

INDUSTRIAL DECISION MAKING & ANALYSIS:
THE IMPLEMENTATION OF THE THEORY OF
CONSTRAINTS

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**What to change?
To what to change?
How to cause the change?**

Don't people already have the capacity to answer all these questions?

Does this mean that through TOC we'll be able to generate an infinite
amount of output?

You make it sound almost too easy. Is it?

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Introduction to the Theory of Constraints

The Theory of Constraints (TOC) is a portfolio of management philosophies, management disciplines, and industry-specific "best practices" developed and popularised over the past 20 years by physicist Dr. Eliyahu M. Goldratt and his associates. Most people are first exposed to the concepts through his book *The Goal*, (North River Press, 1984).

Dr. Goldratt has been described by *Fortune Magazine* as a guru to industry and by *Business Week* as a genius. His books *The Goal*, *It's Not Luck*, and *Critical Chain*, gripping fast paced business novels, are transforming management thinking throughout the world.

Goldratt's Theory of Constraints is being used by thousands of corporations, and is taught in over 200 colleges, universities and business schools. His books have sold over 3 million copies and have been translated into 23 languages.

The Theory of Constraints is an overall philosophy, usually applied to running and improving an organisation. TOC consists of Problem Solving and Management/Decision-Making Tools called the Thinking Processes (TP). TOC is applied to logically and systematically answer these three questions essential to any process of ongoing improvement: "What to change?" "To what to change?" "How to cause the change?"

More specific uses of the Thinking Processes can be used to significantly enhance vital management skills, such as: win-win conflict resolution effective communication team building skills delegation empowerment

Famous for spectacular results, the use of TOC has resulted in Proven Solutions created by applying the Thinking Processes (TP) in specific functional areas such as Sales, Marketing, Logistics, Finance, Accounting, Engineering and Project Management. Many of these solutions are discussed in detail in the books: *The Goal*, *The Race*, *It's Not Luck* and *Critical Chain*.

TOC recognises that the output of any system that consists of multiple steps where the output of one step depends on the output of one or more previous steps will be limited (or constrained) by the least productive steps. In other words, as

paraphrased in *The Goal*, the strength of any chain is dependant upon its weakest link.

Where manufacturing is concerned, TOC postulates that the goal is to make (more) money. It describes three avenues to this goal:

Increase Throughput, Reduce Inventory, Reduce Operating Expense

As Dr. Goldratt notes, the opportunities to make more money through reductions in inventory and operating expense are limited by zero. The opportunities to make more money by increasing Throughput, on the other hand, are not limited.

More than that, though, TOC challenges us to define a goal and re-examine all of our actions and measurements based on how well or how poorly they serve it. This is done through a set of tools that help us identify and resolve bottlenecks.

Fundamental Analysis of the Theory of Constraints

The Theory of Constraints, as it is commonly called, recognises that organisations exist to achieve a goal. A factor that limits a company's ability to achieve more of its goal is referred to as a "constraint." In *The Goal*, the demand for parts produced by a computer-controlled piece of equipment known as the NCX10 exceeded the machine's capacity. Since the factory could only assemble and sell as many products as they had parts from the machine, the capacity of the factory to make money was tied directly to the output of the NCX10. The NCX10, therefore, was the constraint.

It is imperative for businesses to identify and manage constraints. "Because a constraint is a factor that limits the system from getting more of whatever it strives for, then a business manager who wants more profits must manage the constraints. There really is no choice in the matter. Either you manage constraints or they manage you." Noreen, Smith, and Mackey in *The Theory of Constraints and its Implications for Management Accounting* (North River Press, 1995).

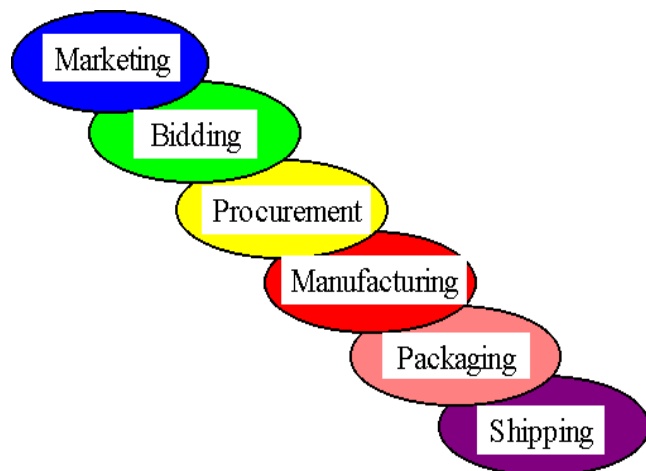
The Theory of Constraints, then, is a management philosophy that focuses the organisations scarce resources on improving the performance of the true constraint, and therefore the bottom line of the organisation. Goldratt uses a **Chain Analogy**¹ to help illustrate why this is the most effective way to get immediate results.

