theory of constraints

a self learning program

TOC on Distribution and Supply Chain 4

By Eliyahu M. Goldratt

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Self Learning Program

By Eliyahu M. Goldratt

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TOC
on Distribution and Supply Chain

A Self Learning Program

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A Complete Self Learning Program

TOC
on Distribution and Supply Chain

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Contents

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A Self Learning Program

What is the problem?

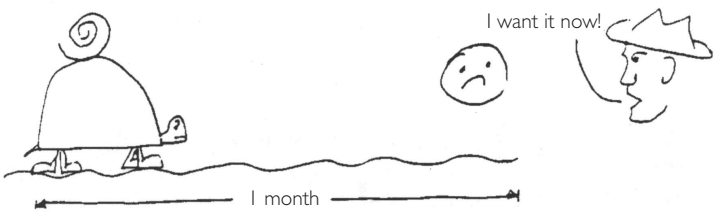
What to change?

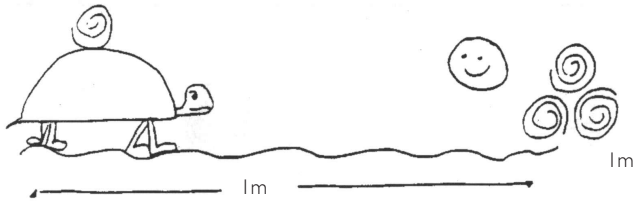
Step 1: **IDENTIFY** the system's constraint.

Clients who come to buy

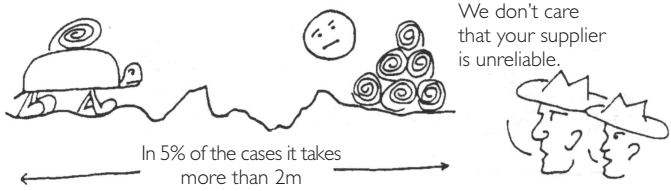
Step 2: Decide how to **EXPLOIT** the system's constraint.

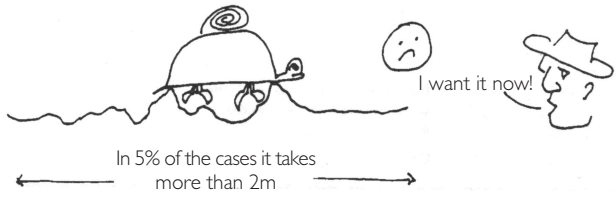
Have the right inventory
in the right place at the right time.

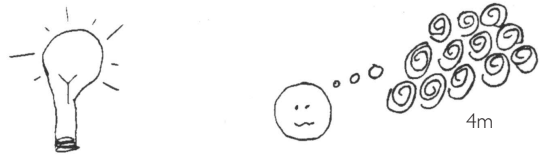


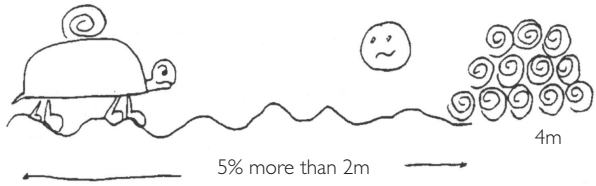


Often a month's demand for an item is equal to two months average demand.









It took two months to reach the service center, where I waited 4 months until my turn to get a customer.

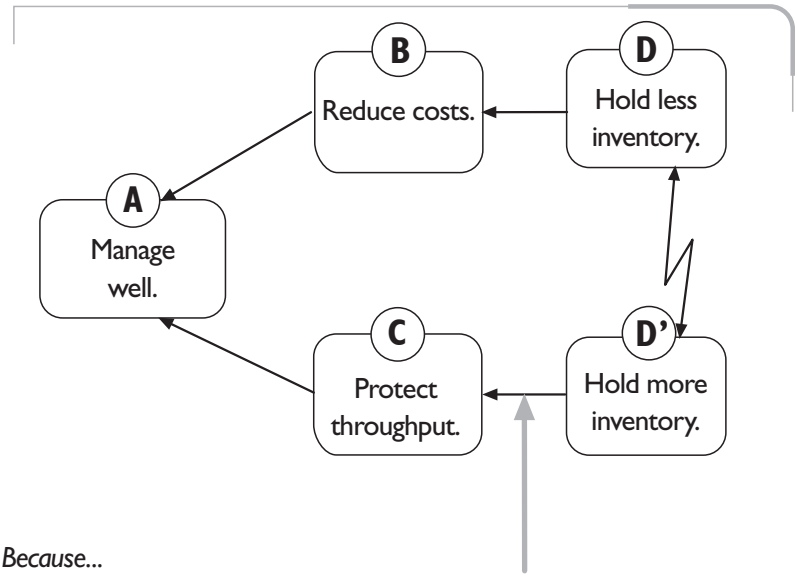
Level of inventory:

maximum forecasted consumption within the average replenishment time, factored by the level of unreliability of re-supply.

