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The Valogix Approach to Inventory Forecasting and Replenishment Planning

WHITE PAPER

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Valogix Inventory Planning Methodology Approach **White Paper**

Foreword

In today's dynamic business climate, companies are looking for simple ways to reduce waste and improve profitability. Going through many business cycles or phases faster than ever, new technology initiatives must be affordable, easy to implement, and have a high, measurable rate of return.

Companies approach their inventory planning in many different ways - from seat of the pants guessing, to team collaboration, to spreadsheets that may invoke more team collaboration and manual changes, to forecasting software and some to advanced planning solutions.

Business software solutions like accounting packages or ERP systems come with some level of inventory management or inventory control functionality but rarely do they include forecasting or demand planning. They rely on the user manually setting min and max levels and safety stock to control the inventory. There are stand-alone forecasting packages that offer dozens of statistical models that allow the user to select the one or ones they want to use, and some even provide automated forecasting in which the solution uses a best-fit approach.

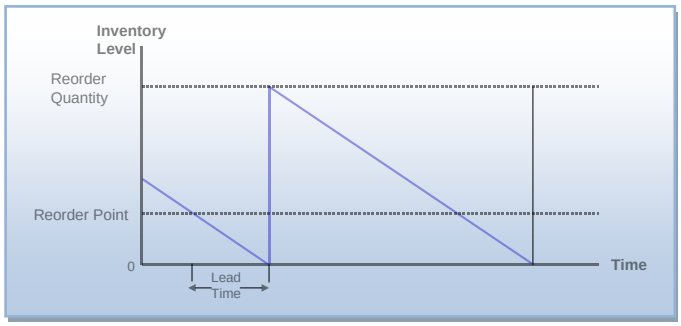
Tools are only as good as the people are at applying them. Clearly, understanding the use and objectives of the business management system and directing how Valogix solutions compliment its results are how Valogix solutions generate real and significant impact.

Valogix solutions run a statistical analysis of up to 48 months of demand (sales) history via a proprietary qualifier algorithm. It then applies the best forecast model from either a horizontal, trend, normal seasonal, high seasonal model or multiplicative model like Season-Trend or Trend-Season. Forecasting 'new' items is elevated through the use of Historic Analogy (Proxy History). History and forecast data are displayed in Valogix and can be user modified. The advanced technology engine includes heuristics based on the 20 years experience of the team providing a rationalization of the inventory approach to enhance performance against real business metrics and operating environment.

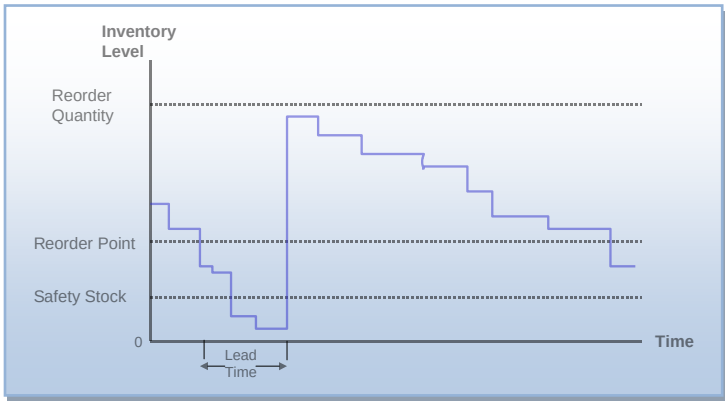
We believe our level of technology is state of the art. Inventory Forecasting and Planning is our business and the sole focus of our R&D. Our special emphasis and experience in a wide variety of industries and product lines allows us to incorporate best practices which further differentiates our team and our products. We do not rely on dated textbook techniques. Our direct approach to problem solving complex inventory business problems has led to significant enhancements to forecast and optimization algorithms. This is reflected in our product design and processes.

Basic Inventory Planning - The 50 Year Old Model

The diagram below illustrates the most basic model of the inventory planning process.



When the item's inventory level falls below a "reorder point" (min), an order goes to the item supplier for a "reorder quantity" (max). Because it may take some days (lead time) to obtain the item, the reorder point must be greater than zero. The replenishment arrives and then the saw tooth pattern repeats until inventory falls below the reorder point again. Actual demand is never as steady as the diagram above suggests. The second diagram shows a more typical situation.



