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APPLYING THE THEORY OF CONSTRAINTS IN THE COURSE OF PROCESS IMPROVEMENT

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Abstract

Theory of constraints (TOC) is about thinking in logical, systematic, or structured processes similar to the PDCA learning loop. It is about analyzing cause and effect, verifying basic assumptions, exploring alternatives and process improvement. The goal of TOC is to maximize the efficiency of a process selectively at the most critical points and thereby maximize profitability, quality, or other corporate objectives. This paper include basic theoretical information about TOC and following application during process improvement.

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Key words

theory of constraints (TOC), process improvement, critical chain

Introduction

Theory of Constraints (TOC) is an overall management philosophy introduced by Dr. Eliyahu M. Goldratt in his 1984 book titled *The Goal*, that is geared to help organizations continually achieve their goal. The title comes from the contention that any manageable system is limited in achieving more of its goal by a very small number of constraints, and that there is always at least one constraint. A constraint is anything that prevents the system from achieving more of its goal.

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Theory of constraints assumption

TOC methodology operates on several assumptions:

- As in the case of lean, the organization places a value on the speed at which its product or service travels through the system. Speed and volume are the main determinants of success.
- Current processes are essential to produce the desired output.
- The product or service design is stable.

Value added workers do not need to have an in-depth understanding of this improvement methodology. Suggestions by the workforce are not considered vital for successful implementation of the theory of constraints. Organizations with hierarchical structure and centralized knowledge value this approach.

Systems as chains

A system is generally defined as a collection of interrelated, independent processes that work together to turn inputs into outputs in the pursuit of some goal. As pictured above, the chain has one "weakest link." If force is applied to the chain at an increasing rate, it would eventually break at this point. Therefore, the weakest link is the constraint that prevents the chain (system) from doing any better at achieving its goal (transmitting force).

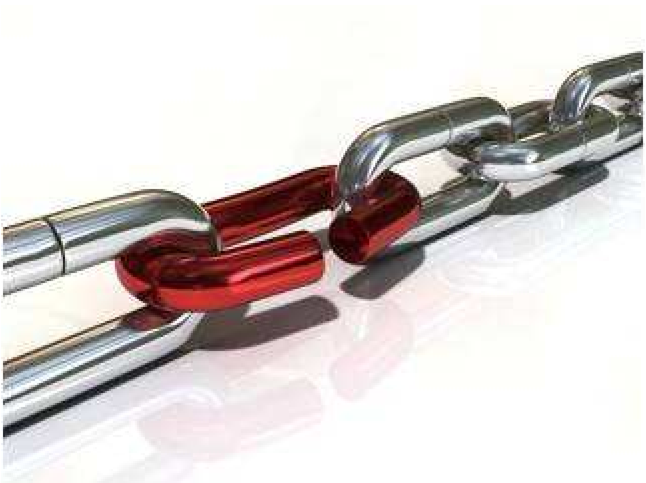

Fig. 1. *Weakest link in the chain*

Goldratt states that there is only one constraint in a system at any given time limiting the output of the entire system. The remaining "links" are known as nonconstraints.

When one constraint is strengthened, however, the system does not become infinitely stronger. The constraint simply migrates to a different component of the system, i.e., some other link is now the weakest and all other links are nonconstraints. The system is stronger than it was but still not as strong as it could be.

To better understand the theory of Constraints and nonconstraints, consider a sample production system that runs raw materials through three component processes and turns them into a finished product, as pictured on figure 2.

