

# ***Lean Manufacturing and the Theory of Constraints - Focusing Lean***

Presented by:

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# *Objectives*


- Learn about Lean Manufacturing
- Learn about TOC (Theory of Constraints)
- Learn how to get the most from your Lean efforts ... using TOC

# *Contents*

- Introduction
- A Brief Overview of Lean Manufacturing
- A Brief Overview of Theory of Constraints
- Similarities of Lean and TOC
- Differences Between Lean and TOC
- Conclusion – Applying Lean and TOC Together
- Focusing Lean – A Methodology

# ***Introduction – Improving with Lean and TOC***

- Both philosophies ...
  - Focus on improvement and advocate techniques to control the flow of material on the shop floor
  - Demonstrate dramatic results of implementation
    - Profit increase, lead time and inventory reduction, and operations simplified
  - Recognize that in order to achieve and sustain ongoing improvement, we must look beyond the walls of manufacturing to include the rest of the enterprise
  - Have expanded their scope to encompass principles and practices of the entire system to enable continuous system-wide improvement



# ***An Overview of Lean Manufacturing Concepts***

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- Primary focus is the elimination of waste
- The goal is to build the highest quality product at the most competitive cost in the shortest possible time
- The philosophy is that quality should be ensured in the production process itself so that defects are not passed on or overlooked
- The approach is to create simple rules that make it very easy for people on the shop floor to follow

# *Some of the more common Lean Tools and Techniques*



# ***Some of the more common Lean Tools and Techniques\****

## **Kanban – Pull Replenishment**

- A consumption based replenishment system that ‘pulls’ material from downstream to upstream work centres.
- The Kanban, a Japanese word for ‘signal or signboard’, is the signal used to indicate the need for replenishment or activity.
- The Kanban authorizes production, movement of material and / or limits inventories

## **Heijunka – Level Production**

- A production scheduling technique that creates a level schedule by sequencing orders in a repetitive pattern and smoothing the day-to-day variations in total orders to correspond to longer-term demand.
- Eg. If customers during a week order 200 of Product A, 200 of Product B and 400 of Product C, level scheduling would sequence the orders to run A, C, B, C, A, C, B, C ...

## **Standardized Work**

- Defined as the sequence of job tasks that must be performed by an operator to efficiently and effectively perform a given job function, no matter who does the work.
- Designed to be repeatable and intended to eliminate waste contributed by the variability associated to the operator and to increase the productivity of the operator.
- A frame work required to build on continuous improvement and promotes the involvement of the operator in defining and improving his/her job function.

# *Some of the more common Lean Tools and Techniques\**

## **Kaizen – Continuous Improvement**

- Kaizen is Japanese for continuous incremental improvements designed to eliminate waste on machinery, material, labour and production methods
- Kaizen is defined as a continuous cycle of continuous improvements focusing on analyzing current state measurements and performance, brainstorming improvement opportunities, implementing improvements and measurements to gauge progress, documenting new standard operations and then repeating the cycle.
- Set-up Reduction is a very popular target of Kaizen

## **Poka-yoke – Error Proofing**

- Poka-yoke is Japanese for error proofing and defined as devices or sensors used in production to detect malfunctions and to ensure mistake-proof production.
- This in-process quality tool is used to reduce human error such as identifying missing parts in an assembly by rejecting the parts and signaling the occurrence automatically

## **Visual Control**

- Visual control is defined as communication tools such as charts that display current status of quality, efficiency, safety, schedule, and boards that display and monitor work station performance to all employees.
- At a glance, these tools allow to everyone to assess whether or not production activities are proceeding normally
- Eg. Andon Board

# *Some of the more common Lean Tools and Techniques\**

## Layout for Flow

- A process of connecting the manual and machine processes of similar operations in order to eliminate non-value adding (i.e., waste) activities – particularly transport and movement.
- Layout designs are to consider balance operations in work cells, one piece flow, ergonomics, etc.

## 5 S - Seiri, Seiton, Seiso, Seiketsu, Shitsuke

- Five S can be summed up as - “A place for everything and everything in its place”
- The English equivalent of the five Japanese words are: Sort, Set in Order, Shine, Standardize, Sustain
- By eliminating the unnecessary, establishing a place for what remains, and cleaning up remaining equipment, tools, and storage devices, clutter is reduced and needed items are readily found

## Team Concept

- The concept of forming teams comprised of hourly employees responsible for meeting company objectives in areas such as quality, production and safety.
- Each team generally consist of six to eight team members.
- Each member is a stakeholder and is directly involved in the area targeted by the team for improvement.