"Safety stock" is required to account for randomness in demand, uncertain lead time, and review periods. The concept of a reorder quantity determined by "order-up-to" level" is typically applied.

The problem: A planner or planning system working on a weekly review cycle, for example, may not notice that the inventory fell below the reorder point until some days later.

Common Approaches to Calculate the Inventory Control Parameters

How should a planner set the reorder point and reorder quantity (or order-up-to level) for thousands of items, perhaps at multiple locations? Due to the absence of an 'intelligent' planning system, three commonly used approaches have been Brute Force Review, Economic Order Quantity, and periods of supply.

In Brute Force Review, planners examine each item at each stocking location and manually set the min and max controls most often in spreadsheets. This is such a time-intensive process that the results get out of date, yet nobody has the time to update them. Moreover, without good tools there is no guarantee that the controls will be set well even at the start.

Economic Order Quantity (EOQ), a simple calculation of the reorder quantity as a tradeoff between the cost of carrying inventory and the cost of placing an order, is another commonly used approach. Frequent re-orders minimize inventory holding, but incur high ordering costs. Likewise, buying in quantity reduces the ordering cost, but results in low inventory turns and high carrying costs. Although EOQ calculations are frequently available in Enterprise Resource Planning (ERP) systems, planners have difficulty determining the two driving parameters, order cost, and inventory holding cost.

Another common approach is to apply "periods of supply" for the max quantity. For example, average demand may be 120 units per week over the last four months. Taking 2 weeks of stock for the min and 8 weeks for the max, this approach would calculate min of 240 units and max of 960. Such an approach has the advantage of being easy to calculate. Although it is safe for high volume items, it works poorly for low and medium volume items.

The biggest problems with both EOQ and 'periods of supply' are that neither: 1. Fully considers the real potential or level of a spike in demand; nor 2. The impact of short life cycles; nor 3. The timing of trend or seasonal changes. These inefficiencies combined with situations where the planner may not have a system that handles 'every' item requiring to be planned, accounts for the over or under buying that occurs daily.

Finally, the weeks of stock approach assumes that demand will stay constant. This is often not the case, because demand is increasing, decreasing, or driven by season. Hence, this common approach tends to cause too much inventory investment or insufficient service levels.

Traditional Forecasting

The planning methods described above rely on forecasting as a starting point. The most common inventory forecasting algorithms are statistical models. Solutions offering these algorithms tend to be labor intensive requiring several highly skilled people to analyze the models, select the best method for each item, tweak the results, and constantly monitor forecast accuracy – always with less than perfect results.

In addition, such solutions usually require fairly long processing times. They also tend to be stand-alone solutions requiring one to consider forecasting results separately from the planning process. None of this works in most businesses, nor is it necessary.

The Business Problem

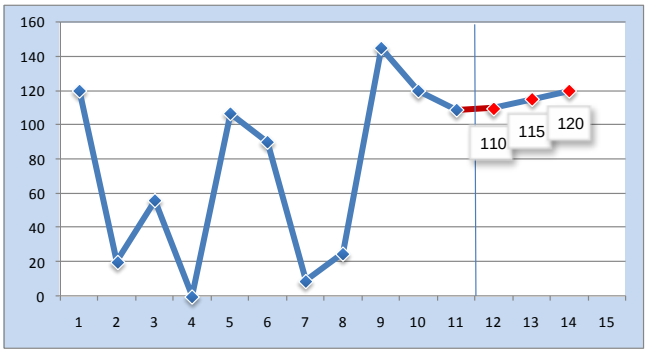
However, the question becomes a matter of how to use or interpret the results of forecasting to establish inventory stocking levels and plan effectively. Lacking anything else, what generally happens is that forecasts are used to set inventory levels and requirements. The user then manually sets min and max levels and ultimately purchasing and production quantities. This approach can be acceptable if only a few items are involved, but it can be a monumental task for hundreds or thousands of items. Relying on forecasting systems with a 40 to 60% accuracy attainment at the Item or SKU/ location level usually results in stock-outs for many items and excess inventory for others. Both results are very costly to the company.

Interpreting Forecasting Results

When you have a product with consistent demand and several years of history, forecasting tends to be relatively straightforward. However, what about products with extremely random or slow demand, or new products with no history? How do you forecast for these differing situations? This problem is particularly pronounced with high tech products that may have a sales life as short as a few months and a service life of several years.

