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Solving the Inventory Optimization Problem

Over the past two decades, retailers, wholesalers and consumer package goods (CPG) firms have made massive investments in supply chain technology. Yet the basic metrics of supply chain performance -- inventory turns and in store availability -- have improved little, if at all. This complex problem has been dealt with to varying degrees by inadequate, poorly timed and badly thought out solutions for the last 30 years. In fact, more than one hundred SCM solution vendors currently promote "Inventory Optimization" as an application solution. Beyond the strong marketing message, though, very few of these software providers provide real inventory optimization.

The ability to automatically determine the correct stock levels for multiple SKUs in multiple locations, in such a way that fulfills a global service level target and simultaneously optimizes a desired objective is a very complex task, and requires a sophisticated technology. As a result, the goal of achieving a synchronized end-to-end supply chain -- with the resulting cost efficiencies and increase in sales -- remains an elusive one.

A few years ago, some vendors realized the inadequacy of their models and added "patches" to deal with this problem. These patches, like the Croston's method (1970) or the Mercia-Finmatica, (SAP® -APO) fixed the most apparent flaws but still didn't solve the problem.

Even the few vendors that are now selling some "inventory optimization" functionality have at best upgraded their inventory models to be more "complete" and closer to the 1968 "state-of the-art". In fact, we'd go so far as to say that we don't believe that you can find an optimal global inventory solution in a complex supply chain, from the big SCM solutions providers on the market

ToolsGroup has more than 130 implementations at 70 companies in 28 countries around the globe. Most ToolsGroup customers have "distribution intensive" businesses, as typically found in:

- Consumer packaged goods manufacturers, food & beverage, pharmaceutical, and fashion
- Aftermarket parts, such as automotive
- MRO (Maintenance, repair and operational) parts
- Consumer durables such as white and brown goods, and consumer electronics
- Retailers and distributors
- Downstream process industries such as chemical and steel

Many of our customers have high customer service level requirements, thousands of product SKUs, or want to optimize their inventory across multi-echelon distribution networks.

"Determining the right amount of inventory to hold in which locations - without excesses or shortages - has been an intractable supply-chain problem. Now new tools, based on breakthrough academic research, promise to reduce inventories across the chain with the same or better service."
Jean V. Murphy - Global Logistics and Supply Chain Strategies - June 2003

The Tools Group Solution

ToolsGroup, Inc. was founded in 1993 by Eugenio Cornacchia of MIT, Draper Labs and ITP and Joseph Shamir, physicist with Tel Aviv University and ITP. This team of mathematic and logistics experts has developed a suite of technologies incorporated into the DPM (Distribution Planning Model) Tool.

To solve the Inventory Optimization problem, ToolsGroup professionals started working on the subject of "inventory modeling" in the mid-seventies, in a project that a large European car manufacturer assigned to Charles Stark Draper Labs. (Cambridge, MA).

The project team realized that, despite of the fact that the entire inventory management system had been designed using what was the "state-of-the-art" for that time, there was very little adherence between planned service and inventory levels and actuals. Our team developed a solution that resulted in a service level improvement of 15 % and a doubling of inventory turns (3.13 to 6.12). We estimated that about 30% of these benefits came from a very early version of "inventory optimization" (the computing power available at that time didn't allow us to work at the SKU-L level for 96,000 active part-numbers and more than twenty warehouses), while the remaining 70% came from a brand new "inventory modeling" technology.

Further refinements have been made in the following 25 years to our "inventory modeling" technology and to our "inventory optimization" algorithms, but the core of the problem that we addressed - the inadequacy of the traditional "inventory theory", is still being used today in DPM.

The main differences between traditional "inventory theory" and our "advanced inventory modeling technology" can be grouped into two different categories:

- how "demand" behavior is modeled
- how "stock" behavior is modeled

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Modeling Demand Behavior

The common approach to "demand modeling" is still based on some traditional assumptions, which are becoming increasingly inadequate.

Traditional, common approach:

- The demand history is only considered in terms of quantity, totally ignoring individual line items or "transaction sets"
- The main focus is on forecast accuracy, with very little attention given to the "stochastic" or "real system" components
- Safety Stock is directly derived from the distribution of the forecast errors
- The presence of a limited number of algorithms creates huge instability in switching from one to another resulting in dramatic swings in safety stock.

Advanced "Demand Modeling" is more realistic and assures more accurate results:

- The demand history is collected and analyzed both in terms of quantity and customer line items, in order to better model the shape of the demand probability distribution
- The main focus is on the "stochastic" components, that is the "full" probability distribution of demand, from which the forecast is derived almost as a by-product
- The demand probability distributions (order lines per period, quantity per order line, quantity per period) are derived from history in a coordinated way, allowing us to see patterns in data
- A wide variety of demand behaviors can be modeled, ranging from very fast movers to lumpy demand items, through a unique, proprietary algorithms
- These algorithms can assume an infinite number of demand shapes allowing the customer to manage any item in any stage of its life cycle with a self-adapting, seamless model.

