10400-2016

DEMAND-DRIVEN PLANNING & OPTIMIZATION AT ELECTROLUX

Aaron Raymond, Sachin Verma and Pratapsinh Patil

ABSTRACT

Electrolux is one of the largest appliance manufacturers in the world. Electrolux North America sells more than 2,000 products to end consumers through 9,000 business customers. To grow and increase profitability under challenging market conditions, Electrolux partnered with SAS® to implement an integrated platform for Demand Driven Planning & Optimization (DDPO), and improve service levels to its customers. The process utilizes historical order data to create a statistical monthly forecast. The Electrolux team then reviews the statistical forecast in Collaborative Planning Workbench (CPW) where they can add value based on their business insights & promotional information. This improved monthly forecast is broken down to the weekly level where it flows into Inventory Optimization Workbench (IOW). IOW will then compute weekly inventory targets to satisfy the forecasted demand at the desired service level.

This presentation will also cover how Electrolux implemented this project. Prior to the commencement of the project, Electrolux & SAS team jointly worked to quantify the value of project and set the right expectations with the executive team. A detailed timeline with regular updates helped provide visibility to all stake holders. Finally, a clear change management strategy was also developed to define the roles & responsibilities after the DDPO implementation.

INTRODUCTION

The partnership between major appliances division of Electrolux North America's (referred to as "Electrolux" in the remainder of this paper) and SAS® began with the meeting of CEOs in New York. They discussed how they could leverage each other's strength to bring greater value for both organizations. Since the 1900s, Electrolux has been a leader in product innovations that shape the appliance market. It was the first company to introduce absorption refrigerators, light household laundry machines, and many others. Market conditions, particularly in the United States, are challenging for appliance manufacturers because of increased competition that results from globalization. Supply chains are also constantly evolving and becoming more complex. Both CEOs agreed that leveraging SAS advanced analytics would enable Electrolux to gain valuable insights from their large data and also make better data-driven decisions. Supply chain process improvement was identified as one of the key areas where advanced analytics could add the greatest values to Electrolux.

Prior to the implementation described in this paper, Electrolux was primarily using spreadsheets for sales and operations planning. A forecast was created primarily using the input from the sales team using a process with manual intermediate steps. This process was often time consuming and also error prone as the analysis was not consistent across the sales team. Spreadsheets are not designed to handle large amounts of data, making it difficult to analyze multiple year's data at a granular level. This manual approach also did not calculate forecast variance which is an important component in the safety stock calculation for inventory optimization. There were also two different approaches for inventory optimization for single and multi-echelon networks. To overcome these challenges, Electrolux envisioned a standardized and automated approach for both forecasting and inventory optimization that can be scaled to satisfy their growing customer demand. The new system should also be flexible enough to adapt to constantly changing supply chain requirements.

DEMAND DRIVEN PLANNING & OPTIMIZATION

Electrolux licensed SAS® Demand Driven Planning and Optimization (

Figure 1) to take advantage of SAS analytics to improve demand forecast modeling and accuracy, and to provide for a more structured, efficient collaborative planning and inventory optimization processes. SAS® Demand Driven Planning and Optimization provides the following capabilities for Electrolux:

- Delivers an enhanced, integrated platform for demand planning and inventory optimization, eliminating the reliance on multiple Excel-based processes.
- Interfaces with the SQL Server stage database to leverage existing master data.
- Produces reports to support exception-based management at Electrolux.
- Enables exception-based management to maximize planning productivity as facilitated by operational reporting.
- Stores statistical and consensus forecast values in SAS system for analysis and reporting purposes.
- Delivers an inventory optimization platform to right-size finished goods inventory and increase customer service levels.