# ***An Overview of the Theory of Constraints (TOC)***

# ***An Overview of the Theory of Constraints***

## ***(TOC)***

- Every business has at least one constraint (or leverage point) which limits the output of the entire operation - the often unidentified constraint limits a business' profitability – just as a chain's weakest link limits its strength
- Change any part of a system and you affect its performance, but, improve the key leverage point of a system and its performance increases exponentially
- The key is to identify the company's constraint and manage it
- A successful business must satisfy three necessary conditions
  - Satisfy the shareholders now and in the future
  - Satisfy the market now and in the future
  - Satisfy employees now and in the future
- Any improvement effort, if it is to be truly ongoing and sustainable, must satisfy all three conditions

# *Some of the more common TOC Tools and Techniques*



# ***Some of the more common TOC Tools and Techniques***

## **Drum-Buffer-Rope Production Planning**

- A production planning technique that maximizes the flow of product through the plant for which there is near term customer demand.
- The 'Drum' is the slowest operation or 'control point' that sets the pace at which the entire plant will process material.
- The 'Buffer' is the amount of work that is currently being processed before the drum that is sized to ensure that the drum never runs out of work.
- The 'Rope' is the material release schedule that releases orders into the plant synchronized with the pace of the 'Drum' – defines how much material goes into the plant.

## **Critical Chain Project Management**

- A project management technique that maximizes the number of projects that can be completed in the shortest possible time by exploiting both resource and task dependencies.
- Safety time is removed from individual task times and aggregated into one primary project buffer.
- CCPM is based on the principle that in order to finish projects on time, they need to be started as late as necessary versus as early as possible – this minimizes bad multi-taking.
- CCPM manages a common 'drum' resource to synchronizes multiple projects

## **Continuous Replenishment for Distribution**

- A consumption based replenishment approach that defines the location and amount of the inventory – both within the company and across the supply chain.
- Inventory is to be located at the point which offers the highest protection and maximum flexibility for RM, WIP and/or FG.
- Inventory size is calculated based on a combination of maximum consumption, reliable replenishment time and an appropriate safety factor.
- Inventory is immediately replenished by the supplier as the customer consumes products

# ***Some of the more common TOC Tools and Techniques***

## **Throughput Accounting**

- A managerial accounting based system that focuses measurement and analysis on what really matters about a business' performance – its net profit.
- The key Throughput Accounting measures are derived from:
  - Throughput (sales less totally variable costs), Investment (fixed assets and inventory, etc.), Operating Expenses (all other costs of the business)
- Under Throughput Accounting, no expenses related to providing capacity are allocated to products (i.e. the only costs that products have are the truly variable costs such as: material, freight, etc.)

## **Thinking Processes Problem Solving Techniques**

- A methodology derived from 'hard sciences' used to design business, operating and marketing strategies as well as assist in tactical problem solving
- Applying these tools ensures that companies maximize the ROI of their improvement efforts by focusing on their system constraint (leverage point).
- There are five 'cause and effect based' Thinking Process tools – Current Reality Tree, Future Reality Tree, Conflict Diagram, Prerequisite Tree and Transition Tree

## **The 5 Focusing Steps of Ongoing Improvement**

- A Process of Ongoing Improvement that provides focus to improvement actions
- The Five Steps are:
  - Identify the system constraint
  - Exploit the system constraint
  - Subordinate to the system constraint
  - Elevate the system constraint
  - Identify the next constraint and decide if you want to move it