Step 3: **SUBORDINATE** everything else to the above decision.

Hold large inventories.

The distribution cloud



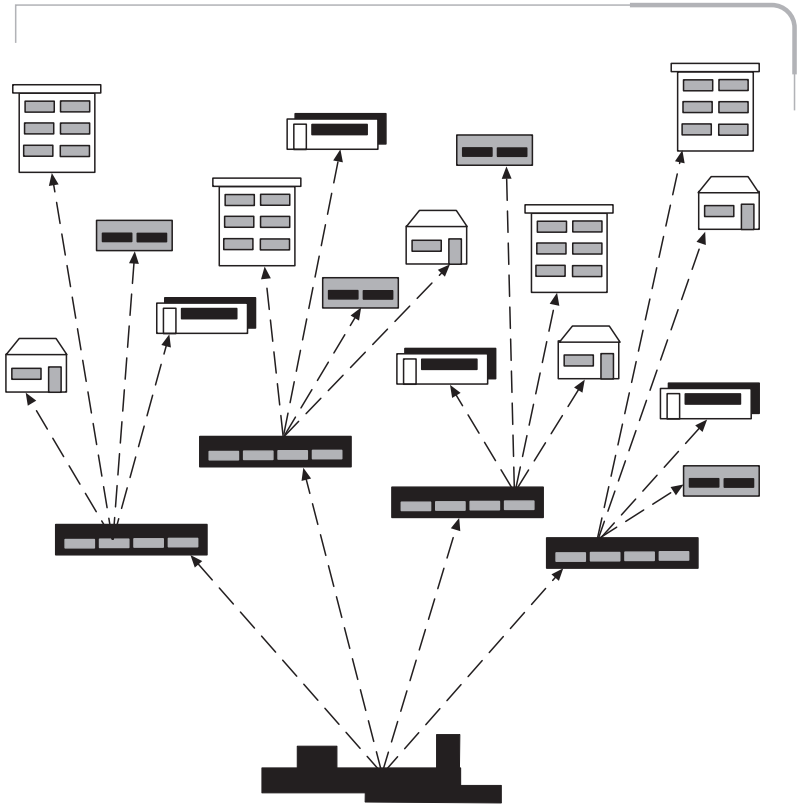
Because...

Replenishment time is long.
Vendors are unreliable.
Forecasts are inaccurate.

What is the solution?

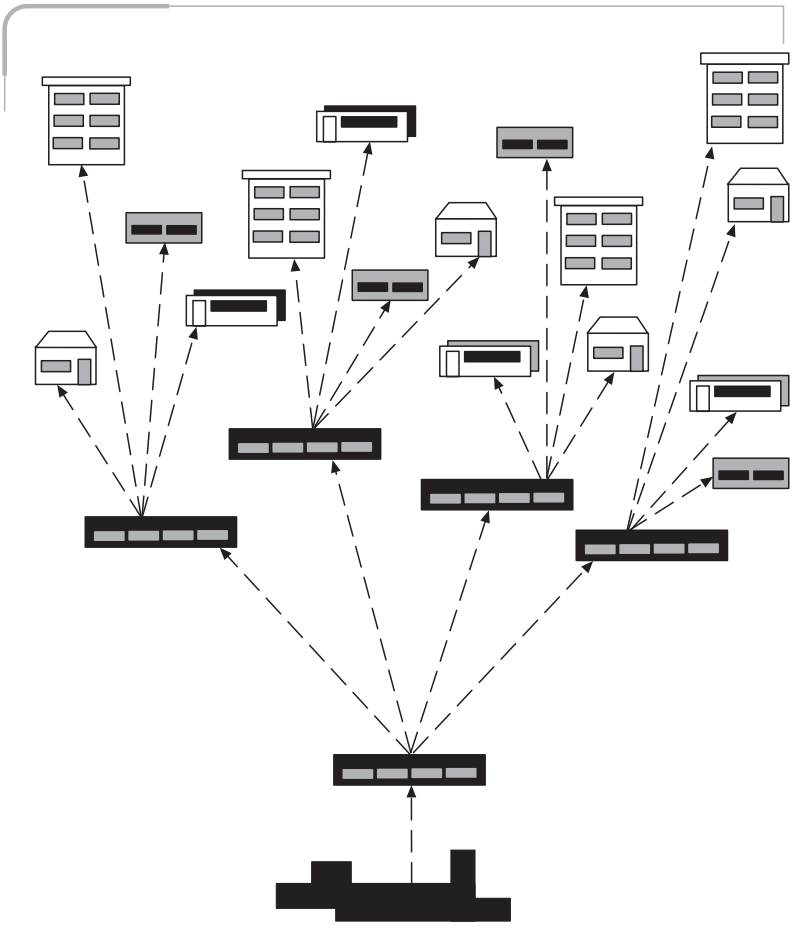
What to change to?