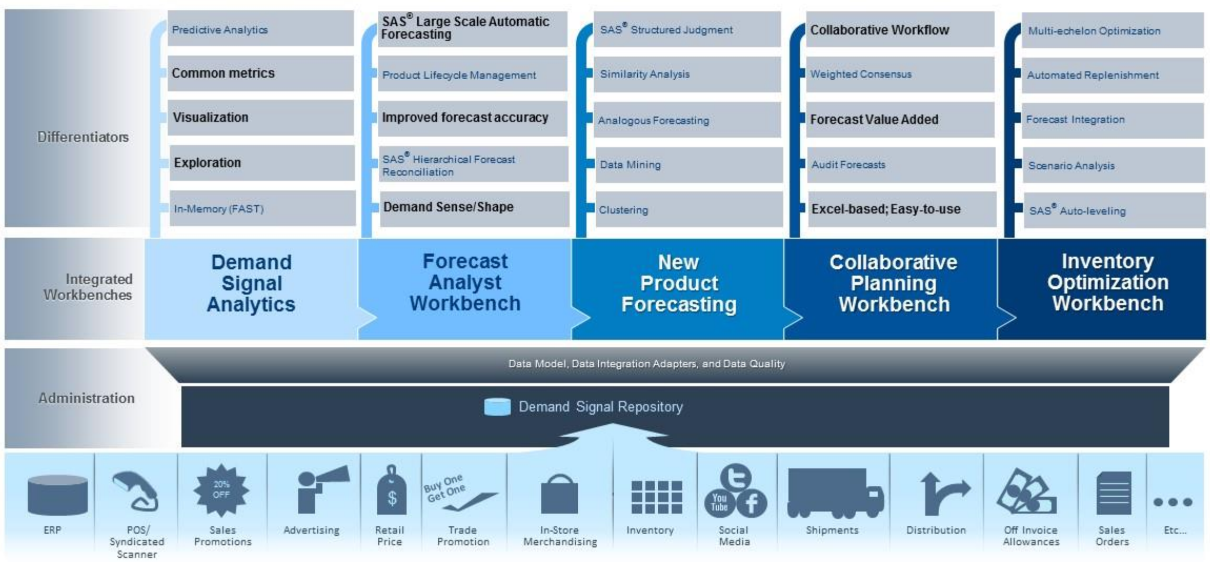

Figure 1. SAS Demand Driven Planning and Optimization

FORECASTING PROCESS

SAS® Forecast Analyst Workbench creates a statistical baseline forecast for demand by product, by location, by customer, and by month in an automated fashion. Baseline forecasting methodologies include considerations for level, trend, and seasonality. The statistical forecast is created at the product line level of the Electrolux product hierarchy and then reconciled to the lowest level. Historical and future product chaining is also supported. The product chaining information can either be entered using the interface in SAS® Forecast Analyst Workbench or adjusted using an offline Excel spreadsheet. There are three key post processing steps after the creation of monthly statistical baseline forecast: Volatility handling, smoothing and breakdown of monthly forecast to weekly forecast.

Volatility handling

Volatility handling is used to reduce the fluctuations from month to month and week to week for the various forecasts. For the monthly plan, this is accomplished by averaging three forecasts together. For example, the forecast for December would be the average of the forecast generated for December in September, October and November. For the weekly plan, this is accomplished by averaging four forecasts together. For example, the forecast for week 39 would be the average of the forecast generated for week 39 during weeks 35-38. Below is an example using monthly data:

Date	October	November	December	January
Forecast Date				
September	1000	900	800	700
October		850	900	800
November			850	900

In September, 800 was forecasted for December.
In October, 900 was forecasted for December.
In November, 850 was forecasted for December.
After volatility handling, the forecast December will show (800+900+850)/3 = 850.

Figure 2. Volatility Handling Example

Forecast smoothing

Forecast smoothing is used to smooth the peaks and valleys that naturally occur within the weekly forecast horizon. Smoothing only occurs for the weekly data and occurs after the breakdown from month to week has occurred. For each week within the forecast horizon, the forecast for the two weeks prior and the two weeks forward will be averaged together to create that week's forecast. Below is an example:

Date	Week 36	Week 37	Week 38	Week 39	Week 40	Week 41	Week 42	Week 43	Week 44	Week 45
Forecast	72	78	82	51	60	73	82	51	57	66
Smoothed Forecast	86	72	69	69	70	63	65	66	63	66