# ***Similarities of Lean and TOC***

# Similarities of Lean and TOC

Lean

TOC

Focused on Value

Only deliver products or services to the customer that the customer values

Increase the customer's perception of value for your product or service

Understanding the Process Flow

Value Stream Mapping

Process Mapping

# Similarities of Lean and TOC

Lean

TOC

Protecting  
Flow

Kanban and variability  
reduction

Time buffers, stock buffers  
and protective capacity

Pull  
System

Kanban and single-piece flow

Drum-Buffer-Rope

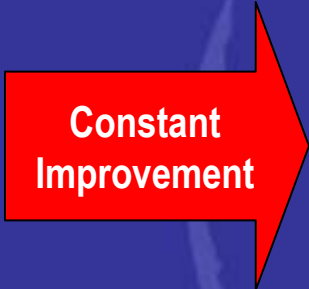
# *Similarities of Lean and TOC*

Lean

TOC

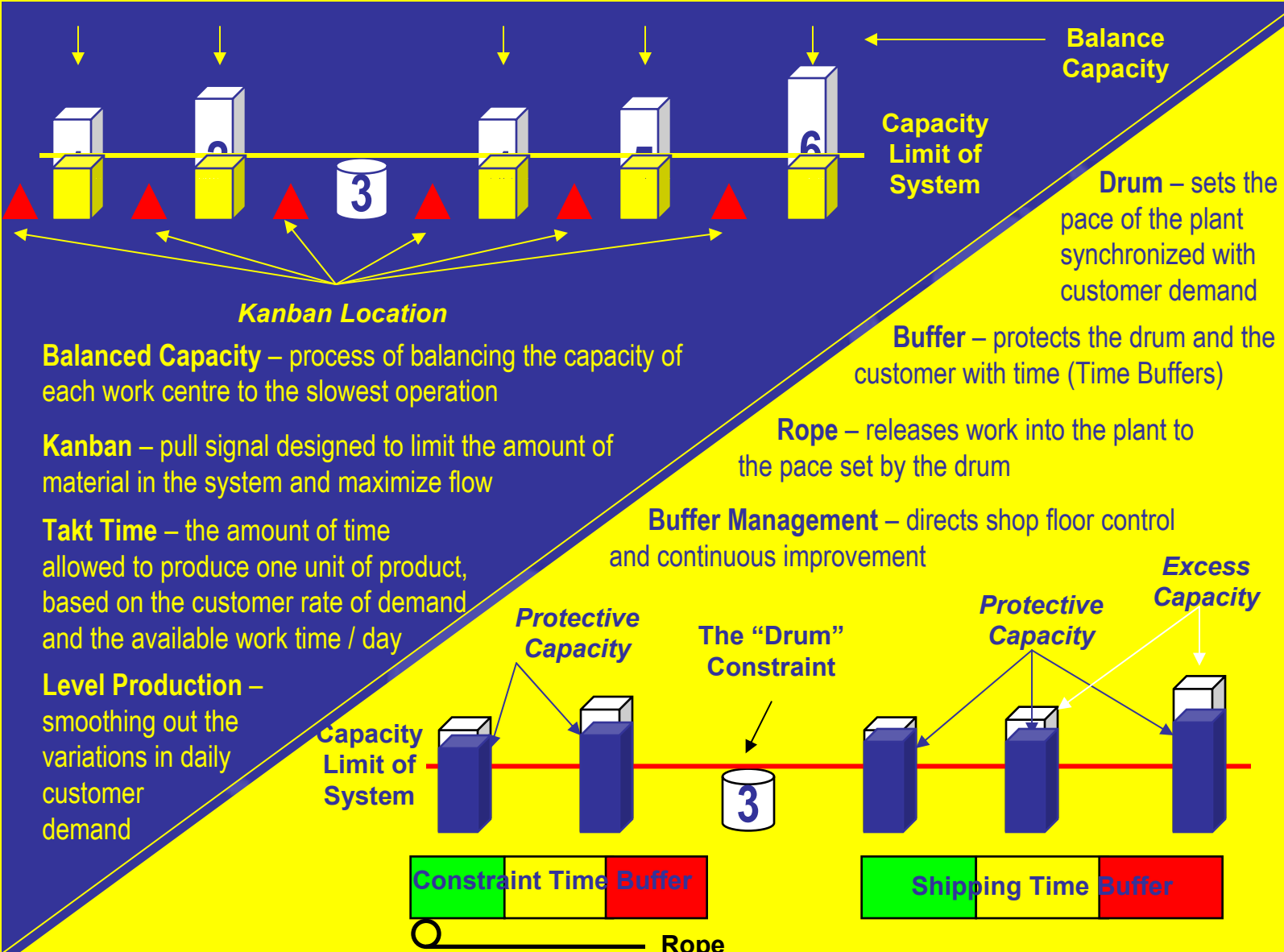
Perfection

Process Of Ongoing Improvement (POOGI)





