Theory of Constraints

Theory of Constraints (TOC) is an overall management philosophy that aims to continually achieve more of the goal of a system. If that system is a for-profit business, then the goal is to make more money, both now and in future. TOC consists of two primary collections of work: 1) The five focusing steps and their application to operations; 2) The Thinking Processes and their application to project management and human behavior.

According to TOC, every organization has one key constraint which limits the system's performance relative to its goal (see Liebig's Law of the Minimum). These constraints can be broadly classified as either an internal constraint or a market constraint. In order to manage the performance of the system, the constraint must be identified and managed correctly (according to the Five Focusing Steps below).

The publicity and leadership behind these ideas has been dominated by Eliyahu M. Goldratt through a series of books, seminars and workshops. The TOC ICO has been established as a certification organization.

Contents

The Five Focusing Steps

Theory of Constraints is based on the premise that the rate of revenue generation is limited by at least one constraining process (i.e. a bottleneck). Only by increasing throughput (flow) at the bottleneck process can overall throughput be increased.

The key steps in implementing an effective TOC approach are:

- Step zero: Articulate the goal of the organization. Frequently, this is something like, "Make money now and in the future."

1. Identify the constraint (the thing that prevents the organization from obtaining more of the goal)
2. Decide how to exploit the constraint (make sure the constraint is doing things that the constraint uniquely does, and not doing things that it should not do)
3. Subordinate all other processes to above decision (align all other processes to the decision made above)
4. Elevate the constraint (if required, permanently increase capacity of the constraint; "buy more")
5. If, as a result of these steps, the constraint has moved, return to Step 1. Don't let inertia become the constraint.

This *Process of Ongoing Improvement* has been applied to Manufacturing, Project Management, Supply Chain / Distribution, Marketing and Sales, and Finance. The solution as applied to each of these areas are listed below.

Operations

Within manufacturing operations and operations management, the solution seeks to pull materials through the system, rather than push them into the system.

- Drum-Buffer-Rope (DBR)
- Simplified Drum-Buffer-Rope (S-DBR)

Drum-Buffer-Rope is a manufacturing execution methodology, named for its three components. The **drum** is the physical constraint of the plant: the work center or machine or operation that limits the ability of the entire system to produce more. The rest of the plant follows the beat of the drum. They make sure the drum has work and that anything the drum has processed does not get wasted.

The **buffer** protects the drum, so that it always has work flowing to it. Buffers in DBR have time as their unit of measure, rather than quantity of material. This makes the priority system operate strictly based on the time an order is expected to be at the buffered operation. In traditional DBR usually calls for buffers at several points in the system: the constraint, synchronization points and at shipping. S-DBR requires only a single buffer at shipping.

The **rope** is the work release mechanism for the plant. Only a "buffer time" before an order is due does it get released into the plant. Pulling work into the system earlier than a buffer time guarantees high work-in-process and slows down the entire system.

For reference, you can read Chapter 37 of "The Goal", where DBR is summarized. S-DBR is discussed in a paper by Eli Schragenheim and Bill Dettmer, Simplified Drum-Buffer-Rope: A Whole System Approach to High Velocity Manufacturing.

Plant types

There are four primary types of plants in the TOC lexicon. Draw the flow of material from the bottom of a page to the top, and you get the four types. They specify the general flow of materials through a system, and they provide some hints about where to look for typical problems. The four types can be combined in many ways in larger facilities.

- I-Plant: Material flows in a sequence, such as in an assembly line. The primary work is done in a straight sequence of events. The constraint is the slowest operation.
- A-Plant: The general flow of material is many-to-one, such as in a plant where many sub-assemblies converge for a final assembly. The primary problem in A-plants is in synchronizing the converging lines so that each supplies the final assembly point at the right time.
- V-Plant: The general flow of material is one-to-many, such as a plant that takes one raw material and can make many final products. Classic examples are meat rendering plants or a steel manufacturer. The primary problem in V-plants is "stealing" where one operation (A) at a diverging point "steals" materials from the other (B). Once it has processed through A, it cannot come back and run through B without significant rework.
- T-Plant: The general flow is that of an I (or multiple lines), which then split into many assemblies. Most manufactured parts are used in multiple assemblies and nearly all assemblies use multiple parts. Customized devices, such as computers, are good examples. T-plants suffer from both synchronization problems of A-plants (parts aren't all available for an assembly) and the stealing problems of V-plants (one assembly steals parts that could have been used in another).

Supply chain / logistics

The solution for supply chain is to move to a replenishment model, rather than a forecast model.