It may be relatively easy intellectually to recognise that an organisation must have a constraint, but it may be quite another thing to positively identify it. In situations when the constraint can be easily identified (which is usually because it is a physical constraint such as the machine known as the "NCX10" in the book *The Goal*), the five step **Process Of On Going Improvement**² will provide the steps necessary to deal with the constraint. In situations when the constraint is not as easily sited (which is often because it has to do with the inter-relationships between the various "links" in the organisational "chain"), the **Thinking Processes**³ will provide the tools necessary to identify the core problem or core conflict and the tools needed to deal with it effectively.

About Chain Analogy

A manufacturing company can be thought of as a chain of dependent events that are linked together like a chain. The activities that go on in one "link" are dependent upon the activities that occur in the preceding "link." The manufacturer in the example

above fabricates products to order. First they market their services. If the marketing is successful they will get some requests for proposals, and create



¹ More information in the section **About Chain Analogy**

² More information in the section **About Process Of On Going Improvement**

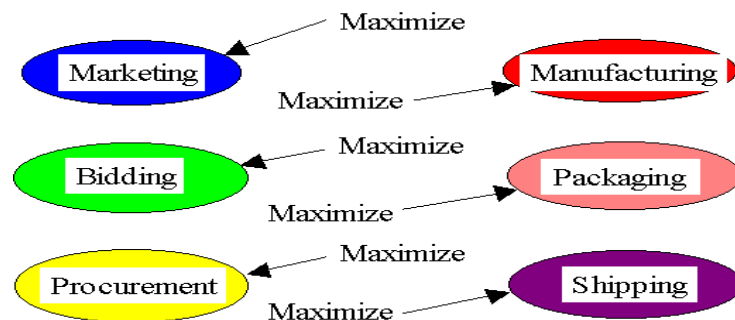
³ More information in the section **About Thinking Processes**

some bids. If some bids are successful they will procure the necessary materials. Once the materials are on hand they will manufacture the product. Once manufacturing is complete packaging prepares the product to be sent to the customer. Finally, once packaged, the product can be shipped to the customer.

We notice that each step is dependent on the preceding step. That is, the product cannot be shipped until after it is packaged; the product can not be packaged until it is manufactured; the product cannot be manufactured until the necessary materials are procured; etc. It is this dependency that explains why the Theory of Constraints is so powerful when compared with "conventional wisdom."

The chain pictured above is for a very simple company. Even so, it doesn't really picture all the operations in the company. For example, billing and collection are not included. The typical company has a much more complex chain than is pictured here. To handle this complexity, management typically splits the chain up into links and endeavors to manage each link so as to "maximize" its performance. As a result, conventional wisdom is as follows:

- An improvement to any link in the chain is considered to be an improvement to the chain.
- System wide or "global" improvement is believed to be the sum of all the "local" improvement made within each link.
- This is analogous to saying the primary measurement of success in managing the chain is the weight of the chain, i.e. if one manager beefs up her/his link that makes the chain heavier and better.



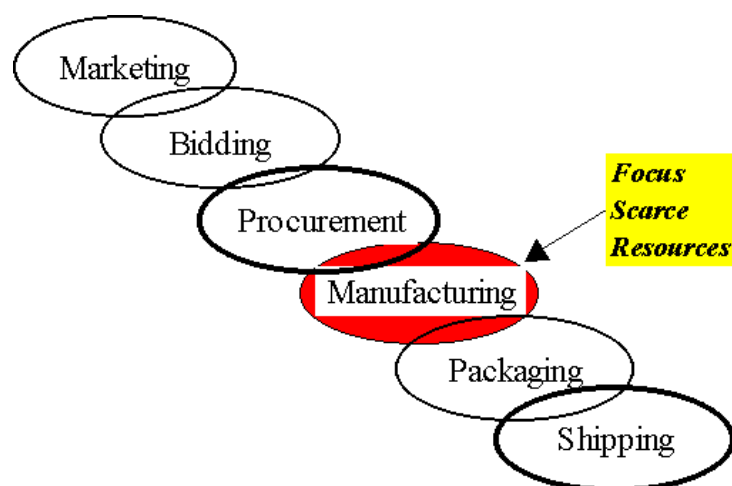
As a result, all managers compete for scarce resources all the time. They all want

to reach their goal of maximising the weight of their link, because they believe that is the way to maximise the effectiveness of the organisation.

By considering the following true story from a printing company, we'll see another view. A team from a press operation in the middle of their system came to management with a proposal for continuous improvement. (We should think of them as being located in the manufacturing link above.) They had discovered an improvement that could be made to their press that would increase productivity 25%! It would cost the company only \$20,000. Conventional analysis showed the payback period on this was relatively short. Would you authorise the investment?

