J. Soc. Korea Ind. Syst. Eng Vol. 39, No. 3 : 170-179, September 2016
http://dx.doi.org/10.11627/jkise.2016.39.3.170
ISSN : 2005-0461(print)
ISSN : 2287-7975(online)

On Rule-Based Inventory Planning Over New Product Launching Period

Hyoungtae Kim†

Department of International Business Management, Woosong University

신제품 출시 시점의 규칙기반 재고계획에 관한 고찰

김 형 태†

우송대학교 국제경영학부

In this paper we have tackled the outstanding inventory planning problems over new product launching period in a more holistic manner by addressing first the definition of efficient business rules to effectively control and reduce the inventory risks followed by the rigorous explanations on the implementation guide on suggested inventory planning rules. It is not unusual for many companies in the consumer electronics market to make a great effort to reduce the time to launch a new product because the ability to bring out higher performing products in such a short time period greatly increases the probability for them to remain competitive in the high tech market. Among so many newly developed products, those products with new features and technologies appeal to many potential customers while products which fail to win customers by design and prices rapidly disappear in the market. To adapt to this business environment, those companies have been trying to find the answer to minimize the inventory of old products so they can move to next generation products quickly with less obsolete material . In the experimental implementation of our rule-based inventory planning, Company 'S' reduced the inventory cost for the outgoing products as low as 49% of its peak level of its preceding product version in just 5 month after the adoption of rule-based inventory planning process and system. This paper concluded the subject with a suggestion that the best performance of rule-based inventory planning is guaranteed not from one-time campaign of process improvement along with system development but the decision maker's continuing support and attention even without seeing any upcoming business crisis.

Keywords : Rule-Based Inventory Planning, New Product Launching, Collaborative Planning Forecasting & Replenishment, Product Life-Cycle, Supply Chain Management

1. Introduction

The poor accuracy of the demand forecasts during the period of the product transition can create an extra chance of having obsolete product inventory [12]. Presence of obsolete product inventory aggravates the company's cash flow, reduces the profit margins from sales at overly discounted prices, and results in reduced market share in the future caused by the elongated product sales period.

Even, APS (Advanced Planning and Scheduling), an outstanding SCM package solution, cannot be of much help in this kind of inventory problem. The main reason is that APS functions based on a stable demand and supply situation while the problem under consideration is dealing with highly

Received 8 July 2016; Finally Revised 16 September 2016; Accepted 19 September 2016
† Corresponding Author : gt4065b@gmail.com

unstable demand and development delay during the product transition time. The production transition issues are regularly checked at the Sales & Operation Planning (S&OP) Meeting, which is a cross-functional decision making council consisted of sales, marketing, procurement and production people. For the best performance of S&OP, it is mandatory to have a concrete problem statement, the list of attendees, detailed schedule and object of the meeting and the presence of the management who has decision making authority [8]. The efficient management of S&OP is one of the key factors to the success of rule-based inventory planning over the new product launching period. This paper, first reviews a few issues and related causes in the new product launching period; second, a brief introduction on the rule-based inventory planning follows describing it as the solution to minimize the 'both old & new products' Inventory at the same time; and finally, we present the implementation steps of the rule-based inventory planning by using a case study. In our research, rule-based inventory planning in new product launching period represents both an integrated planning process and its monitoring system while the traditional approach separates End-Of-Life (EOL) process from New-Product-Launch (NPL) process.