# *Differences Between Lean and TOC*



**Balanced Capacity** – process of balancing the capacity of each work centre to the slowest operation

**Kanban** – pull signal designed to limit the amount of material in the system and maximize flow

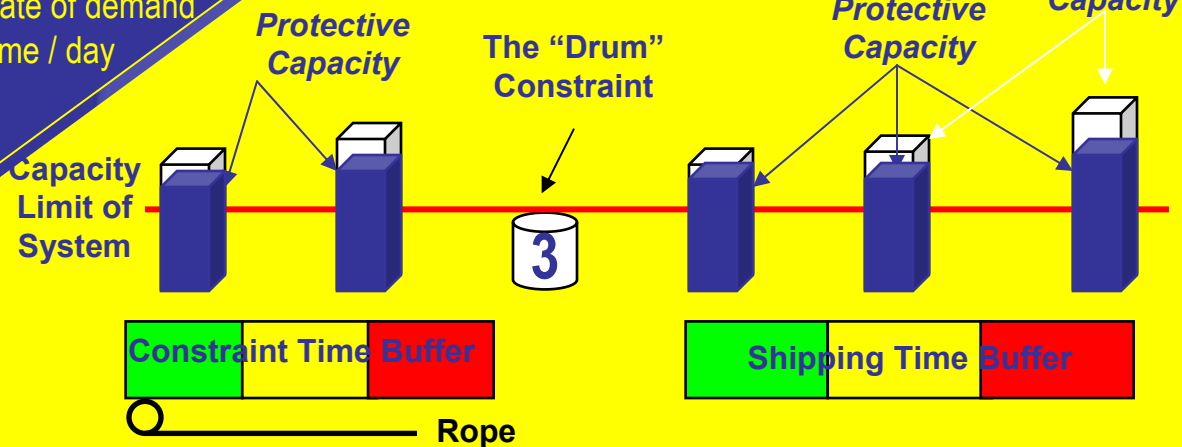
**Takt Time** – the amount of time allowed to produce one unit of product, based on the customer rate of demand and the available work time / day

**Level Production** – smoothing out the variations in daily customer demand

**Buffer** – protects the drum and the customer with time (Time Buffers)

**Rope** – releases work into the plant to the pace set by the drum

**Buffer Management** – directs shop floor control and continuous improvement



# Differences between Lean and TOC

## Lean

## TOC

### Underlying Philosophy

An organization is a collection of parts that can be systematically broken down, individually improved and put back together

An organization is a system of interrelated parts that can only be improved systemically by focusing on the constraint - systems thinking

### Objective

Eliminate Waste – reduce lead time and inventory in order to reduce costs (Reduce)

Increase Throughput – reduce lead time and inventory to gain competitive advantage, increase capacity and grow (Leverage)

# Differences between Lean and TOC

## Lean

## TOC

Breadth of Focus

Process Focus – design, order fulfillment, project management, finance & measurement, and distribution & replenishment

Business Focus – design, order fulfillment, project management, distribution & replenishment, marketing & sales, finance & measurement, and strategy

Resource Management

Dedicate machines and production lines to specific products – strive for maximum resource efficiency

Segment the market, not the resources – strive for maximum resource flexibility

# Differences between Lean and TOC

## Lean

## TOC

Capacity

Idle capacity is waste. Balance capacity to the takt time (rate) of customer demand

Excess capacity is waste - protective capacity is good. Unbalance capacity to maximize the constraint output based on customer demand

Purpose of Inventory

Inventory is waste and thus it must be eliminated – single piece flow with no inventory is the goal

Excess inventory is waste - inventory protects throughput against variability of supply and demand – there is always a role for inventory as a buffer to protect the constraint from Murphy

# Differences between Lean and TOC

## Lean

## TOC

Variability

Strive to reduce variability in all places to zero through: error proofing, level production, kaizen, standardized work, etc.

