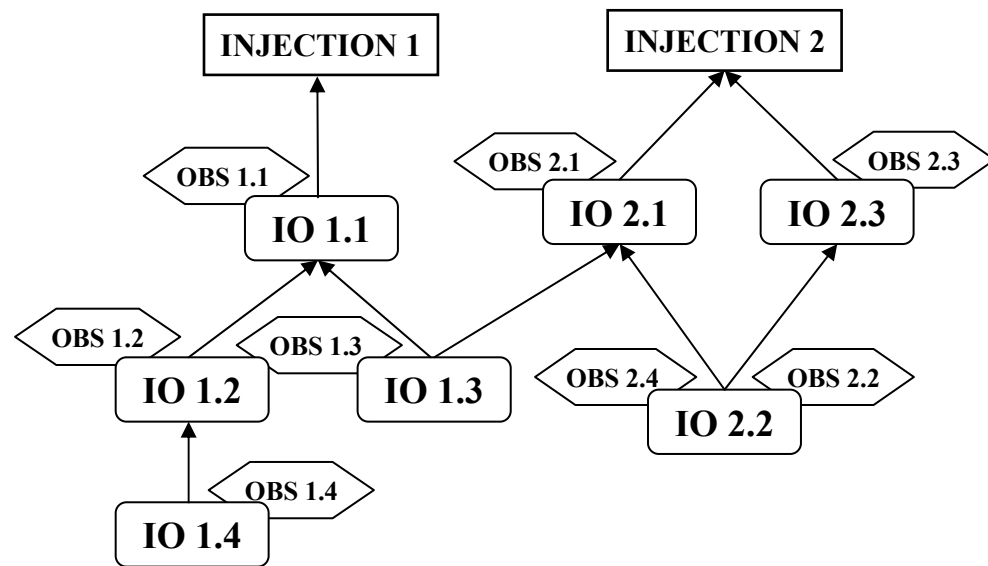
The Prerequisite Tree (PRT)

Pre-Requisite Tree (PRT)

By relying on everybody's natural tendency and "expertise" at pointing out obstacles (why it will not be possible to implement a breakthrough idea), the Pre-Requisite Tree Thinking Process enables managers to systematically identify these major obstacles and the associated Intermediate Objectives necessary to overcome them. Then the manager is able to **create a network showing the interdependencies between Intermediate Objectives** or Steps to implement the new breakthrough solution.

AMBITIOUS TARGET		Injection 1	
No	Obstacle	Intermediate Objective	Who?
1.1	OBS 1.1	IO 1.1	AB
1.2	OBS 1.2	IO 1.2	BC
1.3	OBS 1.3	IO 1.3	AB
1.4	OBS 1.4	IO 1.4	DE

AMBITIOUS TARGET		Injection 2	
No	Obstacle	Intermediate Objective	Who?
2.1	OBS 2.1	IO 2.1	AB
2.2	OBS 2.2	IO 2.2	BC
2.3	OBS 2.3	IO 2.3	AB
2.4	OBS 2.4	IO 2.2	DE



IO = Intermediate Objective

OBS = Obstacle

Part B: TP Review

- **Change Sequence: Answer Three Questions**
- **Resistance to Change**
- **UDEs, Conflict Clouds, and Injections**
- **Negative Branch Reservation**
- **Prerequisite Tree**

Section C

TOC

Applications

Part C – TOC Applications

INTERNAL SUPPLY CHAIN LOGISTICS

- **Managing Operations: Drum-Buffer-Rope**
- **Managing Supply Chain: TOC Replenishment**

FINANCE AND MEASUREMENTS

- **Making decisions using T, I and OE**
- **Making decisions using Throughput / Constraint Unit**