2. Literature Review

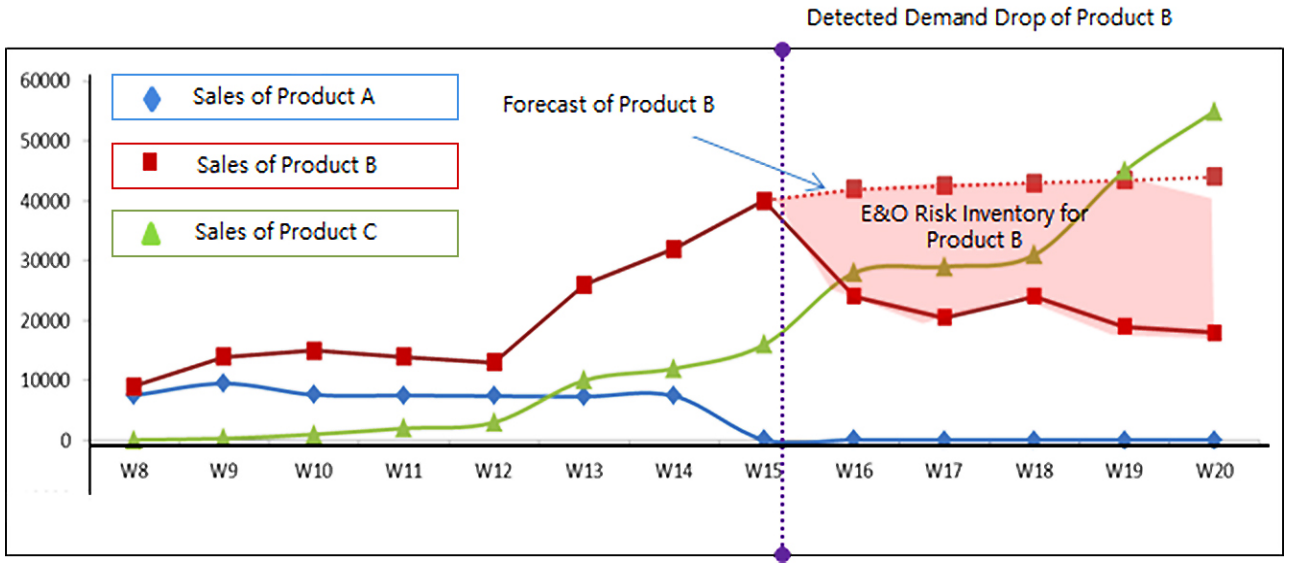
There are numerous research articles on single-product inventory planning problems. Among many interesting topics Goyal and Giri [4] surveyed the topic of the last time buy (LTB) which is related to decision making on when to discontinue their sales of the old fashioned product. An inventory planning problem for inter-generational product transitions when there is no replenishment opportunity during the transition period was investigated to show that the optimal substitution decision is a time-varying threshold policy [7]. Song and Zipkin [14] modeled the demand process as a Markov Chain with alternating between high and low demand states to examine an inventory control problem for a deteriorating demand situation. Unlike others, this paper tackled the outstanding inventory planning problems over new product launching period in a more holistic manner by addressing first the definition of efficient business rules to effectively control and reduce the inventory risks followed by the rigorous explanations on the implementation guide on suggested inventory planning rules.

There exist two categories of research on inventory planning problems for multi-generation products. The first group uses the well known classical problem setting, the newsvendor model to derive the optimal inventory policy for each generation of products [1, 5, 10]. The second group of research focuses on combining the newsvendor problem with the customers' choice model to derive optimal order quantities [6, 9, 13]. Billington et al. [2] provide a comprehensive framework for product "rollover" strategies. They discuss both primary strategies for decision-making before the rollover process starts and contingency strategies that help a company Sdapt to additional market and product information as it becomes available. In the rule based inventory planning problem, we suggest easy to adopt business strategies to systematically reduce the excess and obsolete inventory holding risks for the period of new product launching.

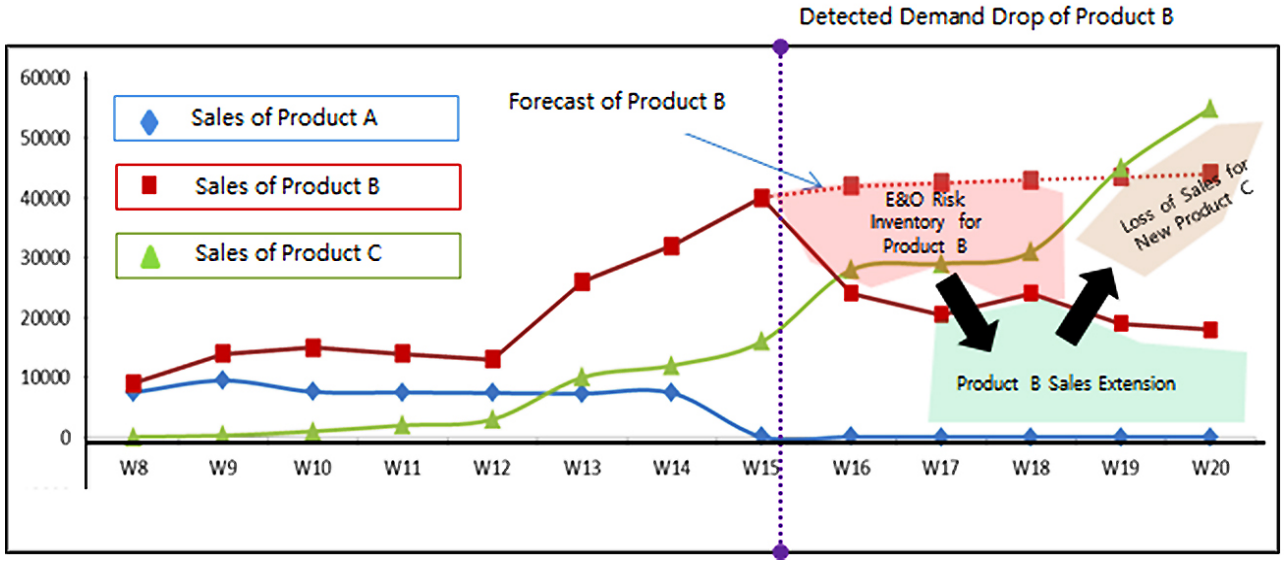
3. Two Issues in Inventory Planning upon New Product Launching

