

## Theory of Constraints (TOC)

# TOC & Lean – Getting the Best of Both Worlds

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Steve Jackson

Rod Gelhorn

Synchronix Technologies Inc. • 300 – 3665 Kingsway • Vancouver • BC • Canada • Tel: 604-668-3253  
www.synchronix.com

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## 4 Prerequisites for Improvement (Regardless of the Improvement Technology)

1. Connection to downstream supply chain – customers, prospects, markets, even their markets
  - Comes with TOC ... not on today's agenda
2. Measurements that tell us the truth
  - Integral with TOC ... not on today's agenda
3. **Cause-Effect between decisions, actions and the bottom line**
  - **The heart of the TOC ... it IS on today's agenda**
4. Connections between Belief Systems, Policies, Procedures, Measurements, Behaviours, and Outcomes (Symptoms, for example).
  - Integral in TOC ... not on today's Agenda

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## Prerequisite #1 for Improvement (Regardless of the Improvement Technology)

1. Connection to downstream supply chain – customers, prospects, markets, even their markets
  - Comes with TOC ... not on today's agenda.
  - There is a need to recognize that some internal improvements that are assumed to provide a competitive edge, might NOT.
    - For example, there are circumstances where a reduction in lead time and improvement in on-time delivery will not be enough to cause a prospect (or market) to drop a current supplier to deal with you.
    - And not enough to cause a prospect or customer to pay more for your offering than the competitors.
    - So in reality they do NOT provide a competitive edge.
  - While those same improvements to a different customer, or market, might be worth GOLD – and represent a genuine competitive edge, as evidenced by winning business, and sustaining or increasing prices.
  - Managers need to have a far greater understanding of their downstream supply chains than is common, and to analyze this BEFORE developing a strategy for improvement.

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## Prerequisite #2 for Improvement (Regardless of the Improvement Technology)

2. Measurements that tell us the truth
  - Integral with TOC ... but not on today's agenda.
  - Common improvement measurements are based around standard cost-accounting concepts – product cost, process cost, margins, resource efficiency.
  - While they are widely accepted (to the degree that are considered un-challengeable, just a “given”) ... they are the single biggest obstacle to meaningful improvements to productivity and profitability and a competitive edge, in 99% of the companies we encounter.
  - Management is often completely or largely blind to them.
    - Which presents a major opportunity for TOC users.
  - Note: Activity Based Costing is not a useful alternative.
  - Lean Accounting recognizes some of the problems of the standard cost approach; we do not recommend it.

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## 4 Prerequisites for Improvement (Regardless of the Improvement Technology)

4. Clearly understood connections between Belief Systems, Policies, Procedures, Measurements, Behaviours, and Outcomes (Symptoms, for example).
  - Integral in TOC ... but not on today's Agenda.
  - There can be no change in outcomes without a change in behaviours.
  - Belief systems give rise to policies (written and unwritten, formal and informal); policies give rise to procedures (same conditions); procedures give rise to measurements (ditto); and procedures and measurements compel behaviours.
  - If deep-rooted measurements, procedures, policies and even belief systems do not change, **any management-caused change in behaviour is bound to place people in conflict ... and create a gravitational pull back to the previous behaviour.**
  - **If outcomes are to change, and the change is to be more than temporary, then the changes must first be made at the level of belief systems, policies, procedures and measurements.**

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## Prerequisite #3 for Improvement (Regardless of the Improvement Technology)

3. Cause-Effect between decisions, actions and the bottom line
  - The heart of the TOC ... it IS on today's agenda, indirectly.
  - This connection is the difference between "correlation" and "cause and effect."
  - **Much of the leverage that the TOC provides to other bodies of knowledge emerges from the cause-effect understanding that permeates every aspect of the TOC.**

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## Let's be clear on the Goal

- Lean and Six Sigma are “natural” allies
- TOC and Six Sigma can be very good “allies”
- TOC and Lean have conflicts ... and powerful synergies

Womack says of Lean, Six Sigma, TOC, et al ... “At the end of the day we are all trying to achieve the same thing: The perfect value stream.”

### I disagree:

**For a for-profit company, TOC is aiming EXPLICITLY to maximize Net Profit and ROI.**

**And the “perfect value stream” MIGHT be a means to that end, (only “might”) ...**

**... but it's NOT the end in itself.**

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## Is It Worth Sorting Through the Disagreements?

