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* + Theory of Constraints

**Theory of Constraints (TOC)** is an overall [management philosophy](http://en.wikipedia.org/wiki/Management_philosophy). Although TOC is often presented as a scientific theory, it has not gained wide traction in the academic community and is largely propagated through profit-seeking enterprises.

TOC is geared to help organizations continually achieve their goals.

TOC is based on a set of basic principles ([axioms](http://en.wikipedia.org/wiki/Axiom)), a few simple processes (Strategic Questions, Focusing Steps, Buy-In processes, Effect-Cause-Effect), logic tools (The Thinking Processes or TP) and through the logical derivation of these some applications to specific fields (Operations, Finance, Distribution, Project Management, People Management, Strategy, Sales and Marketing).

According to TOC, every organization has - at any given point in time - at least one constraint which limits the system's performance relative to its goal (see [Liebig's law of the minimum](http://en.wikipedia.org/wiki/Liebig%27s_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). Over time the constraint may change (e.g., because the previous constraint was managed successfully, or because of a changing environment) and the analysis starts anew.

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##  Basic principles of TOC

The principles are treated as axioms, and therefore have no proof. Even so Goldratt provides some indication on why he chose these as basic assumptions or principles to base TOC upon.

The first two are a derivation of Newton's words: *natura valde simplex est et sibi consona* (nature is exceedingly simple and conformable to herself), while the third is a bridge on how to deal with human reactions and motivations.

###  Convergence

The first principle: Convergence, also called "Inherent Simplicity" states that "The more complex a system is to describe, the simpler it is to manage." Or that the more interconnected a system is the fewer degrees of freedom it has, and consequently the fewer points must be touched (managed) to impact the whole system. A corollary of this principle is that every organization has at least one constraint active in any given point of time (otherwise it would achieve infinite performance relative to its goal).

###  Consistency

The second principle: Consistency, also called "There are No Conflicts in Nature" states that "If two interpretations of a natural phenomenon are in conflict, one or possibly both must be wrong". That is, when in an organization with a common goal, two parts are in conflict (or in a dilemma) this means that the reasoning that led to the conflict must contain at least one flawed assumption.

###  Respect

The third principle: Respect, also called "People are not stupid" states that "Even when people do things that seem stupid they have a reason for that behavior". In other words, this principle is stating that people are not inherently irrational.

##  Basic processes

###  The five focusing steps

One of the most important processes of the Theory of Constraints is based on the premise that the rate of goal achievement is limited by at least one constraining process. Only by increasing throughput (flow) at the bottleneck process can overall throughput be increased.

The key steps in implementing an effective process of ongoing improvement according to TOC are:

0. (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](http://en.wikipedia.org/wiki/Social_inertia) become the constraint.

##  Applications

The focusing steps, or this *Process of Ongoing Improvement* has been applied to [Manufacturing](http://en.wikipedia.org/wiki/Manufacturing), [Project Management](http://en.wikipedia.org/wiki/Project_Management), Supply Chain / Distribution generated specific solutions. Other tools (mainly the TP) also led to TOC applications in the fields of [Marketing](http://en.wikipedia.org/wiki/Marketing) and [Sales](http://en.wikipedia.org/wiki/Sales), and [Finance](http://en.wikipedia.org/wiki/Finance).

The solution as applied to each of these areas are listed below.

###  Operations

Within manufacturing operations and [operations management](http://en.wikipedia.org/wiki/Operations_management), the solution seeks to pull materials through the system, rather than push them into the system. The primary methodology use is Drum-Buffer-Rope (DBR), and a variation called 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. 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 at "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.

####  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 (one-to-one). 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 "robbing" where one operation (A) immediately after a diverging point "steals" materials meant for the other operation (B). Once the material has been processed by A, it cannot come back and be run through B without significant rework.
* T-Plant: The general flow is that of an I-Plant (or has multiple lines), which then splits into many assemblies (many-to-many). 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 robbing problems of V-plants (one assembly steals parts that could have been used in another).