3.1 Excessive & Obsolete Products' Inventories for Old version of Product

There exist great uncertainties in the demand forecast during the products overlapping period. It is hard, upon introduction of the new product, to predict whether the demand for the old product will make a transition to the new product or the demand for the new product won't affect that of the old product. This inaccuracy of the demand forecast will get worse with B2B products as B2B supplier is positioned one step farther from the demand source than B2C supplier in the market [12]. The lead time for customized parts such as customer-programmed semi-conductors is around 12 weeks. Accurately predicting the demand of newly launched product 12 weeks in advance is nearly impossible for the supplier. Even without close collaborative relationship with customers, the accuracy of the demand forecast deteriorates greatly [15]. In <Figure 1>, the company predicted optimistically to have decent demand for the old product B during February and March preparing the launching of new product C (note that product A belongs to same product group with product B, C but it does not affect the sales of product B, C after week 15). However, the real demand for the old product B made a quick transition to the new product C and resulted in great E&O risk for the custom-made parts of the old product B.



<Figure 1> Example of E&O Risk Caused by Demand Drop



<Figure 2> The Vicious Cycle due to Inaccurate Forecast

3.2 Loss of Sales Opportunity for New Product

Without considering the 'Cannibalization Effect' between old and new product demands, the demand forecast has a chance to include doubly counted demands for both the old and new products. Usually, it is not an easy task to compute the exact demand which is directly affected by the new product demand among the total demand for the old product. Both the dynamic nature of market demand uncertainty and the overly preventive action for the product shortage will result in excess procurement for the required resources to produce products. As shown in <Figure 2>, the over-forecast causes extra procurement and increases the risk of E&O inventory. This forces a delay in the end of life for the old product, causing the loss of sales opportunity for the new product. In addition, the discounted sales for getting rid of the E&O Inventory will aggravate the profit margin. Sales of old products cause opportunity cost because the new product, in general, has a lower manufacturing cost than old one and a higher price [12]. Although not many companies could numerically evaluate the Cannibalization Effect, it is manifested that the costs from the opportunity loss reduce the Product Life-Cycle profit.

4. Implementing Rule-based Inventory Planning

By defining an integrated process to combine the new product launching process with the end-of-life process of the old product and by constructing a monitoring system for transition visibility, we can achieve the goal of rule-based inventory planning: minimization of E&O Inventory risk and of sacrificed sales opportunity. Implementation of rule-based inventory planning without both the process and the monitoring system can rarely have the desired effect.