- There *ARE* complementary aspects of Lean and TOC.
- But there are also conflicts.
  
- The question is:

**Are the benefits worth the effort to deal with the conflicts?**

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## The Ultimate Comparison?

- US Corporation, 21 plants
- To resolve arguments over which technology to use, decided on an experiment<sup>1</sup>
  - ❑ 11 plants applied Six Sigma
  - ❑ 4 plants applied Lean
  - ❑ 6 plants applied “TLS”
    - TOC 5 steps applied as the lead technology
    - Lean subsequently applied in support
    - Six-Sigma applied in line with Lean’s “Pursue perfection” step
  - ❑ Double Blind study
  - ❑ Data captured over 2 years

<sup>1</sup> Results published by Reza M. Pirasteh and Kimberley S. Farah in APICS magazine, May 2006

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## The Ultimate Comparison? Not Quite.

- It would have been useful to see TOC stand-alone as part of the experiment, and not just in combination with Lean and Six Sigma
- AND the measurements in the published data are better aligned to Lean and Six Sigma thinking than TOC
  - ❑ The published measurements of success were “natural” measurements for Lean and Six Sigma – contributions to verifiable financial savings
    - Cost savings are almost an “incidental” benefit in TOC where the focus is on “make more money” through profitable sales growth
  - ❑ In an environment with sales responsibility at an individual plant level, the natural measurements for TOC would have been profitability growth, productivity growth

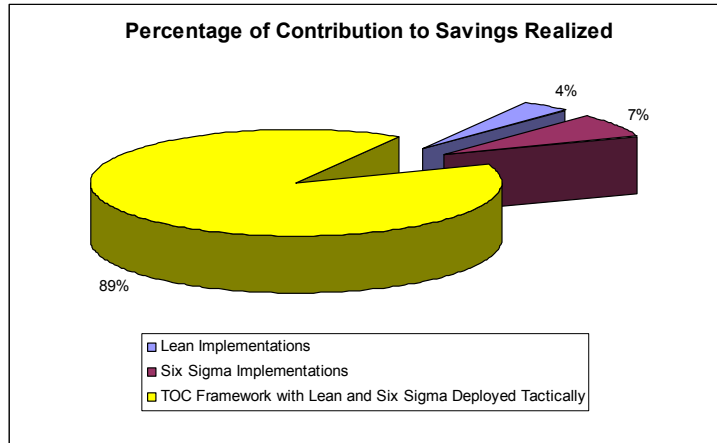
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## The Results

**89% of the benefits came from the 6 plants (out of 21) using TOC as the lead technology with Lean and Six Sigma following**



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## On A Per-Plant basis ...

This means that on average, each plant using the TOC with Lean and Six Sigma contributed...

- **15 times** more of the benefit than each plant using stand-alone Lean
- **23 times** more than each plant using stand- alone Six Sigma

**So: Is that worth dealing with some conflicting philosophies/techniques/measurements?**

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## Some Conflicts seem just a matter of emphasis (but still non-trivial)

- Lean: emphasis on Value, Flow, Eliminating Waste, Customer “Pull,” Continuous Improvement
  - ❑ Implies and assumption ... that successful implementation will convert to financial improvement.
- TOC: For a for-profit business, focus directly on “make more money, now and in the future”
  - ❑ Emphasis on identifying the constraints to doing so, and managing them and non-constraints so as to help achieve the Goal
  - ❑ En-route we’re bound to bump into issues of Value, Flow, Waste, etc. ... and we’ll deal with them when we do.

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## Real Differences Become Clear at Start-Up!

- **Womack on Lean: “How to get started”**
  - ❑ Find a change agent
  - ❑ Get Lean knowledge (e.g. hire an ex-Toyota Sensei)
  - ❑ Find or create a crisis
  - ❑ **Start by simply eliminating waste everywhere possible**
  - ❑ Map the value streams
  - ❑ Begin ASAP
  - ❑ Demand immediate results