###  Supply chain / logistics

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The solution for supply chain is to move to replenishment to consumption 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](http://en.wikipedia.org/wiki/Holistic) thinking to the finance application. This has been termed [throughput accounting](http://en.wikipedia.org/wiki/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](http://en.wikipedia.org/wiki/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.

###  Project management

[Critical Chain Project Management](http://en.wikipedia.org/wiki/Critical_Chain_Project_Management) is utilized in this area. 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 and marketing. For effective sales management one can apply Drum Buffer Rope to the sales process similar to the way it is applied to operations (see reengineering the Sales Process book reference below). This technique is appropriate when your constraint is in the sales process itself or you just want an effective sales management technique and includes the topics of [funnel management](http://en.wikipedia.org/w/index.php?title=Funnel_management&action=edit&redlink=1) and conversion rates.

##  The TOC thinking processes

*Main article:* [*Thinking Processes (Theory of Constraints)*](http://en.wikipedia.org/wiki/Thinking_Processes_%28Theory_of_Constraints%29)

The [Thinking Processes](http://en.wikipedia.org/wiki/Thinking_Processes_%28Theory_of_Constraints%29) 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.

##  Development and practice

TOC was initiated by Dr. [Eliyahu M. Goldratt](http://en.wikipedia.org/wiki/Eliyahu_M._Goldratt), being still the main driving force behind the development and practice of TOC. There is a network of individuals and small companies loosely coupled as practitioners around the world. TOC is sometimes referred to as "Constraint Management" but this understates enormously what TOC is. TOC is a large body of knowledge with a strong guiding philosophy of growth.

##  Criticism

The TOC has a group of adherents who believe that its applicability goes much beyond its origin of factory scheduling. Regardless of how valid this belief might be, the TOC is not part of the mainstream curriculum in business or [Operations Research](http://en.wikipedia.org/wiki/Operations_Research) programs.

Criticisms that have been leveled against TOC include:

###  Effectiveness of Drum-Buffer-Rope

D. Trietsch from University of Auckland argues that DBR methodology is inferior to competing methodologies.

###  Unacknowledged debt

Some academics in the [Operations Research](http://en.wikipedia.org/wiki/Operations_Research) and [Management Science](http://en.wikipedia.org/wiki/Management_Science) communities claim that the TOC founder, [Eliyahu M. Goldratt](http://en.wikipedia.org/wiki/Eliyahu_M._Goldratt), and some of his followers display a strong guru-like and sales pitch attitude that is incompatible with the spirit of true scientific investigation.

 "What is the Theory of Constraints and How Should it be Implemented?", "Beyond The Goal". In these, Goldratt discusses the history of disciplinary sciences, compares the strengths and weaknesses of the various disciplines, and acknowledges the sources of information and inspiration for the Thinking Processes and Critical Chain methodologies.

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* [Liebig's law of the minimum](http://en.wikipedia.org/wiki/Liebig%27s_law_of_the_minimum)
* [List of Theory of Constraints topics](http://en.wikipedia.org/wiki/List_of_Theory_of_Constraints_topics)
* [Systems thinking](http://en.wikipedia.org/wiki/Systems_thinking) — [Joint decision traps](http://en.wikipedia.org/wiki/Joint_decision_trap)
* [Twelve leverage points](http://en.wikipedia.org/wiki/Twelve_leverage_points) by [Donella Meadows](http://en.wikipedia.org/wiki/Donella_Meadows)
	+ [Constraint](http://en.wikipedia.org/wiki/Constraint)
	+ [Thinklets](http://en.wikipedia.org/wiki/Futures_techniques#Systems_engineering)
	+ [Throughput](http://en.wikipedia.org/wiki/Throughput_%28business%29)
* [Quantum Improvement Method](http://en.wikipedia.org/w/index.php?title=Quantum_Improvement_Method&action=edit&redlink=1)

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