4.1 Defining the Rule-based Inventory Planning Implementation Project

4.1.1 A Planning Module Integrated into SCM Planning System

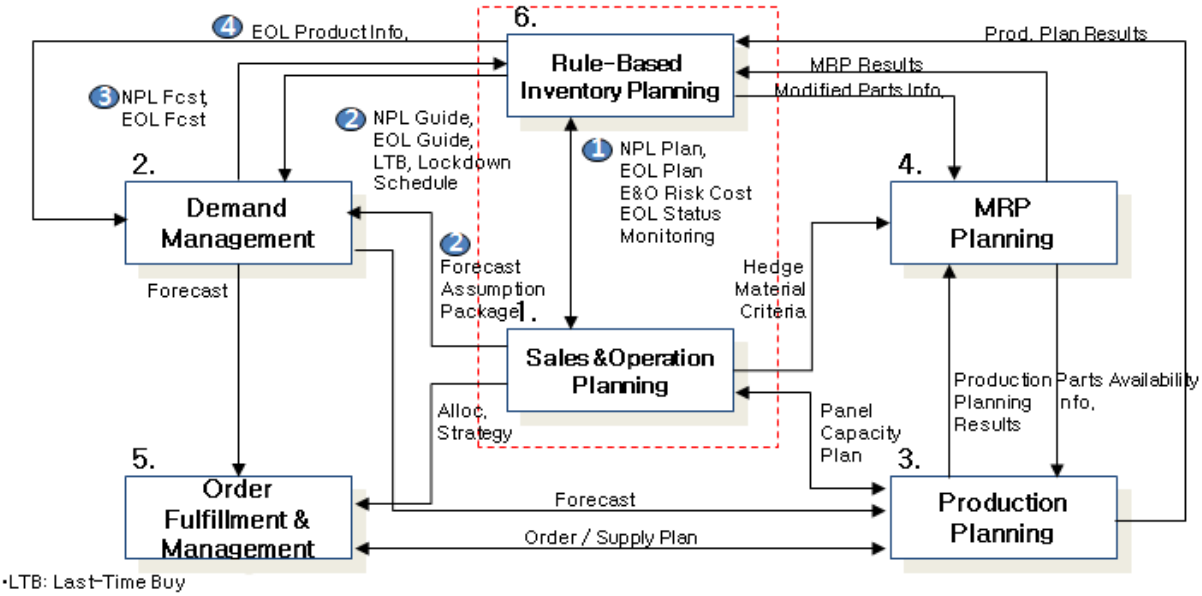
In general, it is possible to implement rule-based inventory planning without SCM system. But the rule-based inventory planning based on SCM system is more effective in the sense that it can predict the potential E&O Inventory costs associated with the future production and procurement plan results. ERP is rather an information system for the execution purpose that takes inputs of various planning data such as sales planning, purchase planning, and production planning to evaluate the future E&O Inventory risk, but ERP is not as good as SCM system. Nonetheless, ERP is absolutely needed to get the current running data for products' and materials' inventories.

4.1.2 A process for Preventing E&O Inventory during Old & New Product Overlapping Period

Many companies implement design review and end-of-life management processes. So what makes it so hard to solve the inventory problem during the production transition? The processes defined in the manual might be unrealistic to observe. But the fundamental cause for this problem is that we consider new product launching process and ending processes independently. In fact, these two processes are related indispensably and it is strongly recommended to develop a consolidated planning and execution for NPL and EOL. Introduction of the new product and ending the old product are major factors that play key roles in system development and SCM activities such as sales, purchase and production. A rule-based inventory planning process helps to plan considering both the new product launching and ending the old product in an integrated fashion.

4.1.3 A System for Monitoring the Old & New Product Inventory Status

<Figure 3> illustrates the rough picture of the data interface between the rule-based inventory planning and the SCM system module. Each box with the number 1 through 5 represents SCM system module such as Sales & Operation Planning, Demand Management, MRP Planning, Order Fulfillment & Order Management and so on. Those arrows between boxes represent the directions of information flows. In particular, the execution information from the legacy system (ERP,



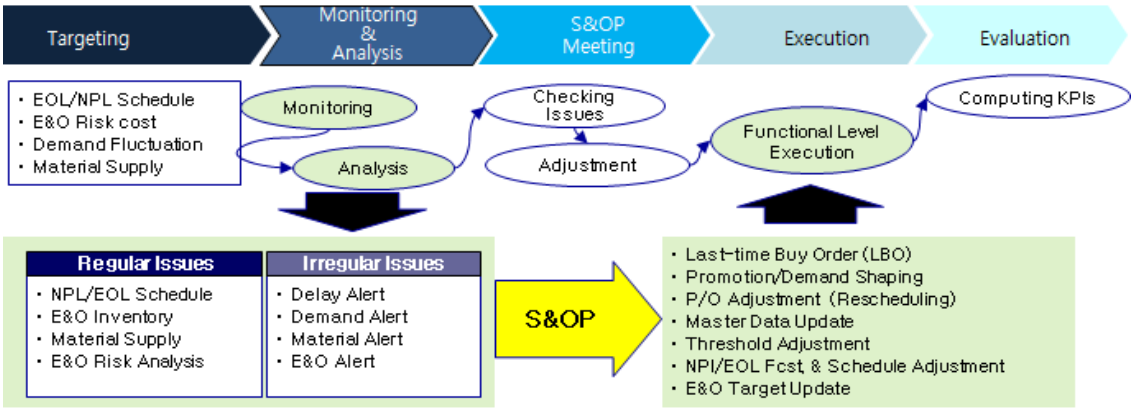
<Figure 3> Relationship between Rule-based Inventory Planning and SCM System Module