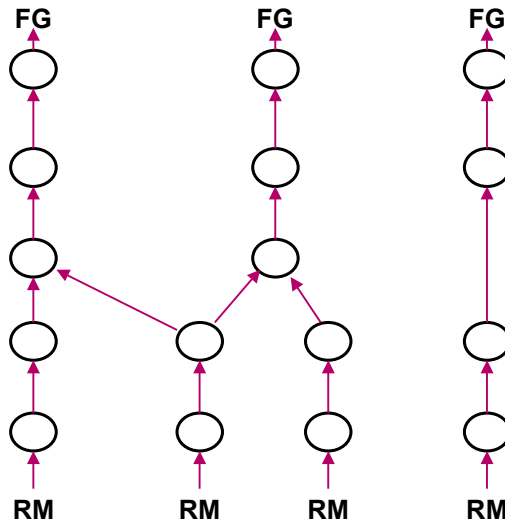
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## A Simple Environment



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## Where Would You Find Waste? What?

In an environment such as this, we can be confident of finding all the classic wastes classified by Ohno:

- ❑ Over-production
- ❑ Inventory
- ❑ Extra processing steps
- ❑ Motion
- ❑ Defects
- ❑ Waiting
- ❑ Transportation

... and, find it throughout the plant and beyond.

**And the guideline is to attack waste everywhere we find it? Hmm... let's consider an alternative!**

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## Instead: A Focused Approach: Theory of Constraints

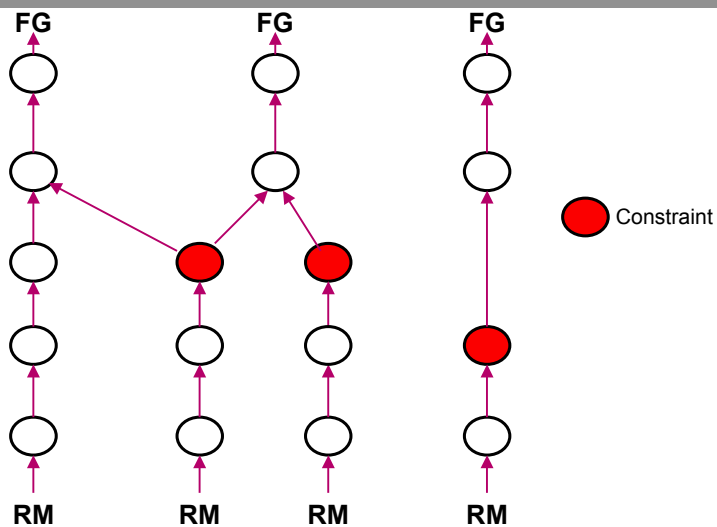
### The 5 Focusing Steps of the TOC:

1. Identify the Constraint(s)
2. Decide how to Exploit the Constraint(s)
3. Subordinate everything else to the decisions in (2)
4. Elevate the Constraint(s)
5. If, in Steps 1 through 4 a Constraint is “broken” ...  
Go back to Step 1.

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## Identify the Constraint(s)



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## We're Keeping It Simple for Purposes of Illustration

- We're assuming an internal (capacity) constraint
- To begin with, constraint may be a lack of sales (a "market constraint") ... or rarely, a supply constraint
- However, to "break" a sales constraint we typically start by improving the plant internals
  - Provides a competitive edge to win more sales ... or at least gives Sales better ammunition
  - Provides internal system to manage aggressive sales growth without threatening newly-excellent on-time performance and lead times
- When a sales constraint is "broken," the emergence of an internal (capacity) constraint is ultimately likely

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## How To Exploit A Resource Constraint

- The following are typical examples
- The best suggestions come from your own resources
  - Don't waste a drop!
    - Stagger breaks
    - Only make what is needed
      - no "economic batches"
      - no "while we're doing this, let's..."
    - Keep on schedule!
    - Fast change-overs
    - Never starve a constraint!

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## How To Exploit A Resource Constraint

- Don't waste a drop! (continued)
  - ❑ Do not work on defective material.
  - ❑ Work to avoid scrapping what's been through the constraint
  - ❑ No breakdowns! Preventative maintenance
  - ❑ If breakdown ... fast fix
  - ❑ Look for faster ways to do the job/timesavers
  - ❑ Good people
  - ❑ Best training

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## This is Not Rocket Science!