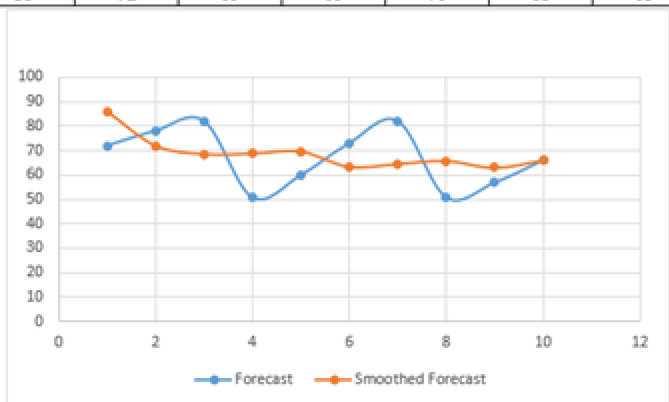

Figure 3. Forecast Smoothing Example

The forecast for week 39 is the average of the forecasts for week 37-41: (78+82+51+60+73)/5=68.8.

Month to week breakdown

Month to week breakdown is used to push the total month forecast volume down into the weekly buckets that are required by the SAS® Inventory Optimization Workbench. This weekly data is required only for the product and location dimensions. The steps to break down the month to weeks are as follows

a) For full weeks that span months, split the initial weekly forecast into partial weeks based on the DOW (Day Of Week) split. DOW split is based on historical data that was clustered.

b) Add the partial weeks and the full weeks to determine the monthly forecast based on the week level values. Calculate the ratio between the month forecast from the monthly plan and the month forecast created by adding the weeks.

c) Multiply the full and split weekly forecasts by the ratio created above. This establishes the new weekly forecast value.

COLLABORATIVE PLANNING

Electrolux allows end-users (Demand Planners) to make adjustments (overrides) to the baseline statistical forecast on a monthly basis using SAS® Collaborative Planning Workbench. Data-entry Forms are published by the Process Administrator. Demand planners receive emails alerting them that overrides can now be entered in the forms. Demand planners have a two-week window of opportunity to enter overrides, either for Events, Flooring, or Miscellaneous Overrides. Upon completion of entering the overrides, the demand planners submit the forms for approval by their manager. After the two-week period of allowing for adjustments, the consensus forecast is aggregated and reviewed by senior management, who may require additional overrides to be entered. Upon completion of the override process, the consensus forecast is exported downstream for further consumption. Collaborative planning process flow is demonstrated in Figure 4.