PDM) such as the inventory status, the product development schedule and the BOM information can be clearly monitored using the web UI (User Interface). On one hand, the PDM (Product Development Management) is able to collect information on products or groups of products, from the product launching to the ending process. On the other hand, the rule-based inventory planning issue events are user-defined to capture the alerts from the systems above mentioned.

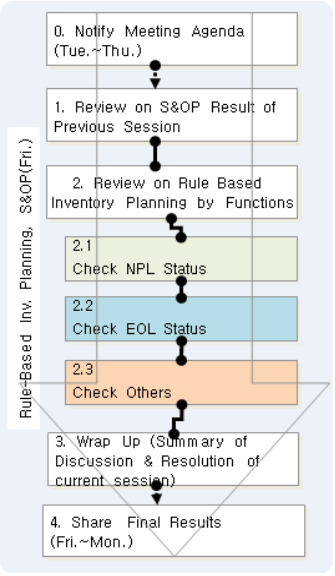
4.2 The Changes in Rule-based Inventory Planning

4.2.1 Collaborative Decision Making Process

The key success factor to the seamless rule-based inventory planning implementation is in the systematic adoption of S&OP. <Figure 4> and <Figure 5> illustrate collaborative activities of various parties in a company to successfully implement the rule-based inventory planning. Such activities include the planning processes for the new product launching and ending process, evaluating the transitions, discussing the lingering issues and actions to be taken by function. A single functional department of a company cannot solve the product transition issues alone as they are cross-functional in nature. S&OP puts into place an effort to connect the scattered information among departments and along the information flows forwardly and backwardly. Usually, the operational cycle of S&OP is the same as that of APS, which is a week typically, but during the last week in each month, a special S&OP is preformed to evaluate the activities for the month and to set out a new plan for the following month.



<Figure 4> Collaborative Decision Making Process



Function	2,1 NPL Check List
1,R&D	Development Schedule Update
	Master Data (Code, BOM)
2,Sales	Register NPL Guide
	Notify Related Divisions and Personnel
	Cust. Approval on NPL Plan
	Register NPL Forecast & Order (OMS)
3,Procurement	New Parts List
	Risk Order Status Monitoring
	Monitoring Part Supply Plan
4,Production Planning	Sharing Pilot Status
	Production Plan (MP) Availability

Function	2,3 Other Check List
1,Sales	Check Sharp Demand Drop (Products, Customers)
	Check Emergent & Short LT Orders
2,Procurement	Check List of Aging Parts
3,Production Planning	Check List of Aging Products

Function	2,2 EOL Check List
1,Sales	Register EOL Guide
	Notify Related Divisions and Personnel
	Cust. Approval on EOL Plan
	EOL Forecast (DM), Last-Time Buy Order (OMS)
2,Procurement	Analyze E&O Risks on Parts Level
	Return Parts & Cancel P/O's
	Additional Material Purchase for A/S
	Monitoring Material Purchase Status
3,Quality	Service Parts Planning
4,Production Planning	Analyze E&O rRisks on Products
	EOL Production Planning
	Termination Plan on Occured E&O (Re-work, Scrap Etc.)

<Figure 5> Roles & Responsibilities of Parties of Rule-based Inventory Planning & S&OP Process

Weekly S&OP is the council for sales/production/procurement planning based on the execution output of APS system and checking for NPL/EOL is the major activity of weekly S&OP. Companies not operating S&OP council still can implement rule-based inventory planning S&OP as a product transition management effort. In contrast to the weekly S&OP consisting of operation-level persons in charge, high ranking personnel attend the monthly S&OP to check mid-/long term product transition plan, to evaluate the performance of the monthly rule-based inventory planning activities, and to make final decisions. In this way, weekly and monthly S&OP are mutually supplementary and different in terms of the depth and width of concerning issues.