Senior managers were about to sign the check when someone asked, "Where does the output of this press go? And, what is the status of work-in-process at that next operation?" It turned out that work was already queued up at the next operation. In other words, the company almost spent \$20,000 so that the output of the press in question could wait 25% longer at the next operation! Had they made the expenditure they may have had a false sense of success when viewing the 25% increase in the "productivity" figures of the press, but the actual bottom line impact would have been a negative \$20,000 because that money was spent without actually bringing any more money into the plant!

TOC Wisdom



TOC says that management needs to find the weak link in the chain. In the

example above it turned out that manufacturing was the weak link. That is to say that marketing was attracting sufficient requests for proposals, and bidding was winning a sufficient number of bids to keep the plant busy, and procurement was able to get the necessary parts on time, and packaging could handle everything that was manufactured, and shipping could keep up with packaging, BUT manufacturing could not keep up with the schedule.

In this case, what would be the bottom line impact of "beefing up" or improving the packaging link? Some cost savings may be produced, but the long term impact on the bottom line will probably not be great because it did not enable the company to fill any more orders than they are currently. (We remember that it is manufacturing that is limiting the rate at which orders are fulfilled.) The same holds true for shipping, procurement, marketing, and bidding. The one place where a significant impact can be made on the bottom line is at the constraint – in manufacturing in this example. The old saying applies: a chain is only as strong as its weakest link. As a result, TOC wisdom is as follows:

- Most improvements to most links do NOT improve the chain.
- System wide, or "global" improvement, then is NOT the sum of the local improvements.
- Thus a company should focus on "chain strength" (not link weight) by working to strengthen the weakest link – the constraint!

The result is that when using the Theory Of Constraints, managers do not fight over scarce resources. They all understand that once the constraint is known, the most bottom line impact can be gotten by channelling those resources to the constraint.

About the Process Of On Going Improvement

To manage constraints (rather than be managed by them), Goldratt proposes a five-step Process Of On Going Improvement. The steps in this process are:

1. Identify

2. **Exploit**
3. **Subordinate**
4. **Elevate, and**
5. **Go back to Step 1**

Identify

In order to manage a constraint, it is first necessary to identify it. In Eli Goldratt's book *The Goal* (North River Press, 1984), a machine known as the NCX10 was identified as the constraint. This knowledge helped the company determine where an increase in "productivity" would lead to increased profits. Concentrating on a non-constraint resource would not increase the throughput (the rate at which money comes into the system through sales) because there would not be an increase in the number of orders fulfilled. There might be local gains, such as a reduction or elimination of the queue of work-in-process waiting in front of the resource, but if that material ends up waiting longer somewhere else, there will be no global benefit. To increase throughput, flow through the constraint must be increased.

Exploit

Once the constraint is identified, the next step is to focus on how to get more production within the existing capacity limitations. Goldratt refers to this as exploiting the constraint. One example from *The Goal* was when the company and the labour union agreed to stagger lunches, breaks, and shift changes so the machine could be producing during times it previously sat idle. This added significantly to the output of the NCX10, and therefore to the output of the entire plant.

Subordinate

Exploiting the constraint does not insure that the materials needed next by the constraint will always show up on time. This is often because these materials are waiting in queue at a non-constraint resource that is running a job that the constraint doesn't need yet. Subordination is necessary to prevent this from happening. This usually involves significant changes to current (and generally long

established) ways of doing things at the non-constraint resources.

Elevate

After the constraint is identified, the available capacity is exploited, and the non-constraint resources have been subordinated, the next step is to determine if the output of the constraint is enough to supply market demand. If so, there is no need at this time to "elevate" because this process is no longer the constraint of the system. In that case the market would be the constraint, and the TOC Thinking Process should be used to develop a marketing solution. However, we should be careful not to over activate the resource that was the constraint and produce unneeded inventory.

If, on the other hand, after fully Exploiting this process it still cannot produce enough product to meet market demand, it is necessary to find more capacity by "elevating" the constraint. In The Goal, schedulers were able to remove some of the load from the constraint by rerouting it across two other machines. They also outsourced some work and brought in an older machine that could process some of the parts made by the NCX10. These were all ways of adding capacity, or elevating the constraint. It is important to note that to "elevate" comes after "exploit" and "subordinate." Following this sequence ensures the greatest movement toward the goal of making more money-now and in the future.

Go back to step 1

Once the output of the constraint is no longer the factor that limits the rate of fulfilling orders, it is no longer the constraint. Step 5 is to go back to Step 1 and identify the new constraint – because there always is one. The five step process is then repeated.

It may appear that implementing TOC involves a never-ending series of trips through the five-step process – a kind of tool to assist in more perfectly balancing a production system.

This is not the case. A fundamental principle of the Theory Of Constraints is that

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