Is the accuracy of the forecast the same for every stage of the distribution system?



Statistical deviations do average out

If we hold the inventories at the source, is the replenishment time the same for every stage of the distribution system?



What is the replenishment time for each stage?

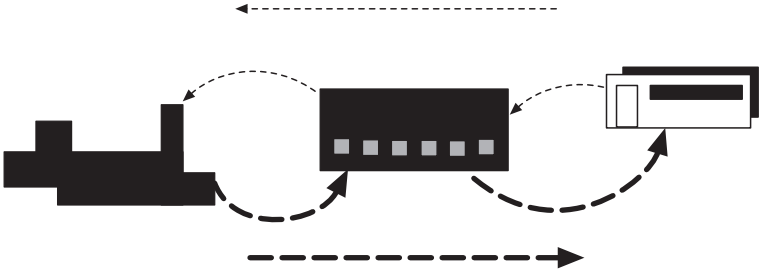
Replenishment time

Plant: Reaction time of production.

Warehouse and sales point: Summation of transportation time plus interval between shipments.

If we hold sufficient inventories at the source, what is the supply reliability for the rest of the system?

CONSUMPTION INFORMATION



REPLENISHMENT OF GOODS

Level of inventory:

maximum forecasted consumption within the average replenishment time, factored by the level of unreliability of re-supply.

Operational measurements for the plant

The purpose of measurements is to motivate the parts to do what is good for the organization as a whole.

Primary measurement -
Throughput Dollar Days (TDD):
Summation (over all products not yet supplied) of the throughput times the number of days from receipt of the order to shipment.
Target: zero TDD.

Secondary measurement -
Inventory Dollar Days (IDD):
Summation (over all products in inventory) of the value of the inventory times the number of days each stays in the warehouse.
Target: reduce IDD.

What will be the impact…

- On the way the plant is scheduling?
- On the way the plant is expediting?
- On the way the plant is considering promotions/seasonality/forecast?
- On the way the plant is trying to improve on lead time?
- On the way the plant tries to reduce set-up?
- On the way the plant is trying to improve quality?

Summary

Inventories should not be held as close as possible to the market. They should be held according to the impact on the system as a whole; switch from push to pull.

- Get a consensus to try the system for a representative family of products. Track inventories and shortages. Within three months from establishing the central warehouse the results should be decisive.

- Get a consensus to change the measurements and implement them across all products.

Judging the plant as a profit center.

or

What are the measurements for the components of a supply chain?

THROUGHPUT

The two main questions:

When did a sale take place?

What is the value of the sale?

As long as the end customer hasn't bought,
no one has sold.

Supply chain composed of companies

The link which is closest to the market has the best knowledge of what prices the market is willing to pay.

Instead of intermediate prices there is agreement on the percentage of sales with a minimum price guaranteed.

What are the drawbacks?

What are the benefits?

Internal supply chain

The entire throughput of a sale is registered to any subsystem who participated.

What are the drawbacks?

What are the benefits?

Summary

Good luck!