"We have always guaranteed a high service level to our clients. The goals set for DPM - to reduce stock, to improve stock mix and to further increase our service level - were therefore very ambitious. With DPM and the support of ToolsGroup we were able to carry out this project and achieve the set goals." R. Chemello, Co-CEO Director Luxottica Group

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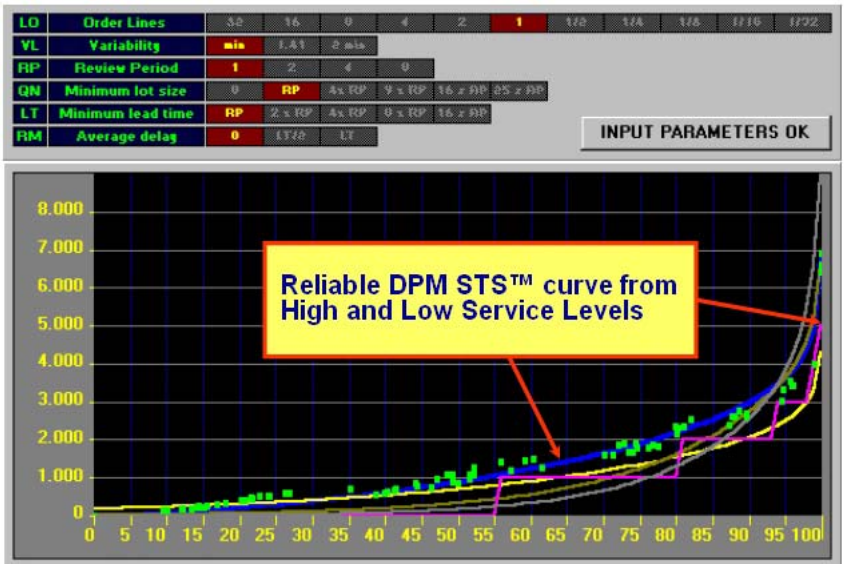
Modeling Stock Behavior

The proof can be illustrated by comparing the "demand curves" shown by other vendors and the STS (stock-to-service) curves created by ToolsGroup products. These curves show the average stock level against the fill rate.

As you can see, when you are below 70% and above 95% service levels, the exchange curve for most vendors (yellow curve) deviates dramatically from actual results. There are a number of reasons why this happens using the traditional models.



-- NORMAL
-- LOG NORMAL
-- POISSON
--EXPONENTIAL
--DPM STS curves
■ Simulation runs

X = Service level (%)
Y = Ave. stock (periods)

Traditional, common approach:

- The safety stock calculation is carried out using a simplistic demand model,restricted to a basic forecast and some measurement of the forecast error.
- Not all the replenishment parameters that are relevant for a correct safety stock caculation are always considered.
- The Service Level goal doesn't always make a clear distinction between fill rate, expected shortage and stock-out probability.
- The relationship between service level and average stock on hand is totally unreliable because it is based on the relationship between service level and safety stock.
- The replenishment frequency is not always taken into account in the calculation of the safety stock.

Advanced "Inventory Modeling":

- The safety stock calculation is carried out using a demand model based on an algorithm that is reliable and stable.
- All the replenishment parameters that are relevant for a correct safety stock calculation are considered, including customer order frequency.
- The "expected" replenishment frequency is derived from all parameters used in the calculation of the safety stock.
- The relationship between safety stock and average stock is described through acomplex analytical function that allows it to correctly derive the stock behavior for the entire range of service levels from 0 to 99.99 %.
- All this leads to stock-to-service curves that guarantee an excellent adherence between planned and actual performance, which we think is an absolute prerequisite for any "inventory optimization" process.

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Benefits of a Streamlined Supply Chain

By enabling a synchronized end-to-end supply chain in which demand drives supply, ToolsGroup helps clients realize the following benefits:

- Decreased stock-outs, increasing sales and customer satisfaction
- Decreased inventory, reducing carrying costs, shrinkage and the need for margin-eroding markdowns or expedited orders
- More effective execution of new product launches and other tactical and strategic initiatives, as the result of better data and better understanding of the drivers of demand and inventory
- Improved allocation of manufacturing and distribution resources and improved customer service levels

ToolsGroup can be implemented quickly on a DC by DC basis, or for an entire division. The system typically generates measurable results in fewer than sixteen weeks, offering a quick return on investment. Specific results vary by customer, but reduction in inventory of over 40% is not uncommon.

About ToolsGroup

Two partners founded ToolsGroup in 1993: Eugenio Cornacchia, an MIT graduate and former engineer at Draper Labs, and Joseph Shamir, a physicist with Tel Aviv University. The pair collaborated on a variety of major supply chain projects together and used their extensive hands-on experience to create ToolsGroup's flagship software product, DPM.

The product was first released in 1996. ToolsGroup is now widely recognized as having the "best of breed" software solution for inventory optimization in distribution intensive industries. Since its release, DPM has been implemented at more than 130 installations in 28 countries around the world and in a wide variety of sectors. The company has added many new capabilities over the years, including self-adaptive modeling, parallel benchmarking of the optimization process, and multiple optimization criteria.

About redcote

The recent merger of mmi services and modanova group bring years of CRM and Supply Chain experience to our clients in addition to significant Business development experience. Together we have relationships with several cutting edge software solutions providers that we believe can give clients a strategic advantage. redcote has clients across the retail and manufacturing verticals. We have offices in New Hampshire, Connecticut and California.

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