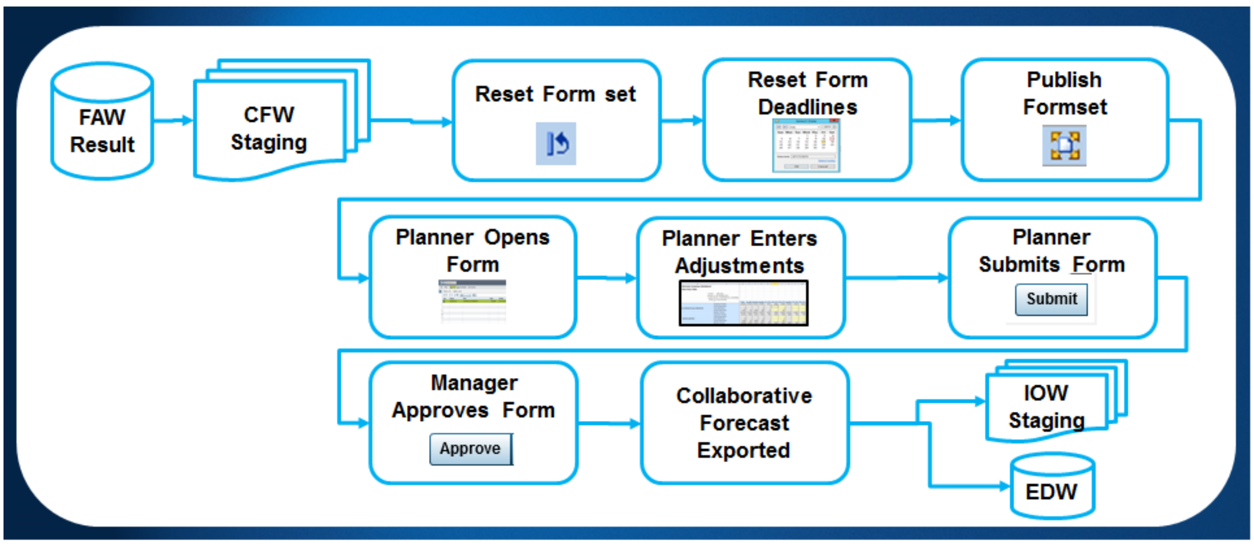

Figure 4. SAS Collaborative Planning Process

Demand planners enter overrides for products, customers, and locations. The overrides can be entered either at a leaf level or at a parent level:

- Leaf level – overrides can be made at the SKU, Customer, and Logical Location levels. These overrides will aggregate to the respective parent levels.
- Parent level – overrides made at a parent level will disaggregate to the leaf level. Disaggregation (allocation) is based upon the baseline statistical forecast for the leaf level crossings. For those crossings without a baseline statistical forecast, no allocation will occur. Also, visibility rules restrict only those crossings with a baseline statistical forecast to appear on the data entry forms.

An example of a SAS Collaborative planning workbench data-entry form is shown in Figure 5.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
	Account	Order Units												
	Customer	08												
	Location	ALL LOCATIONS												
	Version	Current Estimate												
			JAN_2015	FEB_2015	MAR_2015	APR_2015	MAY_2015	JUN_2015	JUL_2015	AUG_2015	SEP_2015	OCT_2015	NOV_2015	DEC_2015
	ALL PRODUCTS	Consensus Forecast	1,452	2,811	2,744	5,344	3,905	10,914	-	-	-	-	-	-
		Flooring	-	-	-	-	1,000	-	-	-	-	-	-	-
		Event	-	-	-	(42)	-	2,500	-	-	-	-	-	-
		Override 1	-	-	0	-	-	-	-	-	-	-	-	-
		Override 2	-	-	15	20	-	-	-	-	-	-	-	-
		Override 3	-	-	-	-	-	-	-	-	-	-	-	-
		Baseline Forecast	1,452	2,811	2,729	5,366	2,905	8,414	-	-	-	-	-	-
		Prior Consensus Forecast	1,452	2,811	2,744	5,386	4,405	12,414	-	-	-	-	-	-
		Prior Year Actual	7,638	2,075	1,634	4,216	4,576	13,835	15,140	3,976	5,402	3,823	2,702	3,134
		Actual	1,259	2,953	-	-	-	-	-	-	-	-	-	-
	806 REF	Consensus Forecast	43	207	103	100	63	13	-	-	-	-	-	-
		Flooring	-	-	-	-	-	-	-	-	-	-	-	-
		Event	-	-	-	-	-	-	-	-	-	-	-	-
		Override 1	-	-	-	-	-	-	-	-	-	-	-	-
		Override 2	-	-	-	-	-	-	-	-	-	-	-	-

Figure 5. SAS Collaborative Planning Example

INVENTORY OPTIMIZATION

Supply chain networks are classified based on the number of echelons (or levels) in their distribution network. In a single echelon network, products flow from the factory to a single regional distribution center (RDC) from where it is supplied to the customer. Products flow through more two or more RDCs before it is distributed to the customers in multi-echelon network. RDCs supplying products directly to customer facilities are called spokes. Hubs are RDCs in multi-echelon network that are located upstream of spokes. Figure 6 illustrates examples of single echelon and multi-echelon network. Inventory optimization of multi-echelon networks are more challenging than single echelon network as the inventory targets needs to be calculated for both hubs and spokes.