Variability (Murphy) will always exist – Protect against it with time buffers (time, inventory and capacity) and prioritize improvements (Lean & Six Sigma Tools) using Buffer Management

Role of People

Rely on people to improve the process, then remove people (automate) in order to reduce costs (waste)

Rely on people to improve the process, then move people in order to grow throughput

# Differences between Lean and TOC

## Lean

## TOC

Measurement

Redefines traditional operational efficiency and managerial accounting measures around plant performance - throughput is defined in units of volume

Redefines traditional operational efficiency and managerial accounting measures around company performance - throughput is defined in dollars

Improvement Focus

Improve all work centres concurrently to improve the entire plant

Focus improvement effort on the constraint (leverage point) and to realize significant results quickly



# ***Client Example – TOC and LEAN***

# ***Client Example – Process Improvement***

- Manufacturer of automotive parts
- Customer is also supplier – they don't own the inventory
- 4 primary production lines
- Approx. \$150 M in revenue

# *Client Example – Process Improvement*

	Assembly	Robotic Polish	Bartex	Rotary Buff	Touch Up	Inspection / Pack
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People	1	1	3	1	2	3
Sets / Hr*	100	86	88	68	150	200
Rework					33%	
Distance	80	20	10	30	10	6

\* Based on 50 minutes per hour

- Non-Value Added Time – 5.4 days
- Value Added Time – 316 seconds
- Total Distance Traveled – 2000 ft
- Demand 4,000 sets per week – could sell more if they could make more

# *Client Example – Process Improvement*

- Traditional Approach: Global Improvement = Sum of Local Improvement
  - Focus – Reduce cost (waste) per part



- Underlying assumptions
  - The best way to maximize the efficiency of the plant is to maximize the efficiency of each operation

# Client Example – Process Improvement

- Traditional Approach: Global Improvement = Sum of Local Improvement
  - Focus – Reduce cost (waste) per part



People	1	1	3	1	2	3
Sets / Hr	100	86	88	68	150	200
Rework					33%	
Distance	80	20	10	30	10	6
Solutions	<ul style="list-style-type: none"> <li>Use compressed air guns vs manual tools</li> <li>Tilt assembly table</li> </ul>	<ul style="list-style-type: none"> <li>Change tray loader to reduce loading / unloading time</li> <li>Change layout to reduce travel time</li> </ul>	<ul style="list-style-type: none"> <li>Reduce need for Touch Up operation (2 people)</li> <li>Automate greasing applicator at Touch Up</li> </ul>	<ul style="list-style-type: none"> <li>Make tools easier to access</li> </ul>	<ul style="list-style-type: none"> <li>Batch rework at Touch Up so Bartex has extra time to keep the flow going</li> <li>Reduce rework after Rotary</li> </ul>	<ul style="list-style-type: none"> <li>Combine work steps and roles to eliminate one position</li> </ul>

# *Client Example – Process Improvement*

- Traditional Approach: Global Improvement = Sum of Local Improvement
  - Focus – Reduce cost (waste) per part
  - Improvement Opportunity
    - Potential to reduce labour hours by up to 3 jobs x 3 shift (approx. \$450K / year)
    - Question to consider - Would the jobs really disappear or would they just be consumed elsewhere in the business?

# ***Client Example – Process Improvement***

## ■ System Approach

- The strength of a chain is determined by the strength of its weakest link
- In order to strengthen the chain (increase its throughput) you need to focus your improvement energy on the weakest link
- Five focusing Steps
  - Identify the system constraint
  - Exploit the system constraint
  - Subordinate to the system constraint
  - Elevate the system constraint
  - Identify the next constraint and decide if you want to move It

# Client Example – Process Improvement

- Systems Approach: Global Improvement  $\neq$  Sum of Local Improvement
  - Focus – Increase Throughput



People	1	1	3	1	2	3
Sets / Hr	100	86	88	68	150	200
Rework					33%	
Distance	80	20	10	30	10	6
Solutions	<ul style="list-style-type: none"> <li>• Identify the System Constraint – Rotary Buff</li> <li>• Exploit the System Constraint – Maximize rotary output, sequence orders, only produce to customer demand, focus preventive maintenance on Rotary, work through lunches and breaks, improve shift changeovers on Rotary, ensure only good quality parts go through Rotary and set targets</li> <li>• Subordinate to the System Constraint – Ensure bank or work remains in front of Rotary to prevent downtime, don't eliminate Protective Capacity, and record reasons for Rotary Downtime</li> </ul>					