PROJECT MANAGEMENT

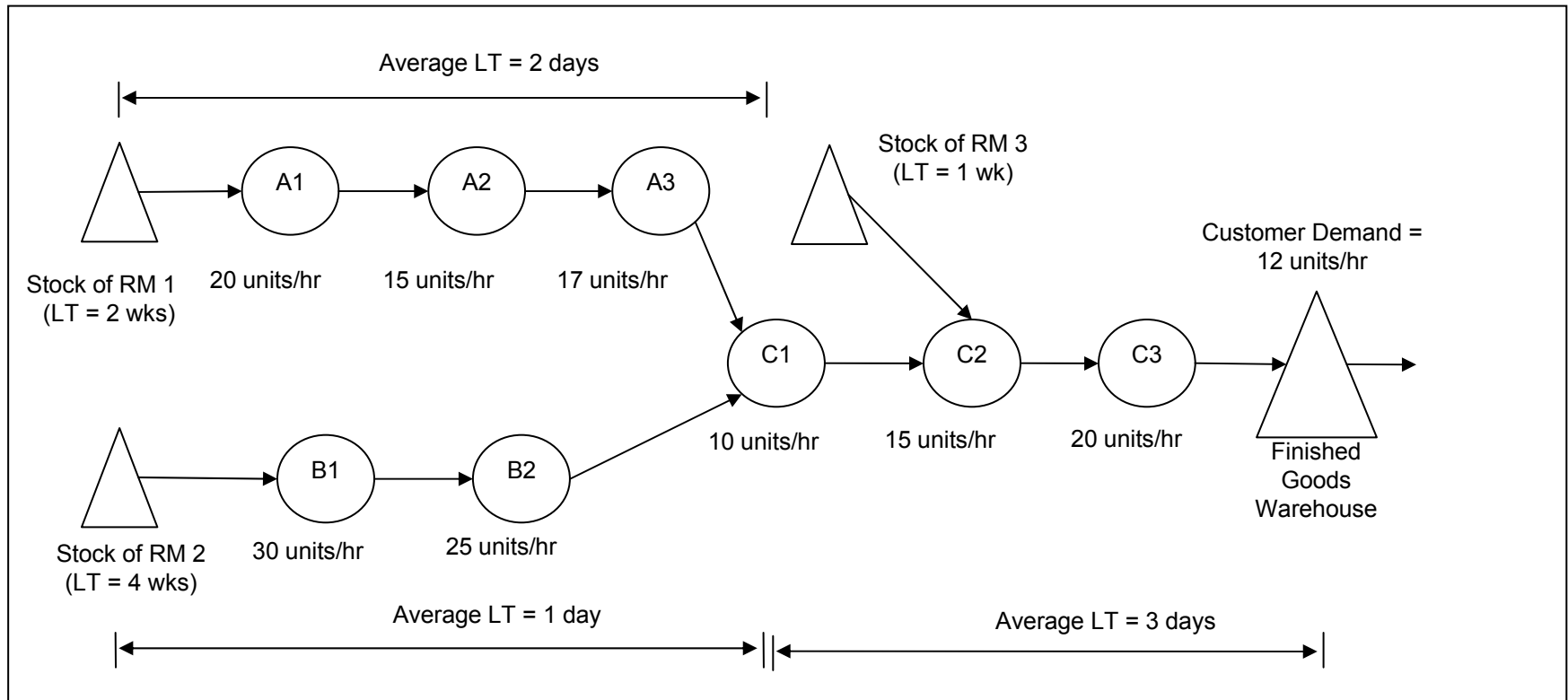
- **TOC Project Planning Rules: Critical Chain**
- **TOC Project Execution Rules: Buffer Management**

Part C – TOC Applications

Internal Supply Chain Logistics

Problem C1 – INTERNAL SUPPLY CHAIN LOGISTICS

Apply the TOC Five Focusing Steps to the situation diagrammed below which is a “Make-to-Order” environment for building Notebook Computers from Raw Material (RM) Buffers by answering explicitly the questions on the next slide.



Part C – TOC Applications

Internal Supply Chain Logistics

Problem C1 – INTERNAL SUPPLY CHAIN LOGISTICS

Apply the TOC Five Focusing Steps to the situation diagrammed below which is a “Make-to-Order” environment for building Notebook Computers from Raw Material (RM) Buffers by answering as specifically as possible the questions below:

1. Where is the “Bottleneck” in this scenario and Why?

.....
.....

2. If you were to implement the ‘Drum Buffer Rope’ system, where is the most appropriate location to position the DRUM and describe how it will work?

.....
.....
.....

3. Where would you place Time and Stock BUFFERS?

.....
.....
.....

4. How would you calculate the required Time and Stock BUFFERS?

.....
.....
.....

5. In the diagram above, show the ROPE(s) and describe how it (they) will work?

.....
.....