- TOC-Distribution
- TOC-VMI (vendor managed inventory)

Finance and accounting

The solution for finance and accounting is to apply holistic thinking to the finance application. This has been termed Throughput accounting. Throughput accounting suggests that one examine the impact of investments and operational changes in terms of the impact on the throughput of the business. It is an alternative to Cost accounting.

The primary measures for a TOC view of finance and accounting are: Throughput (T), Operating Expense (OE) and Investment (I). Throughput is calculated from Sales (S) - Totally Variable Cost (TVC). Totally Variable Cost usually considers the cost of raw materials that go into creating the item sold.

See Throughput accounting for more details.

Project management

- Critical Chain Project Management. Based on the realization that all projects look like A-plants: all operations must converge to a final deliverable. As such, synchronization of activities is a common problem that CCPM seeks to address.

Marketing and sales

While originally focused on manufacturing and logistics, TOC has expanded lately into sales management. First data shows that the sales system is massively constrained and TOC offers significant opportunity to increase enterprise throughput = sales results

- Solution for Sales

The six necessary and sufficient questions relating to technology

This discussion comes out of *The Haystack Syndrome*.

1. What is the real power of the technology?
2. What limitation does it diminish?
3. What old rules helped accommodate the limitation?
4. What are the new rules that should be used now?
5. In light of the change in rules, what changes are required to the technology?
6. How to cause the change (the new win/win business model)?

The TOC Thinking Processes

The Thinking Processes are a set of tools to help managers walk through the steps of initiating and implementing a project. When used in a logical flow, the Thinking Processes help walk through a buy-in process:

1. Gain agreement on the problem
2. Gain agreement on the direction for a solution
3. Gain agreement that the solution solves the problem
4. Agree to overcome any potential negative ramifications
5. Agree to overcome any obstacles to implementation

TOC practitioners sometimes refer to these in the negative as working through *layers of resistance* to a change.

The Thinking Processes, as codified by Goldratt and others:

- **Current Reality Tree** (CRT, similar to the current state map used by many organizations) - evaluates the network of cause-effect relations between the undesirable effects (UDE's, also known as gap elements) and helps to pinpoint the root cause(s) of most of the undesirable effects.
- **Evaporating Cloud** (conflict resolution diagram or CRD) - solves conflicts that usually perpetuate the causes for an undesirable situation.
- **Core Conflict Cloud** (CCC) - A combination of conflict clouds based several UDE's. Looking for deeper conflicts that create the undesirable effects.
- **Future Reality Tree** (FRT, similar to a future state map) - Once some actions (injections) are chosen (not necessarily detailed) to solve the root cause(s) uncovered in the CRT and to resolve the conflict in the CRD the FRT shows the future states of the system and helps to identify possible negative outcomes of the changes (Negative Branches) and to prune them before implementing the changes.

- **Negative Branch Reservations** (NBR) - Identify potential negative ramifications of any action (such as an injection, or a half-baked idea). The goal of the NBR is to understand the causal path between the action and negative ramifications so that the negative effect can be "trimmed."
- **Positive Reinforcement Loop** (PRL) - Desired effect (DE) presented in FRT amplifies intermediate objective (IO) that is earlier (lower) in the tree. While intermediate objective is strengthened it positively affects this DE. Finding out PRLs makes FRT more sustaining.
- **Prerequisite Tree** (PRT) - states that all of the intermediate objectives necessary to carry out an action chosen and the obstacles that will be overcome in the process.
- **Transition Tree** (TT) - describes in detail the action that will lead to the fulfilment of a plan to implement changes (outlined on a PRT or not).
- **Strategy & Tactics** (S&T) - the overall project plan and metrics that will lead to a successful implementation and the ongoing loop through POOGI.

Some observers note that these processes are not fundamentally very different from some other management change models such as PDCA "Plan-Do-Check-Act" (which is quite often now displayed as PDSA for Plan-Do-Study-Act as 'checking' merely indicates it's been looked at where 'studying' fosters a proactive approach) or "Survey-Assess-Decide-Implement-Evaluate", but the way they can be used is clearer and more straightforward. More on this can be seen on Goldratt's Theory of Constraints - A Systems Approach to Continuous Improvement by William Dettmer ISBN 0-87389-370-0.

Development and practice

TOC has been initiated by Eliyahu M. Goldratt and is being actively developed by a loosely coupled community of practitioners around the world. TOC is sometimes referred to as "Constraint Management".

The TOC International Certification Organization maintains a variety of TOC certifications.

See also

- Law of the minimum
- List of Theory of Constraints topics
- Systems thinking - Joint decision traps
- Twelve leverage points by Donella Meadows
  - Constraint
  - Thinklets
  - Throughput
- Quantum Improvement Method