# *Client Example – Process Improvement*

- Systems Approach: Global Improvement = Sum of Local Improvement
  - Focus – Increase Throughput
  - Improvement Opportunity
    - Historical average daily output – 43 sets / hour
    - After implementation (8 weeks) – 69 sets / hour
      - 60% increase in Throughput units or the potential for a \$4.3M increase in annual \$Throughput



***Conclusion – Applying Lean and TOC  
Together***

# *Lean and TOC Together*

Combining the best of Lean and TOC creates a highly focused and effective improvement approach that is fully aligned with the growth objectives of the business

Companies can realize results quicker by using TOC to focus Lean

TOC is an improvement effort more focused on growth (Leverage)

Improvement efforts should be prioritized as follows: throughput increase, inventory reduction, operating expense reduction

Many companies are not improving at a fast enough rate

An increase in Throughput Dollars results in a greater net profit increase than reduction in costs

The goal of improvement efforts should be profitable growth

Lean is a highly effective improvement approach focused throughout the entire plant

One of TOC's offerings is a highly effective improvement approach (DBR) focused on the constraint

The goal of most businesses is profitable growth

The goal of improvement efforts should be aligned with the goal of the business



# *Applying Lean and TOC together in a 5 step process*

Combining the best of Lean and TOC creates a highly focused and effective improvement approach that is fully aligned with the growth objectives of the business

## **1 – Identify the system constraint**

- Unbalance capacity, if required

## **2 – Exploit the system constraint**

- Schedule the constraint to maximize its performance while simultaneously satisfying customer demand (Takt time)
- Apply Lean tools and techniques (Set-up reduction, standardization, poka-yoke, visual control, 5 S, etc.) to the place that promises the fastest and most dramatic improvement – continually strive to remove waste at the constraint
- Manage time buffers and implement buffer management

## **3 – Subordinate to the system constraint**

- Application of Kanbans and pull systems
- Choke the release of material to the floor with the Rope
- Sacrifice upstream work centre efficiency, if required, to maximize the constraint output
- Manage time buffers and implement buffer management
- Apply Lean tools and techniques to the work centres that hinder flow