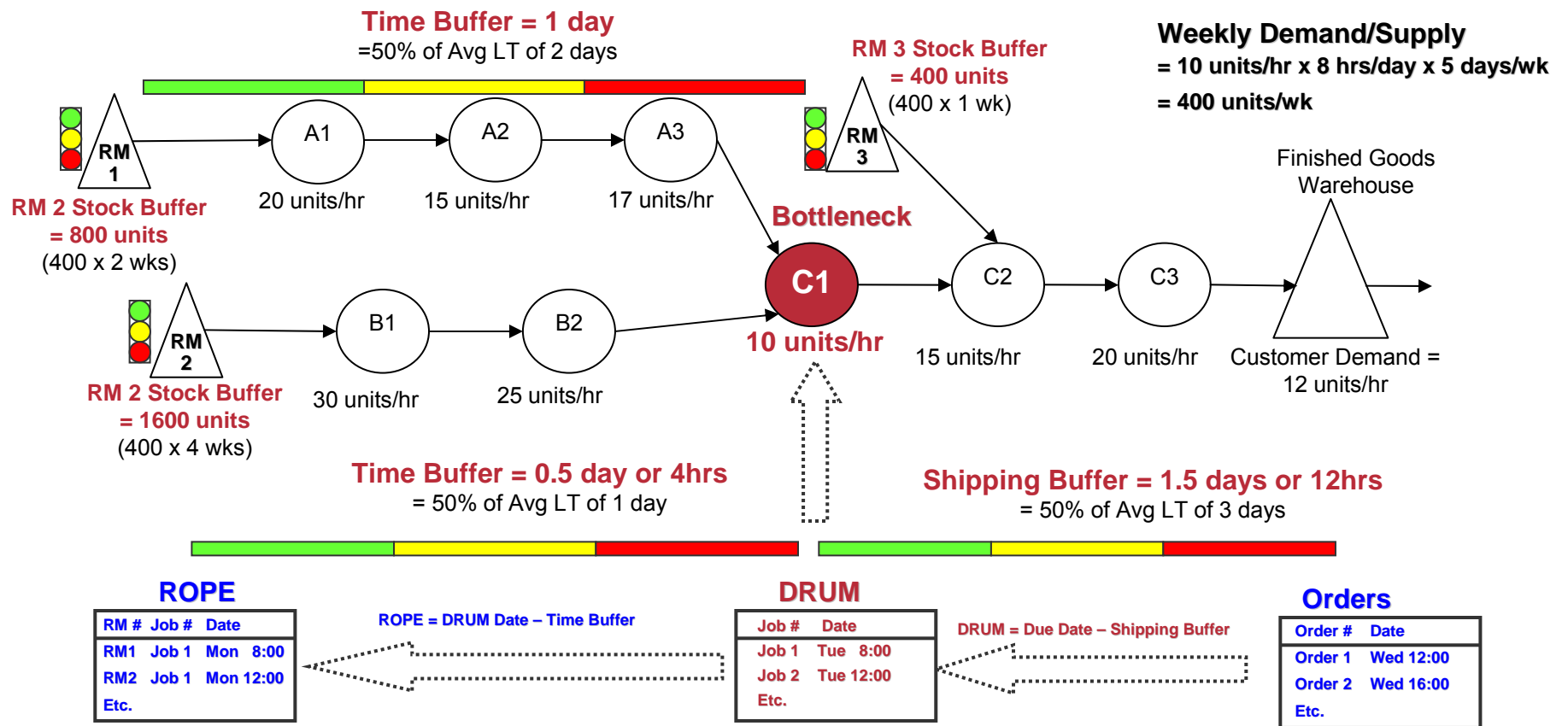


Part C – TOC Applications

Internal Supply Chain Logistics

Problem C1 – INTERNAL SUPPLY CHAIN LOGISTICS

Apply the TOC Five Focusing Steps to the situation diagrammed below which is a “Make-to-Order” environment for building Notebook Computers from Raw Material (RM) Buffers by answering as specifically as possible the questions on the previous slide (#47):