TOC terms and definitions

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To obtain the complete APICS dictionary, TOC publications, APICS Membership, or information on the Constraints Management Special Interest Group and other APICS activities, contact:

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activation
– In constraint management, the use of nonconstraint resources to make parts or products above the level needed to support the system constraint(s). The result is excessive work-in-process inventories or finished goods inventories, or both. In contrast, the term *utilization* is used to describe the situation in which nonconstraint resource(s) usage is synchronized to support the needs of the constraint. See: utilization.

buffer
– In the theory of constraints, buffers can be time or material and support throughput and/or due date performance. Buffers can be maintained at the constraint, convergent points (with a constraint part), divergent points, and shipping points.

buffer management
– In the theory of constraints, a process in which all expediting in a shop is driven by what is scheduled to be in the buffers (constraint, shipping, and assembly buffers). By expediting this material into the buffers, the system helps avoid idleness at the constraint and missed customer due

dates. In addition, the causes of items missing from the buffer are identified, and the frequency of occurrences is used to prioritize improvement activities.

constraint
– Any element or factor that prevents a system from achieving a higher level of performance with respect to its goal. Constraints can be physical, such as a machine center or lack of material, but they can also be managerial, such as a policy or procedure.

control points
– In the theory of constraints, strategic locations in the logical product structure for a product or family that simplify the planning, scheduling, and control functions. Control points include gating operations, convergent points, divergent points, constraints, and shipping points. Detailed scheduling instructions are planned, implemented, and monitored at these locations. Other work centers are instructed to "work if they have work; otherwise, be prepared for work." In this manner, materials flow rapidly through the facility without detailed work center scheduling and control.

convergent point
– In the theory of constraints, a control point in the logical product structure where nonconstraint parts are assembled with constraint parts. To maintain the flow of parts to products, the schedule of nonconstraint parts must be synchronized with that of constraint parts.

critical chain
– In the theory of constraints, the longest route through a project network considering both technological precedence and resource contention constraints in completing the project. Where no resource contention exists the critical chain would be the same as the critical path.

critical chain method
– In the theory of constraints, a network planning technique for the analysis of a project's completion time, used for planning and controlling project activities. The critical chain, which determines project duration, is based on technological and resource constraints. Strategic buffering of paths and resources is used to increase project completion success.

current reality tree (CRT)
– A logic-based tool for using cause-and-effect relationships to determine root problems that cause the observed undesirable effects of the system.

divergent point
– In the theory of constraints, a control point in the logical product structure where a common part or assembly can be directed to two or more different end items. To maintain the flow of parts to products, the schedule of common parts must be synchronized with the constraint schedule and shipping commitments.

drum
– In the theory of constraints, the constraint is viewed as a drum, and nonconstraints are like soldiers in an army who march in unison to the drumbeat; the resources in a plant should perform in unison with the drumbeat set by the constraint.

drum-buffer-rope
– In the theory of constraints, the generalized technique used to manage resources to maximize throughput. The drum is the rate or pace of production set by the system's constraint. The buffers establish the protection against uncertainty so that the system can maximize throughput. The rope is a communication process from the constraint to the gating operation that checks or limits material released into the system to support the constraint.

drum schedule
– In the theory of constraints, the detailed master production schedule for the plant that sets the pace for the entire system. The drum must reconcile the customer requirements with the system's constraints.

evaporating cloud
– In the theory of constraints, a logic-based tool for surfacing assumptions related to a conflict or problem. Once the assumptions are surfaced, actions to break an assumption and hence solve (evaporate) the problem can be determined.

excess capacity
– A situation where the output capabilities at a nonconstraint resource exceed the amount of productive and protective capacity required to achieve a given level of throughput at the constraint.

excess inventory
– Any inventory in the system that exceeds the minimum amount necessary to achieve the desired throughput rate at the constraint or that exceeds

the minimum amount necessary to achieve the desired due date performance. Total inventory = productive inventory + protective inventory + excess inventory.

five focusing steps
– In the theory of constraints, a process to continuously improve organizational profit by evaluating the production system and market mix to determine how to make the most profit using the system constraint. The steps consist of (1) identifying the constraint to the system, (2) deciding how to exploit the constraint to the system, (3) subordinating all nonconstraints to the constraint, (4) elevating the constraint to the system, (5) returning to step 1 if the constraint is broken in any previous step, while not allowing inertia to set in.

future reality tree (FRT)
– In the theory of constraints, a logic-based tool for constructing and testing potential solutions before implementation. The objectives are to (1) develop, expand, and complete the solution and (2) identify and solve or prevent new problems created by implementing the solution.