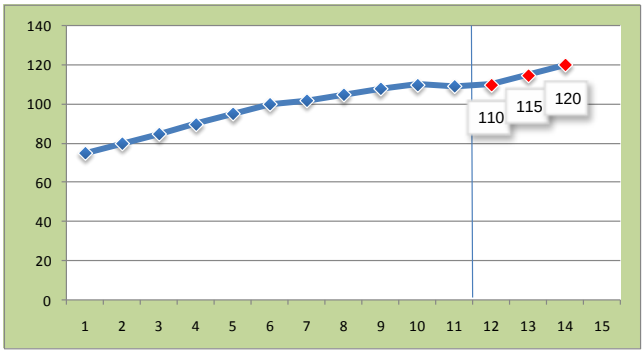
Below are two typical graphs of demand history. The one on the left has a random demand pattern and the one on the right shows a relatively constant demand stream.

Random Demand



Historic Demand Forecast

Steady Demand

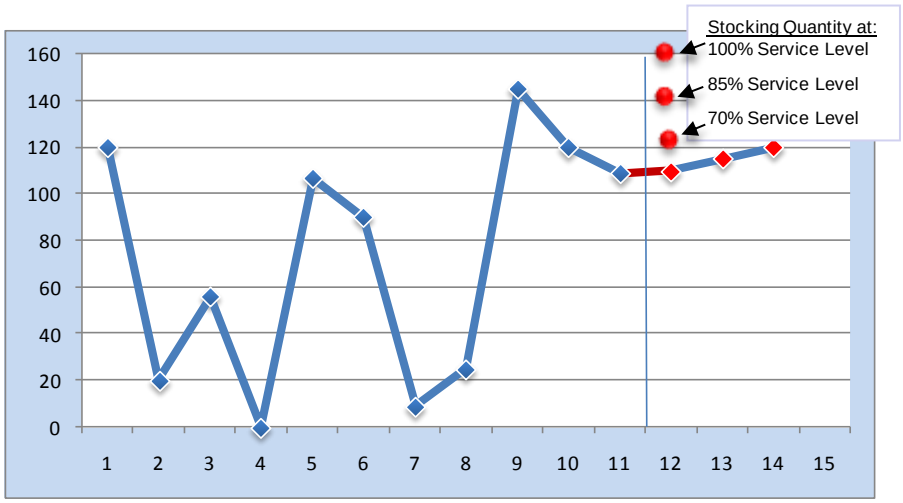


Historic Demand Forecast

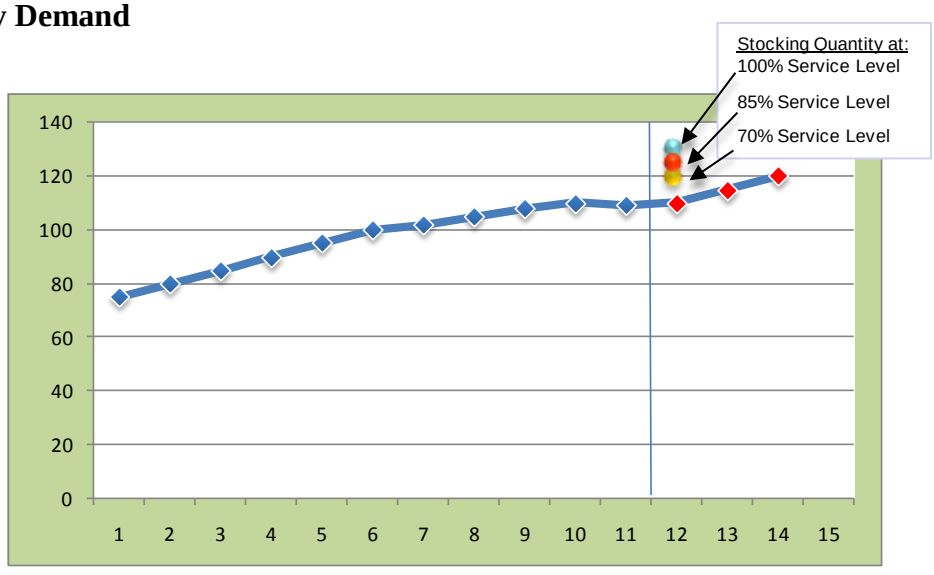
In both cases, the forecast trend line may suggest the forecast ramping up slightly at around 110 in the first forecast month, 115 in the second and 120 in the third.