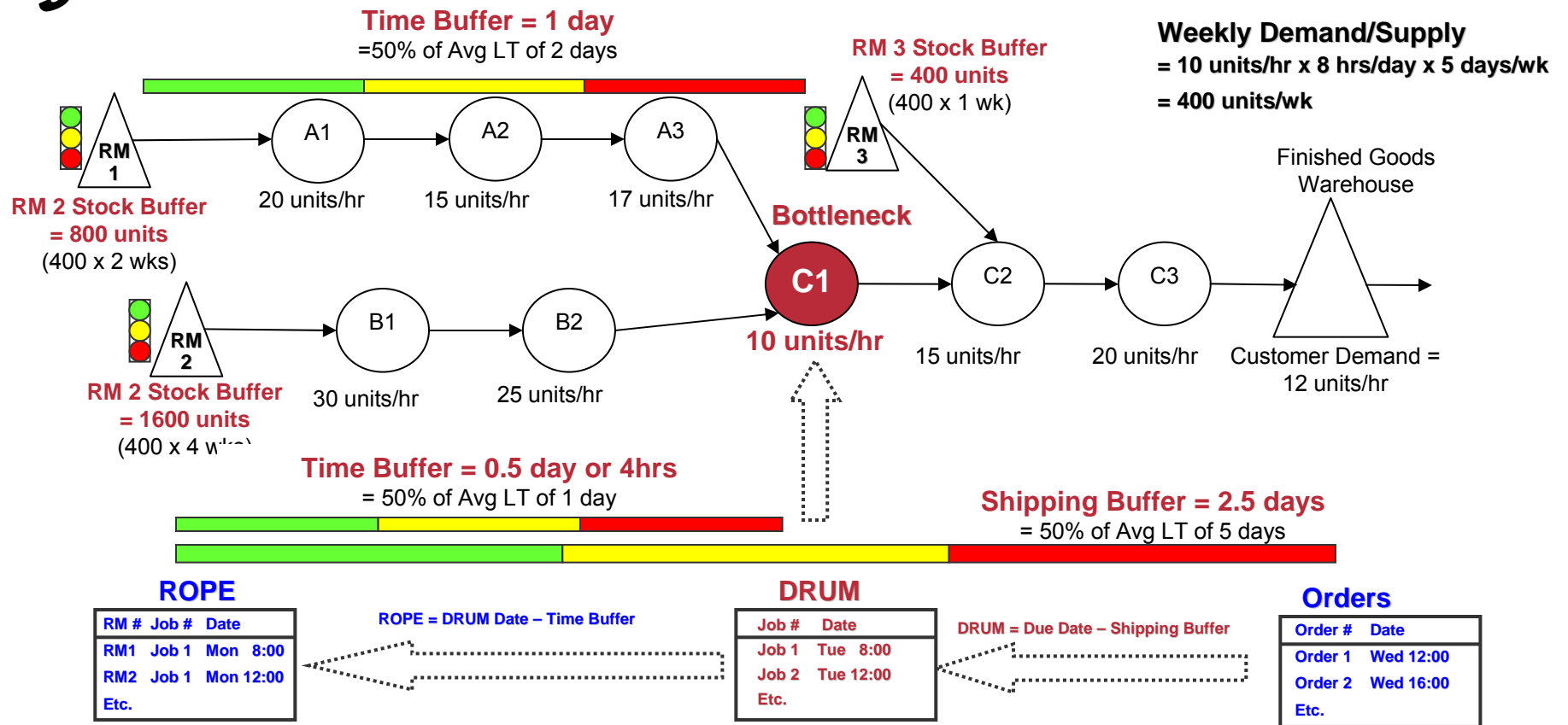
Part C – TOC Applications

Internal Supply Chain Logistics

Alternative Solution

Problem C1 – INTERNAL SUPPLY CHAIN LOGISTICS

Apply the TOC Five Focusing Steps to the situation diagrammed below which is a “Make-to-Order” environment for building Notebook Computers from Raw Material (RM) Buffers by answering as specifically as possible the questions on the slide #47:



Part C – TOC Applications

Internal Supply Chain Logistics

Problem C1b – TOC Distribution and Replenishment

1) Identify the key ideas associated with the generic TOC Distribution and Replenishment solution.

2) True or False - Explain your answer: The key metric in implementing the TOC D&R solution is throughput dollar days.

Part C – TOC Applications Finance & Measurements

TOC Global Measurements:

Throughput (T): The rate at which a system generated money (or goal units) through sales.

Inventory (I): All money used to purchase things that the system intends to sell.