## **4 – Elevate the system constraint**

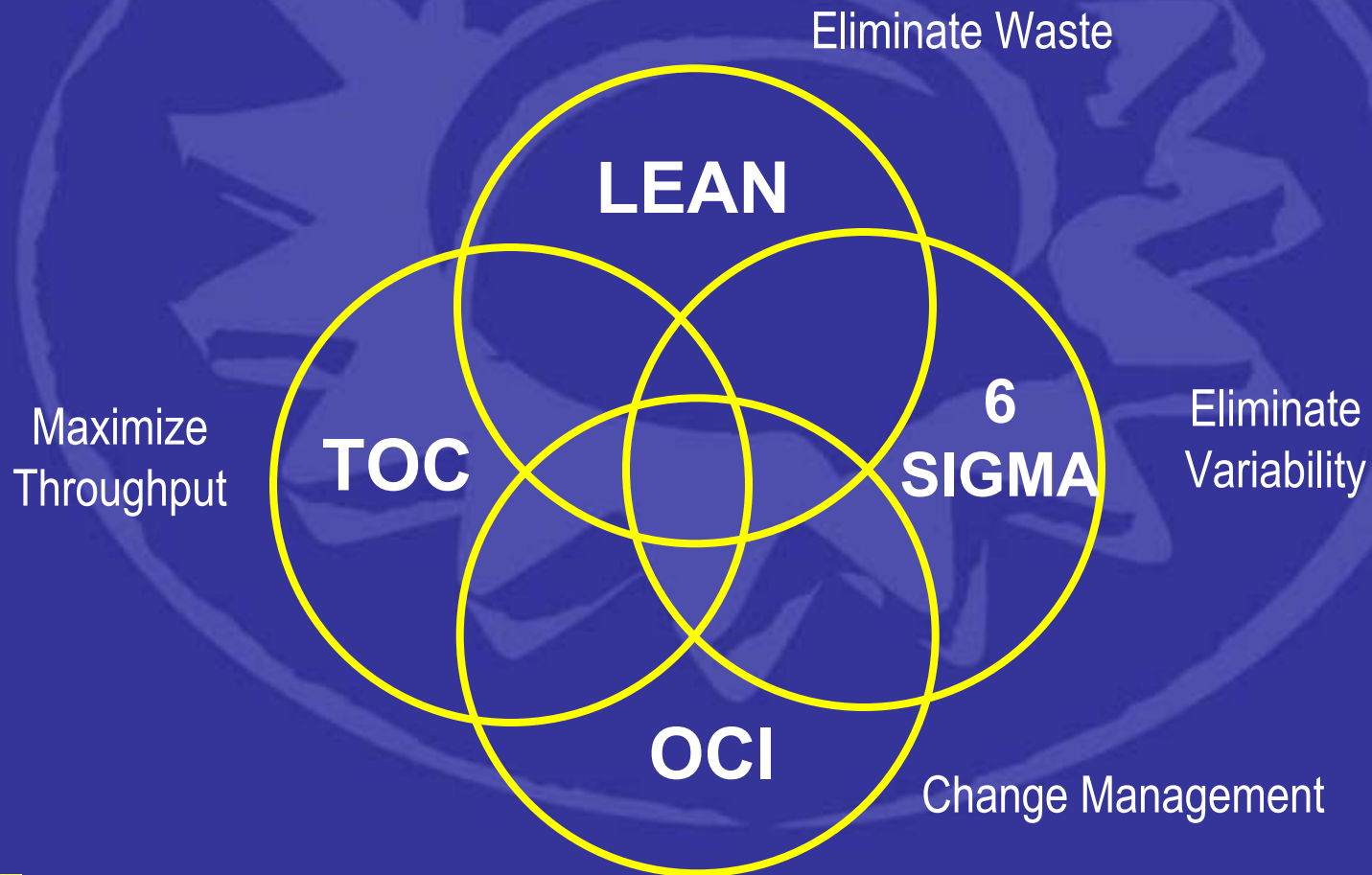
- If still required, spend money to acquire additional capacity

## **5 – Identify the next constraint and decide if you want to move it**



# ***Focusing Lean – A Methodology***

# *Manufacturing's "Big Four"*



# ***Focusing Lean – A Methodology***

## **Phase I:**

### **Agree on the Problem**

1. Agree on business issues preventing you from achieving profit & growth targets
2. Determine core conflict and cause / effect relationship among issues.
3. Create solutions and plan to implement
4. Define resources required (Steering Committee and project teams)
5. Develop training and communication plan (e.g. TIS)

## **Phase II: Design & Implement**

### **Capacity Management**

1. Develop Rough Cut Capacity Plan
2. Select “control point” in plant and apply Lean tools
3. Implement order “pull” and “release” scheduling mechanisms (MPS)
4. Determine protective capacity requirements in “non-control point” areas and subordinate performance
5. Change key performance measure to “on-time-to-schedule”

### **Materials Management**

1. Develop Rough Cut Material Plan
2. Ensure BOM accuracy
3. Implement order “pull” and release scheduling mechanisms for Raw Material Stock Buffers (RMSB), Finished Goods Stock Buffers (FGSB) & contractors
4. Apply lean tools to RMSB / FGSB order/storage
5. Change key performance measure to stock-outs and lead time / variability reduction

### **Plant Layout and Flow**

1. Re-evaluate order fulfillment product flow (macro view)
2. Dedicate storage locations for RMSB & FGSB
3. Dedicate staging areas for time buffers & in-process material flow
4. Utilize visual controls / signals / measures
5. Implement “5S”

### **Quality Improvement**

1. Define critical customer characteristics
2. Create measurement system
3. Identify critical process characteristics (Design Of Experiments - DOE)
4. Measure process capability (Statistical Process Control - SPC)
5. Identify and minimize sources of variation (DOE) causing out-of-control and out-of-spec conditions

## **Phase III:**

### **Buffer Management**

1. Develop “On-time” measures for:
  - To customer, to FGSB, to Schedule, to time buffer
2. Perform buffer management & pareto / root-cause analysis to determine barriers to flow
3. Utilize buffer management data to direct Continuous Improvement process
4. Post results company-wide
5. Go to Phase I

**Project / Change Management and Software Support**

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