4.2.2 Advance Planning of NPL and EOL

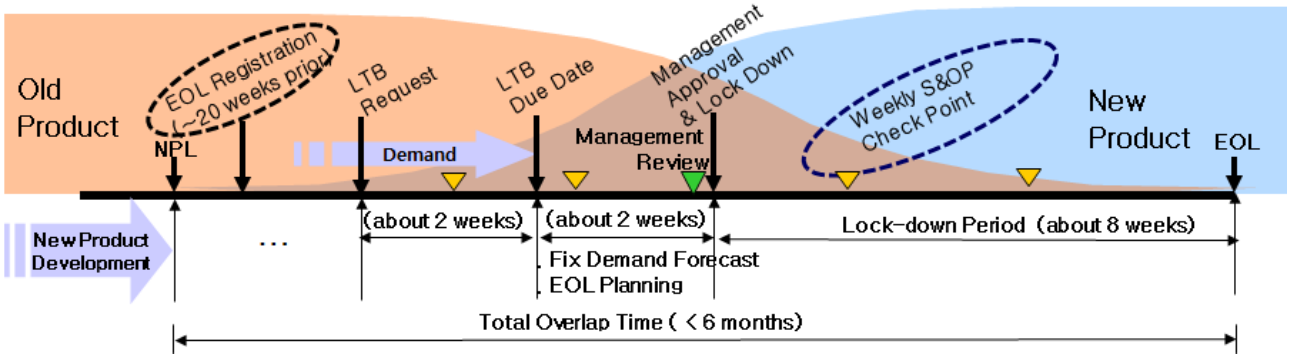
One attribute of rule-based inventory planning that differentiates it from both new product launching and old product ending process is 'prior planning' or 'integrated planning.' The life-cycle of a product as determined by exogenous factors such as sales decreases and customer requests may cause a longer overlap period between old product and new product due to the overly extended sales of the old products. This elongated sales overlap period makes the product management extremely complicated, resulting in smaller procurement, a delay in the new product launching point due to the dispersed development resources, and the lack of concentration in sales with the increased product kinds. When it comes to the sales overlap period, shorter is always better. However, in reality, there always is a limit to how much a company can shorten the overlap due to the internal supply chain inflexibility and safety buffer for unsolicited demands. Whatever the reason is, well-managed 'speedy transition' is a key to competitiveness enhancement in Total Cost of Ownership as it indispensably comes with lower inventory and supply chain agility.

4.2.3 Roles and Responsibilities

The seamless and efficient operation of S&OP strongly requires well-defined roles and responsibilities for the corresponding parties. The rule-based inventory planning coordinator who leads the rule-based inventory planning S&OP meeting (separately from or under extensive S&OP) and is responsible for the successful rule-based inventory planning operation has great impact on the rule-based inventory planning performance. The roles and responsibilities must be defined for the all participating departments in detail so that each functional department can clearly understand the tasks they should take at each transition planning stage and take the full or shared responsibilities over the E&O inventory caused by their unsatisfied performance. Though roles and responsibilities are specifically defined for each function, most of the planning and executing actions come out through cross-function discussions.

New product launch is often delayed by unexpected events during the product development phase. However, a launch delay after the new product materials were procured can cause not only the lost of sales but also excessive inventory. rule-based inventory planning itself can not fix the NPL delay directly. Nonetheless, it helps synchronize the time for required resources between the product launching plan and the actual implementation of the new product launch. The sharing of the product transition issues, such as delay in development and procurement, modification of BOM and fluctuating demand is realized with the rule-based inventory planning process. Through the cross-function rule-based inventory planning S&OP, development delay is continuously monitored and shared with supply chain functions such as sales, procurement, and production. As a result, it helps reduce development delays caused by lack of check and balance. In other words, it reduces the lead time for related departments to know about the 'delay information' so that relevant departments can adjust their plans accordingly.

When the demand for the old product rapidly goes down during the old and new product overlapping period, these products and their materials are at E&O risk. In high-tech industries, companies rush to bring out new higher performing products sooner; therefore, there is little room to adjust the launch time. They are in a hurry not to be behind in the race. Because of this, EOL management is getting more important. When a new product has a characteristic that makes it a substitute for an old one, the latter will eventually disappear in the market after the introduction of the new product. The important issue is to decide whether to drive down the demand for the old on purpose or just leave it to the market for natural extinction. For example, in the case of company S as shown in <Figure 6>, the optimal overlap period was agreed as six month among sales, procurement, production management departments. Thus, the six months after the introduction of new product is considered as an overlap time. This information is shared company-wide and with the customers as well.