Operating Expense (OE): All money spent by the system to turn Inventory into Throughput.

Part C – TOC Applications Finance & Measurements

TOC Financial Measurements:

Throughput: $T = SR - VC$

Net profit: $NP = T - OE$

Return on investment: $ROI = (T - OE) / I$

Cash flow: Cash inflows – cash outflows
(in terms of changes in T, I and OE)

TOC Productivity Measurements:

Productivity: T/OE

Investment Turns: T/I

Preferential Products: Highest T/Cu

Part C – TOC Applications Finance & Measurements

Problem C2 – FINANCE and MEASUREMENTS

What is the maximum weekly profit you can make from the company described below?
(Show your assumptions and calculations).

Situation

	Product P	Product Q
Weekly Demand	100 units	50 units
Selling Price per Unit	\$90.00	\$100.00
Variable Cost per Unit	\$45.00	\$40.00
Allocated Overhead per Unit	\$40.00	\$35.00

This table shows the processing time per unit of each product/service on each resource. Assume that each type of resource (i.e. person, machine, and department) works one 8-hour shift five days a week (2400 minutes). Assume that setup time is zero, that quality is perfect and that the resources are always available during work hours (no breaks or downtime). In addition, our weekly operating expenses (overhead and labor costs) are \$6000. Finally, we can sell up to the amount of weekly demand for each product (will make the sale for all products/services made if they are less than or equal to the weekly demand). The customers will buy from our competitor if we are not able to meet their demand. If we make more, we can not sell more.

	Product P	Product Q
Resource A	15 min.	10 min.
Resource B	15 min.	30 min.
Resource C	15 min.	5 min.
Resource D	15 min.	5 min.

Part C – TOC Applications Finance & Measurements

Problem C2 – FINANCE and MEASUREMENTS

What is the maximum weekly profit you can make from the company described below?
(Show your assumptions and calculations).

Scenario 1: Ignoring Supply Capacity Constraint

Financial Model									
	Product P		Product Q		Total				
	Unit	Total	Unit	Total					
Demand per Week	100		50						
Supply per Week	100		50						
Sales Value	\$90	\$9,000	\$100	\$5,000	\$14,000				
Variable Cost	\$45	\$4,500	\$40	\$2,000	\$6,500				
Throughput	\$45	\$4,500	\$60	\$3,000	\$7,500				
Operating Expenses					\$6,000				
Net Profit					\$1,500				
Throughput/C Min	\$3		\$2						
Capacity Model									
	Product P		Product Q		Total	Utilization	TVA/Min		
	Min/Unit	Total	Min/Unit	Total			P	Q	
Resource A	15	1500	10	500	2000	83%	\$3	\$6	
Resource B	15	1500	30	1500	3000	125%	\$3	\$2	
Resource C	15	1500	5	250	1750	73%	\$3	\$12	
Resource D	15	1500	5	250	1750	73%	\$3	\$12	
Totals	60		50						
Available Capacity					2400				

Part C – TOC Applications Finance & Measurements

Problem C2 – FINANCE and MEASUREMENTS

What is the maximum weekly profit you can make from the company described below?
(Show your assumptions and calculations).

Scenario 2: Preferring Q based on highest Margin

Financial Model								
	Product P		Product Q		Total			
	Unit	Total	Unit	Total				
Demand per Week	100		50					
Supply per Week	60		50					
Sales Value	\$90	\$5,400	\$100	\$5,000	\$10,400			
Variable Cost	\$45	\$2,700	\$40	\$2,000	\$4,700			
Throughput	\$45	\$2,700	\$60	\$3,000	\$5,700			
Operating Expenses					\$6,000			
Net Profit					-\$300			
Throughput/C Min	\$3		\$2					
Capacity Model								
	Product P		Product Q		Total	Utilization	TVA/Min	
	Min/Unit	Total	Min/Unit	Total			P	Q
Resource A	15	900	10	500	1400	58%	\$3	\$6
Resource B	15	900	30	1500	2400	100%	\$3	\$2
Resource C	15	900	5	250	1150	48%	\$3	\$12
Resource D	15	900	5	250	1150	48%	\$3	\$12
Totals	60		50					
Available Capacity					2400			

Part C – TOC Applications Finance & Measurements

Problem C2 – FINANCE and MEASUREMENTS

What is the maximum weekly profit you can make from the company described below?
(Show your assumptions and calculations).