- This is the type of list that the people associated with the Constraints can generate in minutes.
- And, they can probably put some semblance of many of the ideas in place in days.
  - ❑ Not every one, immediately
  - ❑ Not a great job on those that get done, initially
  - ❑ **But because we're focusing on the constraint, the impact of even a poor job is typically massive!**

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## A Little More Advanced ... Develop A Finite Schedule

- A finite schedule on the Constraint is called the “DRUM” ... think, soldiers marching in step to a cadence or drumbeat
- For orders, or parts, the Drum might look like this ...

Job	Set-Up Start	Set-Up End	Run Start	Run Duration	Run End
A1004	0600	0645	0645	100	0825
A4122	0825	0835	0835	60	0935
A2666	0935	etc			

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## The TOC Brings WHAT to the Table?

- Total time we've focused on Constraints so far in the start-up discussion: 100%
- Total time we've spent on non-constraints so far in the start-up discussion: 0%
- **What the TOC brings is:**
  - ❑ **Focus**
  - ❑ **Leverage**
- ◆ Managers *can* focus without TOC, of course, but TOC takes it to a whole new level ... AND changes WHERE they focus, too.

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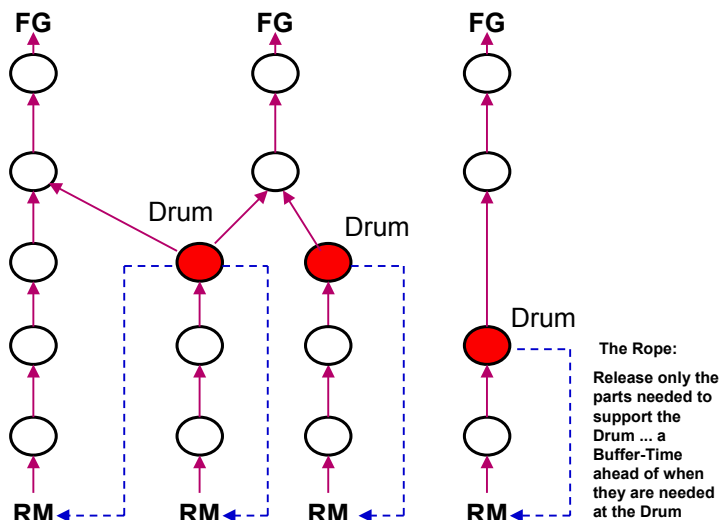
## What's the Shape of "Subordinate the Non-Constraints?"

- Choke-off material releases ...
  - ❑ Only release *the right materials* needed to support the Drum, ...
  - ❑ Only *the right quantity* to support the Drum, ...
  - ❑ Only *the right time* ahead of when the parts are needed at the Drum ... never earlier! (Right time ahead = Buffer Time ... See slide 27)
- The rules at non-constraints ...
  - ❑ Start work when parts arrive, work at a good but safe speed, work with quality, and pass the parts along in small transfer batches when it makes sense (not dogmatic about single piece flow ... Just, smaller transfer batches where practical)
  - ❑ If you have no work in front of your work station ... don't work on it
  - ❑ It's OK to create idle time! (We have good uses for it!)
    - ❑ It's beyond today's discussion but we NEED idle time to be created in order to get the maximum performance from the plant as a whole
    - ❑ An understanding of this issue makes the conflict with Lean, moot – the advantages are obvious, and substantial, in most environments

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## Subordinate non-Constraints: Buffers, Ropes, small Transfer Batches



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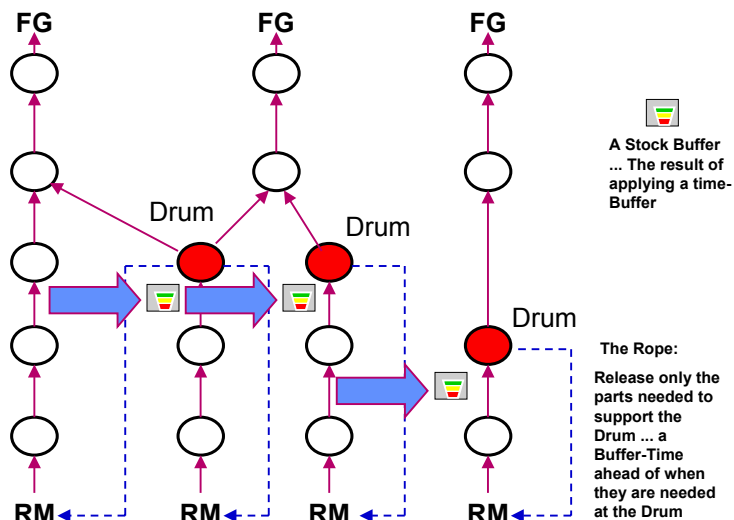
## Buffer Time: Manage Time, not Inventory