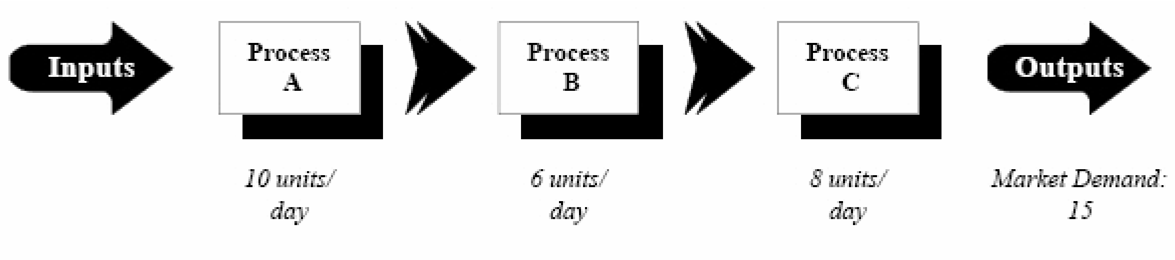

Fig. 2. *Standard process flow in organization*

Within the system, each process is equivalent to a link in the production chain. Where is the constraint in this chain? Process B is the weakest link since it produces only six units per day no matter how many the rest of the components produce. Where are the nonconstraints? Everywhere else.

Imagine that the manufacturer improves process B until it can produce 18 units per day. Now, process C becomes the system constraint while the nonconstraints are everywhere else. If process improvements continue until all processes are producing 18 units/day or higher, the system constraint becomes the marketplace, which can accept only 15 units per day.

At this point, internal constraints have been replaced by an external constraint. Overall, the theory of constraints emphasizes fixing the weakest link in the chain—the system constraint—and temporarily ignoring the nonconstraints. In this way, the theory has a profound impact on process improvement.

Rather than spreading limited time, energy, and resources across an entire system (which may or may not result in tangible results), teams focus on that part of the system with the potential to produce immediate system improvement.

The five focusing steps of TOC

***Step 1: Identify the system constraint*.**

In the first step, an organization identifies what part of the system constitutes the weakest link and determines whether it is a physical constraint or a policy-related issue.

Step 2: Decide how to exploit the constraint.

Organizations "exploit" the constraint by utilizing every bit of the constraining component without committing to potentially expensive changes and/or upgrades.

***Step 3: Subordinate everything else*.**

With a plan in place for exploiting the constraint, organizations adjust the rest of the system to enable the constraint to operate at maximum effectiveness and then evaluate the results to see if the constraint is still holding back system performance. If it is, the organization proceeds to Step 4. It it's not, the constraint has been eliminated and the organization skips ahead to Step 5.

Step 4: Elevate the constraint.

If an organization reaches Step 4, it means that Steps 2 and 3 were not sufficient in eliminating the constraint. At this point, the organization elevates the constraint by taking whatever action is needed to eliminate it. This may involve major changes to the existing system, such as reorganization, divestiture, or capital improvements. Since these typically require a substantial up-front investment, the organization should be certain that the constraint cannot be broken in Steps 1 through 3 before proceeding.

Step 5: Go back to Step 1

But beware of inertia. After a constraint is broken, the organization repeats the steps all over again, looking for the next thing constraining system performance. At the same time, it monitors how changes related to subsequent constraints may impact the constraints that are already broken, thus preventing solution inertia.

Advantages and disadvantages of application Theory of constraints

Advantages:

- Potential for tremendous increases in productivity with minimal changes to operations.
- Most powerful and cost effective tool for increasing production capacity.
- Very simple to communicate and apply, making it ideal for shop floor teams.
- Great for fostering teamwork as different areas become aware of the constraint and the need to work together to assist the constraint process.
- Great process for kick starting improvement efforts as it provides immediate and very tangible benefits.
- Allows growth of turnover/productivity without the need for additional space or staff.
- Provides a means to evaluate the true value of changes (using T, O, I), and utilize this to select the best options, and drive the right behaviour/decisions.

Disadvantages:

- Can be difficult to apply if the constraint process is constantly moving (for example if the nature of the work sees dramatically different and difficult to predict demands on various production resources).
- Can be difficult to apply in a jobbing environment (however it is still very applicable).

Possible conflicts of application TOC at Slovak industrial practice

We can meet often at industrial practice that exists situation or process which is not coordinated. We can immediately find root cause of this problem, but is possible that in the future we find out that root cause was incorrect.