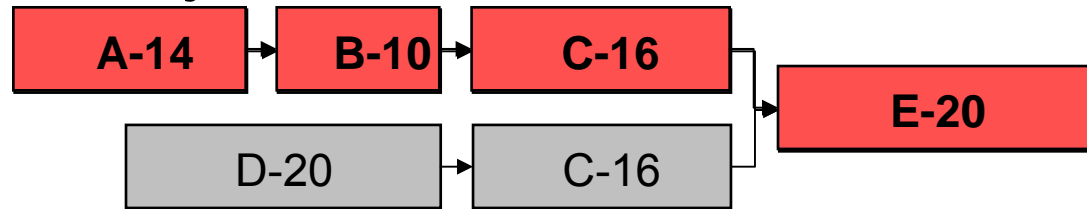
Scenario 3: Preferring P based on Highest T/C min

Financial Model									
	Product P		Product Q		Total				
	Unit	Total	Unit	Total					
Demand per Week	100		50						
Supply per Week	100		30						
Sales Value	\$90	\$9,000	\$100	\$3,000	\$12,000				
Variable Cost	\$45	\$4,500	\$40	\$1,200	\$5,700				
Throughput	\$45	\$4,500	\$60	\$1,800	\$6,300				
Operating Expenses					\$6,000				
Net Profit					\$300				Max Profit = \$300
Throughput/C Min	\$3		\$2						
Capacity Model									
	Product P		Product Q		Total	Utilization	TVA/Min		
	Min/Unit	Total	Min/Unit	Total			P	Q	
Resource A	15	1500	10	300	1800	75%	\$3	\$6	
Resource B	15	1500	30	900	2400	100%	\$3	\$2	
Resource C	15	1500	5	150	1650	69%	\$3	\$12	
Resource D	15	1500	5	150	1650	69%	\$3	\$12	
Totals	60		50						
Available Capacity					2400				

Part C – TOC Applications

Critical Chain Project Management Rules

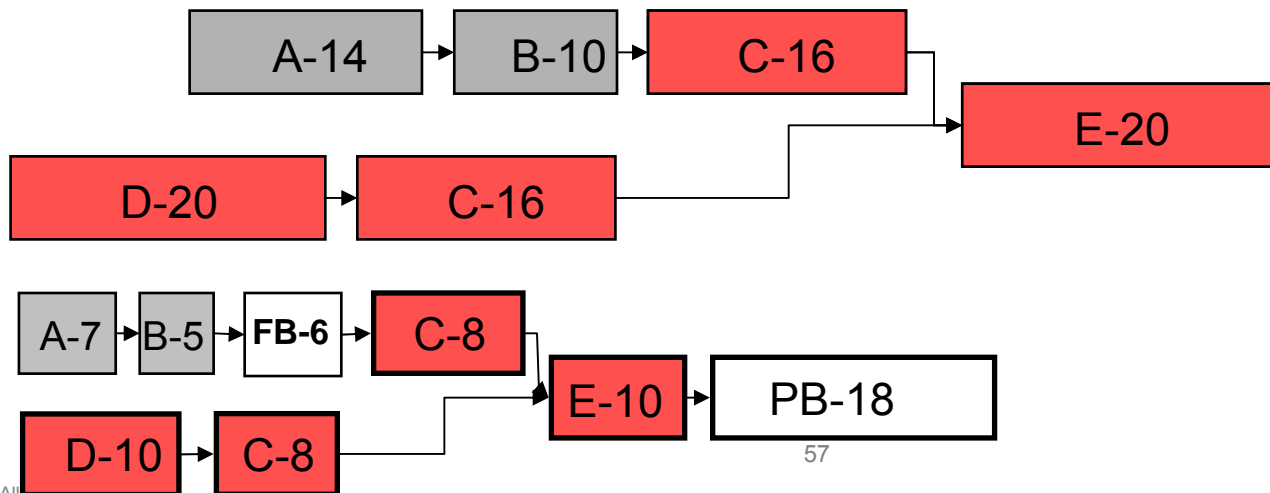
Traditional Project Network with Critical Path



LT = 60 days

Critical Chain Project Network

1. Resolve Resource Contention
2. Identify Critical Chain
3. Insert Project Buffer (50% of Critical Chain Path LT)
4. Insert Feeding Buffers (50% of Feeding Path LT)



LT = 72 days

LT = 54 days



Part C - TOC Applications

- **TOC application problems often require a number of steps to arrive at the correct answer.**
- **Often problems have several parts and some answers depend, in part, on answers to previous questions.**
- **The arithmetic is usually simple, but errors are common.**
- **Make sure to show work so partial credit can be given where applicable.**

Key Points:

Always show your work because if you fail to get the right answer, but show your work, you may still get partial credit.