Depending on the forecast model chosen, a random demand pattern may cause you to carry more inventory when you don't need it and not enough on hand at times to meet a spike in demand.

Random Demand



Steady Demand



In addition to a forecast, there are other factors to be considered when deciding how much inventory to stock. One factor is Service Level. This can dramatically affect your investment depending on the service levels you want to provide as illustrated in the graphs above.

Other factors include budget, carrying costs, planning horizon, lead times, and many more, such as:

- When planning ocean shipments, a large number of possible replenishment options should be examined to figure out how to optimally load full containers, while meeting demand.
- Which supplier should be used when one has higher costs and shorter lead times than another.
- Suppliers may offer quantity discounts, so an important decision is "How much extra should I buy now, at a lower price, beyond what I need for the near future to be most cost effective?"
- Positioning inventory properly across the supply chain and across items may be a major consideration. Centralizing inventory allows "pooling" of demand and a smaller total inventory quantity. However, sending inventory out to regional and field sites or retail locations could improve responsiveness to customer demands.
- Your customers supply you with their forecast using you as a ready source of supply. How did they arrive at their numbers? Do you use their numbers entirely or do you adjust them? Should you be planning and forecasting for them instead?

Getting Value from Forecasting

You should understand that forecasting is an important first step, but not the only step in good inventory planning. The entire inventory planning process must work smoothly and be in-sync from forecasting to setting stocking levels, to calculating replenishment levels, to purchasing and production.

Valogix Forecasting and Planning

Valogix applies the concept of Demand Planning to its fullest scope. Demand Planning, is exactly what it says "planning demand". Two sub-sets of demand planning are: Forecasting and Planned Demand e.g. equipment maintenance organizations that schedule item usage in advance or firm blanket orders with release dates.

The combination of a good forecast and a good optimization method is the key to making the most of your inventory investment. Valogix solutions do both easily and reliably. You do not have to be a statistician to benefit from the power of advanced planning.

The first step, demand planning, is a powerful automated approach establishing a rolling 12 month demand forecast for every item that you want to plan. You can modify the forecast if you know information that is not reflected by demand history (for example, promotions or expected new usage for a project). Valogix forecasting algorithms handle trends and seasonality, projecting ahead rather than assuming the past average demand will continue.

The next step involves optimizing the inventory by setting optimal stocking levels. Valogix's unique approach to solving this complex problem generates an order-up-to quantity we call the *"Valogix Stocking Quantity (SQ)."*

The SQ calculation is a proven statistical approach determining the optimal amount of an item to stock on the shelf. Unlike the common approaches described above, this automated calculation:

- Accounts for changes in demand patterns, using the Valogix forecasting process.
- Provides user-controlled service level, the real objective of replenishment.
- Accounts directly for review periods and lead times, by item and stocking location.

The Valogix Advantage

- While one might think the same algorithms work for all businesses, it is not the case. Service organizations servicing equipment and systems, for example, get orders for an item when it fails or is broken. Essentially, these organizations are predicting part failure. They forecast, plan and buy oftentimes in multiples of one. Other businesses such as finished goods and distribution, especially master distributors, are predicting business-to-business replenishment orders. These organizations order in multiples (25, 50, 100, etc) and buy in even larger multiples. The algorithms and business rules for each are different.
- Low volume: Most organizations have a mix of volume demand with the extremes of high and low. Low volume items are much more difficult to forecast than high volume. Since low volume items may also have infrequent demand, forecasting on a monthly basis means predicting when demand is going to occur, not just how many.
- The answer to these issues does not reside only with forecasting. Intelligent replenishment planning includes several components, of which forecasting is just one. Valogix solutions are complete planning systems that handle all behavior including low volume items as part of a total process.
- Optimization. While Valogix has an ongoing effort to improve forecasting algorithms, its optimization methods are what make inventory and replenishment planning highly effective. Valogix optimization considers the wild cards in planning e.g. how random the demand of an item is (i.e. standard deviation) and service level objectives, and it does it for each item, leaving nothing to chance.
- Valogix solutions process automatically and quickly. We use sophisticated and complex methods in a way that makes sense to people who use the output.

Forecasting Methods

The first forecast step is, for each inventory item, decide which forecast model works best. The second forecast step is to apply a forecast model. Valogix solutions do both steps automatically and quickly.