Typical situation at production:

- Low profit, low economic return of invest.
- Delivery time and through time of production are long than can customer wait.
- Delivery precision is not followed.
- Not enough time for good decision.
- Moving bottlenecks on another place, etc.

All of these symptoms have a root from exist so called General conflict at production. His logic is displayed on the next figure.

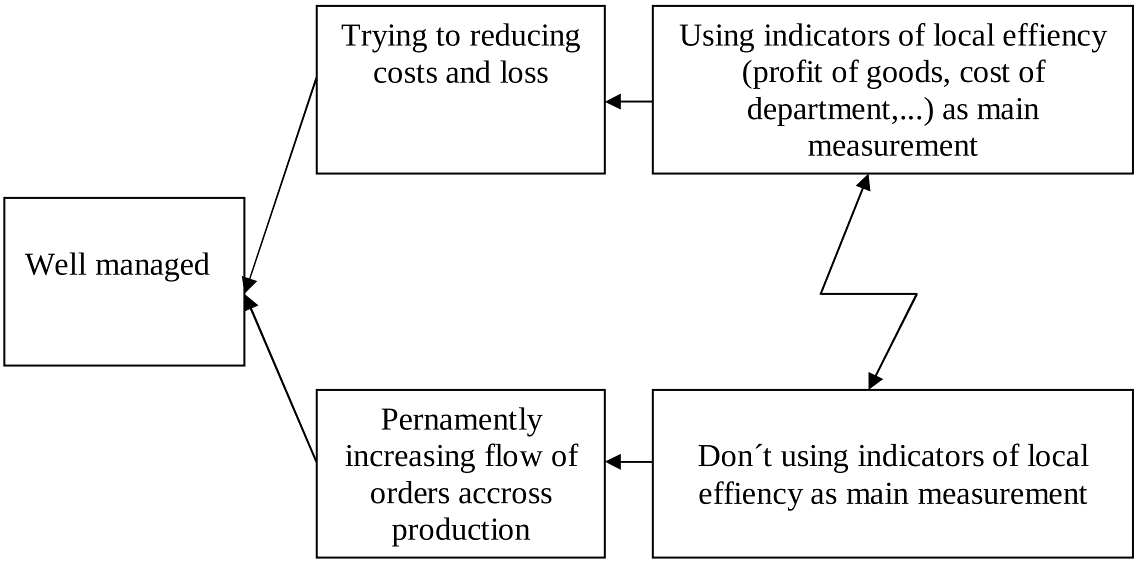

Fig. 3. *General conflict at production*

I would like to mention some other aspects of possible conflict at Slovak industrial practice. It is important consider about human factor. During application we can meet often with following problems:

- Resistance to change - human don't accept radical change at company.
- Disagreement on the issue - the same problem human understand different.
- Disagreement about problem solving - every person has idea for solving problem.
- Solution has sometimes unwanted risk - it is normal process, during application human must be informed about this risk.
- Unspoken concerns - of course, this concerns can occurred or not but doesn't exist clear answer for solution.

Research contribution

The authors described in this research theoretical and practical knowledge about Theory of constraints. Consequently, this article pointed to the possible problems and barriers at Slovak industry during application. Results from this research give an impulse for next working out about continues process improvement at Slovak industry. At the present is solving doctoral thesis about interconnection TOC, LEAN and Six Sigma and output from this research will regard in the further research.

Conclusion

So far this paper has focused on maximizing throughput as the end goal. Actual manufacturing is a trade off between throughput, the number of units through the factory per unit time, and cycle time, the start to finish length of the process. Short cycle times allow you to be more responsive to customers and can allow more rapid process improvement, an important consideration in rapidly changing processes. However, short cycle times are incompatible with high throughput: if you're going to make sure that the bottleneck tool is available when the hot lot gets to it, then you risk having the bottleneck tool sitting idle while it waits. For maximum throughput, you always want the bottleneck tool to run at full capacity. That's one reason why *Just In Time* isn't really compatible with mass customization and other agile manufacturing requirements. Goldratt's approach *should* be flexible enough to work in a low cycle time environment, simply by redefining the constraints.

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