Check your arithmetic.

Part C – TOC Applications Review

- **Supply Chain Logistics and Operations**
- **Finance and Measurement**
- **Project Management**

Time for your Questions

TOC Fundamentals



Summary of Key Insights

THEORY OF CONSTRAINTS

The Focusing & Synchronization Mechanism to
Achieve Breakthrough Performance

Summary of Key Insights

Common Question

How do we identify the “System Constraint”?

We can follow three different approaches to assess *whether the constraint is internal or external*:

1. Develop a model to determine if demand is $<$ or $>$ supply.
2. If demand $>$ supply, then interview key people in the internal supply chain to identify where Throughput is getting stuck (build-up of WIP).
3. Using Cause-Effect Analysis to identify the Constraint by determining what Symptoms or Undesirable Effects key stakeholders are complaining about...

(See the “Constraint Identification Matrix” on the next slide for an example of approach 3.)

Summary of Key Insights Constraint Identification Matrix

TOC Fundamentals

Select the set of symptoms with which you most closely identify:

- Reluctance to take on new business
- Poor factory on-time performance and long lead times
- Frequent back orders on top sales
- High WIP and/or finished goods inventory
- High overtime
- Lots of expediting and rescheduling
- Wandering or stationary bottlenecks

Operations

- Too many late or partial shipments to customers
- Frequent emergency shipments to branches or clients
- Excess finished goods of some products
- Frequent periods of high demand on production
- Excess returned goods from your channel
- Reluctance to take on new Business
- High number of Credit notes

Distribution

- Projects regularly over budget
- Improvement Projects not adding value
- Research & Development take too long to be considered a competitive advantage
- Projects regularly exceed expected Lead Time
- Chaotic reprioritization and midnight oil-burning to meet project due dates
- Reluctance to take on new projects
- Takes too long to develop, launch new products

Project Management

- Not able to quantify impact of "improvements" on bottom line
- Measurements not providing good "Early Warning" mechanism or seem in conflict with others
- Takes too long to get together data to make decisions & can't trust the numbers
- Not all employees behaving in line with company goal

Finance & Measurement

- Difficulty in attracting & retaining customers
- Losing Market Share to Competitors
- Pressure on pricing and the need to compete on price
- Frequent consideration of downsizing due to excess capacity relative to demand
- We do not have a sustainable competitive advantage
- Market demand is (much) less than Capacity
- Inability sell to all customers that could benefit from your products or services

Marketing & Sales

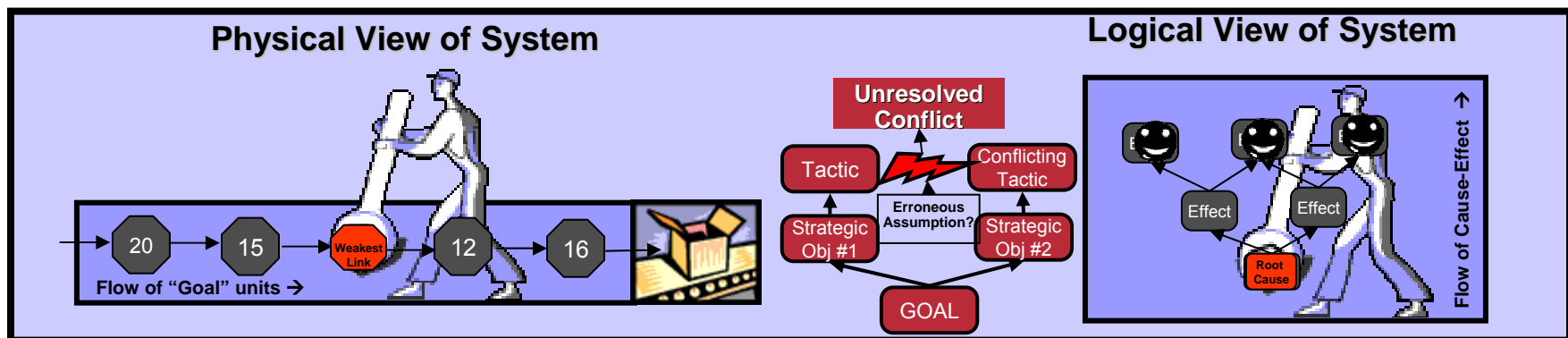
- Too much bureaucracy
- A "keep your head down" mentality
- Lack of initiative & "out-of-the-box" thinking
- Reluctance to review what we do
- Unclear vision and direction
- "Can't do" & "finger pointing" attitudes
- Defensive attitudes - questions and concerns perceived as attacks
- Lack of clarity of roles and regular Conflicts
- Many "improvement project" but few ever completed