Algorithm Selection

Using history to predict the future is the most common type of forecast modeling. Such forecast methods are called historical time series models. Extensive analysis of historic time series has shown that most demand histories have distinctive patterns consisting of one or more characteristic e.g. seasonality, trend, random-intermittent demand, highly stable, highly erratic (which statisticians would tend to describe as lots of 'noise'), batch order history (e.g. master distributors), single order history (e.g. service parts), etc. Valogix solutions apply a proprietary algorithm to qualify each item based on its characteristics and patterns.

Based on the outcome, the system automatically applies the best model for forecasting demand. Applying the best forecast model is fast. It processes quickly and requires no user intervention. The value of this automated method enables users to plan faster and more accurately, and allows them to focus on exceptions and buying 'smart', rather than tediously laboring over selecting or evaluating the best forecast algorithm for each and every part or part/location combination.

Historical Time Series Based Models

Historic data are an excellent source for computing a forecast, particularly for finished goods and service parts. Whether applying all or part of the time series to compute a forecast, oftentimes, it is the only possible basis of providing a forward look at future requirements.

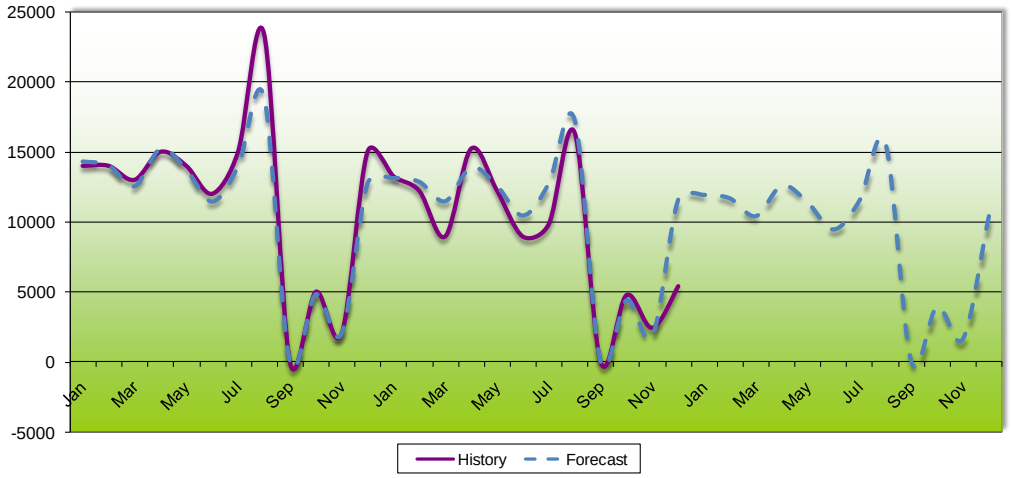
Trend and Seasonal Models

These models are modern statistical algorithms, which automatically detect the existence and characteristics of the components of a time series. They assume any time series to have the following components: trend, seasonality and noise. These models decompose the components of the time series and then extrapolate future values according to the characteristics of these components.

The system measures the trend and seasonal components to determine the strength of each. Keep in mind, the existence of seasonality, requires at least 24 or more periods of data to be confirmed. Once the strength of the trend and seasonal components are determined, the appropriate model is applied.

Items having more than 24 months of history are tested for the strength of the trend and seasonal components to determine which is stronger. If seasonality is stronger, the model applies the Seasonal/Trend algorithm applying a trend, if the trend factor is significant. If the trend component is stronger than the seasonal, the Trend/Seasonal model is computed putting special emphasis on the trend. It looks at trend in two ways, long term (as much history as available) and near term (i.e. what the most recent period trend is), and uses both pieces of information to project forward. The model also checks for seasonality. If present, it will then factor that component in with the trend data to project future demand.

Either users can choose to smooth a seasonal forecast or not, which reduces the variation between the seasonal and non-seasonal periods. If an item has less than 24 periods of history, a Trend model is applied.



This example shows the capabilities of the Valogix Multiplicative Forecast algorithm.

New Item Forecasting

New items without a history are very difficult to forecast without additional information. Valogix forecasts one period out only for an item with only one month of historic demand. The forecast number is the single history month quantity, divided by the number of historic periods since the demand. In most cases the most recent history month is the only demand point so it's the historic usage quantity divided by one so the forecast month will equal the historic month. To better forecast new items, an alert is generated allowing the user to manually enter a forecast for the items they wish to forecast differently.