- If for example, we are confident work can flow from release to Constraint in 8 hours ...
- But we are making sure we don't starve the Constraint
- Then we'll choose a Buffer Time which is:  
run + set-up + some buffer amount ...  
**to make sure the parts get to the Constraint on time without management intervention 9 times out of 10 even if "typical" things go wrong!**
- The inevitable outcome ... a Buffer of stock builds up in front of the Constraint
- **Which is EXACTLY where we need it to be, to protect the performance of the Constraint AND therefore the performance of the Plant!**
  - ❑ Note: total WIP inside the plant likely to be less than that of a kanban approach

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## Buffer Time Translates to PIN-POINT Buffer Stock ... Exactly Where We Need It!



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## What Do We Get?

### From the Initial “Exploit” activities (1 to 30 days)

1. **On-time delivery into the 90% - 95% level** (by getting more from the constraints, and staying closer to schedule at the constraints)
2. **10% to 20% more product produced and shipped from the same resources** (by getting more from the constraints)
3. **Optional twist: Lead time reduced 25% to 50%** (By a simple choking-off of material releases even without a full “Rope” in place)

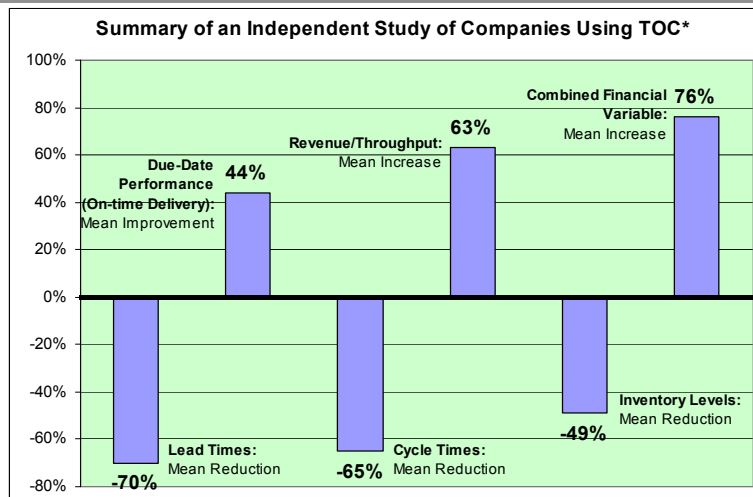
### From the later development of the Drum-Buffer-Rope system (30 – 90 days)

1. Lead time reduced by 50% to 70% ... sometimes more
2. On-time delivery to 95% to 98%, sometimes better
3. 20% to 30% (common) to 40% (rare) additional product produced and shipped from the same resources

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## In Support of the Claim: Average Results from 400 Case Studies



\* The World of the Theory of Constraints, Mabin & Balderstone, St. Lucie Press, 2000

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## The Low-End Business Case

Assume annual Sales of \$10MM

Assume Raw Material costs are 40% of \$ Sales

Assume 15% increased capacity surfaced

Assume products generated from the exposed capacity can be sold at standard prices

Added Revenue: \$1,500,000

Material Component: \$ 600,000

Added Throughput: \$ 900,000

➡ **If genuinely no added OE,  $\Delta NP =$  \$ 900,000**

Note: (1) TOC typically exposes 20% to 40% capacity

➡ (2) **Even if this company added, e.g. 5 or 10 people at \$30,000 to achieve this (never, in our experience)... this scale of improvement is *still* very lucrative!  
- In terms of Profit AND company valuation**

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## This Plant Is STILL Chock-A-Block O'Muda

**In Lean terms, we HAVE attacked some Wastes ...**

1. Over-production (Drum = demand, material releases = Drum)
2. Inventory (Often less WIP even than with JIT)
3. Waiting (Only wait is at constraint)

And DBR is a PULL mechanism; different from kanban, but PULL.