Strategy & Organizational Culture

THEORY OF CONSTRAINTS SUMMARY OF BASIC PRINCIPLES

TOC Fundamentals

- Fact 1:** To understand any System (such as human based organizations), we need to understand three parts: The **Goal**, the **Physical side** and **Logical side**.
- Fact 2:** **Very Few** factors govern the performance of the Physical and Logical parts of a system at any point in time (*the law of the weakest link & significant few*)
- Fact 3:** **Unresolved Strategic and Tactical Conflicts** can limit or block us from exploiting, protecting and overcoming physical and logical “constraints.”



THEORY OF CONSTRAINTS provides tools to assist management to **find the few** physical and logical **leverage point(s)** of the system (organisation) where an improvement can cause a quantum improvement for the system as a whole....

THEORY OF CONSTRAINTS provides the tools to assist managers to **build the few** physical & logical **lever(s)** - the new rules/metrics - and **resolve conflict(s)** to **focus & synchronize** the whole organization according to better exploiting the few leverage points.

SUMMARY OF IMPORTANT TOC INSIGHTS

1. The **performance** of any system is **limited by** the performance of the **weakest link or constraint**. Therefore, to improve the performance of the system, we must first improve the performance of the weakest link or constraint.
2. **Constraints governs** not only the rate of **Throughput** but also the level of **Inventory**.
3. To achieve a focused **Process of Ongoing Improvement**, we should follow the following 5 Focusing Steps Process:
 - Step 0: Agree on the **SYSTEM GOAL** (and its metrics)
 - Step 1: **IDENTIFY** the System Constraint
 - Step 2: Decide how to **EXPLOIT** the System Constraint
 - Step 3: **SUBORDINATE** everything else to the above decision
 - Step 4: **ELEVATE** the System Constraint
 - Step 5: If a Constraint has been broken in a prior step, **GO BACK** to Step 1.
- To exploit the Constraint, we must focus on those products/services with the highest **Throughput\$/Constraint unit**.

SUMMARY OF IMPORTANT TOC INSIGHTS

6. **All problems** (gap between goal and reality) are the **result of a unresolved conflict**. To truly solve the “problem”, we must find a way to **break the conflict without compromise**; often **clouds** help identify effective solutions.
7. The conditions that cause conflicts often stem from **conflicting rules/metrics and or erroneous assumptions**.
8. Therefore, when we see “**Bad**” **behavior** (which results in less goal units), most likely it **stems from a “Bad” policy or measurement**. The fastest and most reliable way to change “bad” behavior is to change the policy/metric that caused it...
9. **Where ever we get stuck** in the Five Focusing Step process, we can **use the Thinking Processes** such as the Conflict Cloud to identify what **old rules or metrics** to change to achieve the needed synchronization (**what we must STOP doing**) and use TOC and other Improvement Tools such as the tools from **DMAIC (Six Sigma) and LEAN** to identify what the **new rules or metrics** should be (**what we must START doing**).
10. There are some common erroneous assumptions managers make to deal with complexity that could result in **conflicting rules and measurements** which TOC have identified (such as “*An idle resource is a major waste*”)
11. The **only way to judge the impact of a local change**, it to judge it based on **the impact it will have on the System as a Whole** (impact on Sales, Costs, Inventory and Investment or T, OE and I)