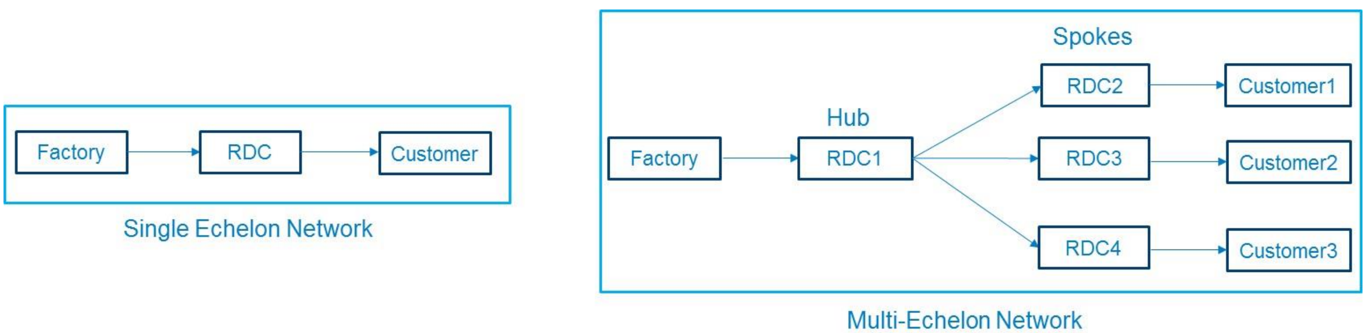

Figure 6. Supply Chain Network Examples

Like many manufacturers, Electrolux has a complex supply chain for its two main product types: produced and sourced goods. Produced goods are manufactured in North America and have a short lead time. Produced goods network is single echelon in USA and multi-echelon in Canada. On the other hand, sourced goods are primarily manufactured in Asia and distributed via Regional Distribution Centers (RDCs). Sourced goods are distributed through multi-echelon networks in USA and Canada.

Electrolux uses SAS® Inventory Optimization Workbench to compute weekly inventory target at the hubs and spokes of the multi-echelon network. These computations are executed in a batch mode. The weekly inventory optimization process utilizes data from the staging tables and forecasts in order to calculate optimal inventory target levels for each product-location combination. The optimal inventory target is the sum of the safety stock and forecasted demand over lead time. The weekly forecast input data include forecast mean and variance by product-location. The variance of forecast data along with the service level desired for that particular product-location are the main drivers for the safety stocks calculation.

Tuning and validation

Electrolux uses historical data in the tuning process to calibrate parameters such as coefficient of variation (CV) to optimize performance. Tuning is a simulation and optimization process that iterates across feasible parameter space and determines the value of parameters that will optimize the key performance indicators (KPIs) of the supply chain network such as maximize service level, maximize inventory turns and so on. Coefficient of variation (CV), defined as the ratio of forecast's standard deviation and mean value, is a critical parameter that is used in calculating safety stock. Safety stocks are required to cover the uncertainty in demand data. CVs of SKU-location are typically in the range of 0.1 to 1. The simulation part of the tuning process iterates through discrete feasible values of the CV and calculates KPIs of the supply chain network at every step. The optimization part of the tuning process selects CV that optimizes the KPIs while satisfying the business rules.

The validation process quantifies the benefit that can be expected using SAS® Inventory Optimization Workbench. The validation process uses the parameters that are obtained from the tuning process and then runs a simulation process to determine the KPIs of the supply chain network. These KPIs can then be compared against historical KPI metrics during the same time frame to determine the benefits such as improvements in service level, and reduction in inventory cost. The tuning and validation process runs automatically every quarter.

Reports

SAS worked with Electrolux to design reports in SAS® Visual Analytics to meet their business requirements. Reports can be classified into three types:

- Future Target & Order report is based on SAS Inventory Optimization Workbench output table. The primary utility of this report is to analyze the inventory target and replenishment orders created across the time horizon. Electrolux can use this report to quickly review the output by customer & location hierarchy. Monitoring the KPIs such as inventory turns and backlogs plays a key role in the continuous improvement of supply chain.
- Historical performance report keeps track of the performance of the supply chain network by using KPIs such as inventory turns, service level, backlog and so on. Electrolux can use this report to quickly identify outliers and SKU location that needs improvement
- Tuning & Validation reports help to quantify the value that is obtained by calibrating parameters during the tuning process. These reports compare tuning and validation results with historical data enabling Electrolux to identify the areas where their historical performance could be improved through optimization.