idle capacity
– The capacity generally not used in a system of linked resources. Idle capacity consists of protective capacity and excess capacity.

idle inventory
– The inventory generally not needed in a system of linked resources. Idle capacity generally consists of protective inventory and excess inventory. See: excess inventory, productive inventory, protective capacity.

inventory
– In the theory of constraints, inventory is defined as those items purchased for resale and includes finished goods, work in process, and raw materials. Inventory is always valued at purchase price and includes no value-added costs, as opposed to the traditional cost accounting practice of adding direct labor and allocating overhead as work in process progresses through the production process.

operating expense
– In the theory of constraints, the quantity of money spent by the firm to convert inventory into sales in a specific time period.

policy constraint
– In the theory of constraints, a constraint which is not physical in nature. This category includes the entire system of measures and methods and even the mindset that governs the strategic, tactical, and operations (day-to-day) decisions of the organization.

prerequisite tree (PRT)
– In the theory of constraints, a logic-based tool for determining the obstacles that block implementation of a problem, solution or idea. Once obstacles have been identified, objectives for overcoming obstacles can be determined.

productive capacity
– The maximum of the output capabilities of a resource (or series of resources) or the market demand for that output for a given time period.

product structure
– The sequence of operations that components follow during their manufacture into a product. A typical product structure would show raw material converted into fabricated components, components put together to make subassemblies, subassemblies going into assemblies, etc.

protective capacity
– A given amount of extra capacity at nonconstraints above the system constraint's capacity, used to protect against statistical fluctuation (breakdowns, late receipts of materials, quality problems, etc.). Protective capacity provides nonconstraints with the ability to catch up to "protect" throughput and due date performance.

protective inventory
– The amount of inventory required relative to the protective capacity in the system to achieve a specific throughput rate at the constraint.

supply chain
– 1) The processes from the initial raw materials to the ultimate consumption of the finished product linking across supplier-user companies.
– 2) The functions inside and outside a company that enable the value chain to make products and provide services to the customer.

theory of constraints (TOC)
– A management philosophy developed by Dr. Eliyahu M. Goldratt that can be viewed as three separate but interrelated areas-logistics, performance

measurement, and logical thinking. Logistics include drum-buffer-rope scheduling, buffer management, and VAT analysis. Performance measurement includes throughput, inventory and operating expense, and the five focusing steps. Thinking process tools are important in identifying the root problem (current reality tree), identifying and expanding win-win solutions (evaporating cloud and future reality tree), and developing implementation plans (prerequisite tree and transition tree).

theory of constraints accounting
– A cost and managerial accounting system that accumulates costs and revenues into three areas–throughput, inventory, and operating expense. It does not create incentives (through allocation of overhead) to build up inventory. The system is considered to provide a truer reflection of actual revenues and costs than traditional cost accounting. It is closer to a cash flow concept of income than is traditional accounting. The theory of constraints (TOC) accounting provides a simplified and more accurate form of direct costing that subtracts true variable costs (those costs that vary with throughput quantity). Unlike traditional cost accounting systems in which the focus is generally placed on reducing costs in all the various accounts, the primary focus of TOC accounting is on aggressively exploiting the constraint(s) to make more money for the firm.

throughput
– In the theory of constraints, the rate at which the system (firm) generates money through sales. Throughput is a separate concept from output.

TOC performance measures
– In the theory of constraints, throughput, inventory and operating expense are considered performance measures that link operational decisions to organizational profit.

transition tree (TRT)
– In the theory of constraints, a logic-based tool for identifying and sequencing actions in accomplishing an objective. The transitions represent the states or stages in moving from the present situation to the desired objective.

utilization
– In the theory of constraints, utilization is the ratio of time the resource is needed to support the constraint to the time available for the resource, expressed as a percentage. See: activation.

VAT analysis
– In the theory of constraints, a procedure for determining the general flow of parts and products from raw materials to finished products (logical product structure). A *V logical structure* starts with one or a few raw materials, and the product expands into a number of different products as it flows through divergent points in its routings. The shape of an *A logical structure* is dominated by converging points. Many raw materials are fabricated and assembled into a few finished products. A *T logical structure* consists of numerous similar finished products assembled from common assemblies, sub-assemblies, and parts. Once the general parts flow is determined, the system control points (gating operations, convergent points, divergent points, constraints, and shipping points) can be identified and managed.