Items with Little History

While history may be a great indicator of future demand, if an item has very little history, then, like new items, forecasting is more difficult. If an item has only a few months of history, a simple moving average is computed, using carry-forward rounding.

Example: Month: 1 2 3 4 5
History demand per month is: 7 0 10 0 0
Average is 17/5 = 3.4
Forecast cumulatives are:

3.4 6.8 10.2 13.6 17 20.4 23.8 27.2 30.6 34 37.4 40.8

The forecast is finalized by subtracting the cumulative adjusted forecast from the actual forecast. For example:

Month1: Forecast = 3.4. Round up to 4 for month 1 of the adjusted forecast.
Month 2: Cumulative forecast = 6.8
Cumulative Adjusted Forecast Previous Period = 4
6.8 – 4 = 2.8 Round up to 3 for month 2 of the Adjusted Forecast

Month 3: Cumulative Forecast = 10.2
Cumulative Adjusted Forecast previous period = 7
10.2 - 7= 3.2 Round up to 4 for month 3 of the Adjusted Forecast
The Adjusted Forecast is:
4 3 4 3 3 4 3 4 3 3 4 3

Manual Forecast

Valogix solutions enable users to edit forecast periods. Switching back to the system forecast is easy, just select 'Reset Forecast'.

Forecast Frequency

Valogix solutions currently forecast in monthly buckets. (the replenishment plans, however, are in daily or weekly buckets). Except for some industries e.g. retail where volume is high enough to be able to predict accurately on a weekly basis, most other businesses either do not have the monthly volume to be able to dissect it at a weekly level or do not have weekly patterns that can be reliably predicted. Therefore monthly is the safer and more accurate approach.

Forecast Accuracy

Forecast inaccuracies have long been an excuse for buying or producing poorly. The burden does not rest solely on forecasting. By virtue of the fact that it is a prediction, it inherently has a degree of error. It is the degree of error is handled for purposes of planning is the focus and metric should be.

In the case of finished goods and service part replenishment planning, good replenishment or good inventory level planning which includes buying and transferring items, is best achieved using the best forecasting available along with optimization which in turn utilizes statistical information about the history of an item, business rules driving inventory management, vendor constraints (e.g. discounts, free freight, minimums, etc.), and information only a planner would know such as the timing of promotions. Valogix looks at the complete inventory picture – not just forecast accuracy.

In a production environment, a forecast is the basis of a recommended production quantity (PQ) which is designed to drive production. In reality, many other factors alter the actual PQ at any given point in time. These factors include machine capacity, equipment and production line up time, raw material supply, labor issues, workforce availability, PM schedules, weather, and so on. If the PQ is higher or lower by 10% or more based on the any of above factors the accuracy of the forecast comes into question. Rarely, if ever, are these factors included in the automated forecast accuracy analysis.

Forecast quality, meaning how it represents actual demand, is not the same as forecast value. A forecast has high *value* if it helps the user to make a better decision.

We recommend the metric should instead be the accuracy of the optimization model. While we strive for high forecast accuracy we have proven that effective planning is best achieved by a good planning model in which forecasting is just the first component. The advantage of optimization modeling is that it utilizes forecast data along with demand pattern statistics. Further, it factors in business planning rules and objectives, such as service level and cost factors.

Therefore, when a configuration does not support the objectives of the inventory strategy it is more a matter of tweaking the planning model and measuring the ability of the model and its configuration capability, rather than putting the burden on forecast accuracy.

Summary

Valogix continues to focus R&D to continue to advance the state of the art in planning and optimization. Enhancing dynamic calculations, understanding demographic and econometric conditions, and providing just the right amount of automation for ease of use and measurable results are hallmarks of our ongoing dedication to excellent customer service.

Valogix Solutions Advantages Recap:

Valogix optimization and SQ offer a highly improved approach to inventory replenishment planning. It offers these advantages over common planning approaches:

1. Easy to use; the Valogix software does the heavy lifting totally replaces lengthy manual analysis previously needed to set replenishment controls. No more need for the best guess approach.

2. It is dynamic, changing automatically as business conditions change. Replenishment controls stay up-to-date.

3. It takes into account many variables insuring the right coverage without over-or under- investing. Valogix calculates optimal quantities, which means you save money without sacrificing service by procuring or producing just the right amount of stock