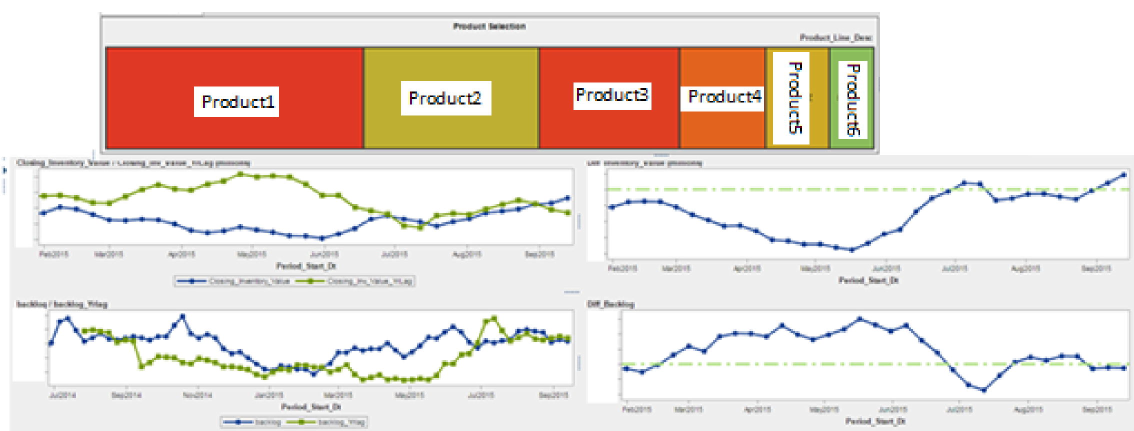

Figure 7. SAS Inventory Optimization Workbench Reports

IMPLEMENTATION APPROACH

Electrolux and SAS implementation team adopted an incremental approach with the following steps:

a) Start with a small segment of the supply chain network

b) Execute SAS Demand Driven Planning and Optimization with basic functionality to produce output tables

c) Evaluate the output tables and iteratively fine tune parameters of SAS Demand Driven Planning and Optimization.

d) Slowly scale the input data by adding more supply chain network for analysis.

e) Enable additional functionalities such as reviewing solution in user interface.

An Early Results System (ERS) was created at SAS to speed up the implementation process. Electrolux shared the input data with SAS through File Transfer Protocol (FTP) which would then be loaded into SAS Demand Driven Planning and Optimization in ERS. The results from ERS were shared with Electrolux using FTP. Four independent rounds of validation were performed using four different data snapshots before ERS was signed off. After sign off, all the work was migrated from ERS to the development and production servers on Electrolux's side. An automated end to end process was also developed to automatically extract data from the source system, run it through SAS Demand Driven Planning and Optimization, and feed the results back into Electrolux execution system.

CONCLUSION

Electrolux and SAS have forged a mutually beneficial partnership by implementing SAS Demand Driven Planning and Optimization, which delivers an enhanced, integrated platform for demand planning and inventory optimization, eliminating the reliance on multiple Excel-based processes. SAS Forecast Analyst Workbench creates a statistical forecast that is based on the historical data. The statistical forecast is fed into the SAS Collaborative Planning Workbench where Electrolux analysts can add value to the forecast based on market insights and real time promotional information. This enhanced forecast is utilized by SAS Inventory Optimization Workbench to calculate the inventory targets in the multi-echelon network to right size the inventory and satisfy the desired customer service level. A tuning & validation process is run automatically every quarter to calibrate inventory optimization parameters and quantify the benefits that could be expected from inventory optimization. Visual reports are also available for Electrolux to monitor the performance of the supply chain and to identify areas of improvement.

CONTACT INFORMATION

Your comments and questions are valued and encouraged. Contact the author at:

Aaron Raymond
Electrolux North America
aaron.raymond@electrolux.com