**But so far ... think about it! ... we haven't touched:**

1. Any extra processing steps
2. Plant layout is not changed ... there will certainly be too much travel between resources
3. Probably not 1-piece flow (but will be smaller transfer batches)
4. Nothing done about defects (outside of the focus on constraint performance)
5. Few or no process improvements outside of the Constraints
6. No attacks on process variability
7. Many more opportunities we haven't touched!

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## Yet this Waste-full Plant will Be Kicking Butt!

- Lead time probably best-in-class within 90 – 120 days
- On-time delivery probably best-in-class within 90 – 120 days
- Improved quality is a by-product
- Added productivity translates into a MUCH more profitable plant
  - ❑ Not through spurious “cost savings”
  - ❑ From shipping significantly more, for just the cost of materials!
- Improved cash flow (after 1 – 2 cash cycles)

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## This Is Where Lean (and Six Sigma) Can Come Out To Play

- Inside the plant, we'll be focusing on 3 things in priority:
  - ❑ #1: Better performance at the Constraint
  - ❑ #2: Remove the obstacles from everywhere else in the system that inhibit improved performance at the Constraint or actually threaten performance at the Constraint; or that threaten Shipping performance
  - ❑ #3: Improvements in non-constraints that support lower inventory, faster flow, less variation, less “uneven-ness”
- TOC offers a mechanism for identifying where the improvements are necessary, and for prioritizing them by the degree of threat to performance
- **But this is where Lean and Six Sigma come into their own!**

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## Lean and Six Sigma Practitioners Should be Drooling at the Opportunities

1. Map, challenge, improve the process flow
2. Improve processes ... constraint, feeders, fed-from
3. Reduce set-ups ... constraint, then non-constraints in priority
4. Attack variability ... on constraint, feeders, fed-from
5. Reduce defects ... bring all the tools to bear!
6. 5S ... clear opportunities everywhere, visible results
7. Change plant layout ... improve flow, reduce travel
8. Poka-Yoke ... wherever appropriate
9. TPM ... keeping "Exploit," "Subordinate" in mind, though
10. "Blitzes" on appropriate problems (TOC pin-points where)
11. Perhaps kanban ... Judiciously
12. Many, many more opportunities

**BUT: All within a framework of "Exploit," "Subordinate," and "Elevate"**

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## Lean's Role Can Go Even Further

1. Lean's "define value" concept
  2. Lean's 3P approach
  3. Lean product development
- ... are more advanced concepts with complete affinity if practiced within a TOC framework
- TOC's "Exploit" and "Subordinate" add a new dimension to the "standard Lean" use of these tools
  - The TOC approach to sales and marketing ("change the customer's perception of value" adds a new dimension, too
  - TOC's Critical Chain Project Management... ditto

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## So ... Is There An End To Conflict? Do We Have Peace in Our Time?

Hmmm ... Not quite.

**At the nitty-gritty level, there are still some potential conflicts:**

- ❑ Line balancing – a very limiting concept!
- ❑ Target costing – an aspect of Lean Accounting
- ❑ Others

**BUT ... A solid understanding of TOC and of Lean will make the resolution of these (and others) a non-issue ... while the company is banking the benefits of the TOC-focused activities!**

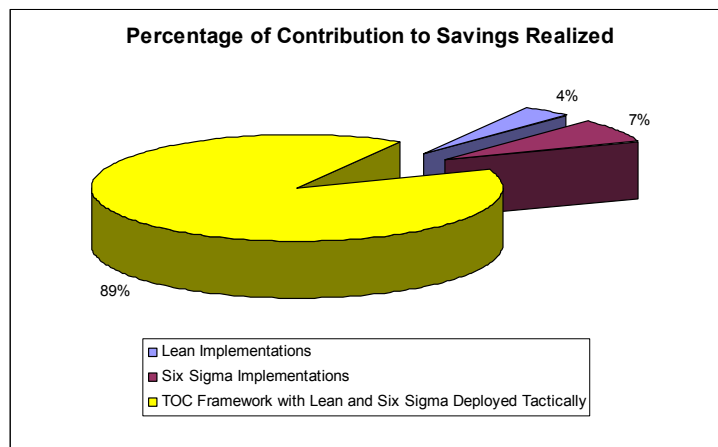
**Be pragmatic, not dogmatic!**

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## Once Again: Is it worth it? Remember ...

**89% of the benefits came from the 6 plants (out of 21) using TOC as the lead technology with Lean and Six Sigma following**



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