<Figure 6> Rule-Based Inventory Planning of NPL and EOL

Based on the new product launch date, the EOL Guide is automatically set in the 'PLC menu' of rule-based inventory planning UI built into the SCM system in this case of company S (manual setting is also possible and useful in some cases). Once the EOL Guide schedule is registered in the PLC menu, the Lock Down period-the minimum required time to freeze the demand and supply activities-is set to EOL-8 weeks automatically and the LTB (Last-Time Buy) Due is set at EOL-10 weeks. By LTB Due, all the final demand for the old must be gathered to calculate the final supply plan for EOL. Without 'Lock Down', the procurement department will continue to generate purchase orders based on the demand information, and materials purchased during this period may become E&O Inventory upon any demand variations in the same period.

Some may argue that rule-based inventory planning Parameters, Lock Down as an example, are so strict that they can hardly reflect the sales dynamics of the real business world. This criticism is valid to some extent. In fact, the uncertain nature of real-world situations causes many unexpected and difficult results. As an example, it's possible to receive some demand from a customer after the LTB Due and it is difficult to turn down the important purchase orders. Another example is when the E&O Inventory estimate indicates a warning on high inventory after EOL. Under these situations, a new EOL date can first be discussed and agreed at the operational level in the S&OP meeting, then submitted to the management in charge for approval in prior to a release of new EOL date. The final decision on the postponement of EOL should not come from a single department or from the operational level agreement because of its potential effect on the company-wide business operation. The direct impact of EOL schedule changes on the business performance requires discussions through S&OP meetings [11].

4.2.4 Monitoring Old & New Products Inventory Planning Status

The Old & New product inventory status visibility can be obtained through both the system and the S&OP meeting. Through the meeting, personnel from various functional departments gather and through the rule-based inventory planning monitoring system, they are able to discuss the outstanding issues based on the information captured in the system in real time. In this way, all S&OP attendees can share the same data for discussion and this brings great efficiency to the S&OP meeting (In this case, company 'S' designed the rule-based inventory planning UI in three categories: Monitoring, Analysis and Master Data. The company saved time and effort in detecting various product transition problems with the predefined 'Transition Alerts' on demand variation, E&O Inventory risk, NPL delay).

5. Benefits of Rule-based Inventory Planning

The biggest benefit of rule-based inventory planning is the minimization of E&O Inventory cost realized with advanced planning and rule-based execution regarding NPL and EOL. NPL and EOL are not independent events but the inter-dependent; therefore, they should be put on the same product transition horizon for integrated planning. Our Rule-based inventory planning will provide an effective management tool to maintain the lowest optimal inventories in product transition.

5.1 Optimized New Product Launch

In general, we use the 'optimal' launching time to mean 'fast' one. For the companies manufacturing high-tech products, faster NPL is critical than other industries to stay

competitive. Postponement of NPL could also be considered to maximize the product life-cycle profits. However, in this paper we focus on the 'delay' of the NPL which is the most common phenomenon in the market.

Regarding rule-based inventory planning, some companies might ask questions like "Why the product launch is always delayed?" or "Can we prevent this in the context of supply chain management?" These are very legitimate questions as they seek an answer from the correlation between product development and demand-supply oriented supply chain processes. Sometimes, SCM detects changes brought on by development problems but they easily give up bringing up the issue believing that product development is beyond the control of the supply chain departments.

In the case of company S, the workers were reluctant to provide the product development information to other departments in excuse of security even though it is for optimizing supply chain operation. This lack of participation by the product development function may not be justified in light of the fact that inaccurate development schedule and BOM data are the main causes for the shrunk margin due to the new product launch delay and elongated sales of old products.

The conspicuous effect of rule-based inventory planning is found in two areas : The real time visibility on product development issues (e.g., development delay, BOM modification) and the R&D and SCM collaboration through the S&OP meeting for sharing and discussing the product transition issues. Under the new role defined in rule-based inventory planning, the product development department participates in the S&OP meeting. In the meeting, the development issues related to schedule and BOM are shared with SCM departments. Also, the information is regularly (e.g., weekly) updated in the rule-based inventory planning UI for official release. With the more accurate development schedule and BOM data, SCM departments can set out a more accurate and timely plan for procurement, pilot manufacturing, and marketing, which helps reduce the demand-supply unbalance inefficiency

5.2 Minimized E&O Inventory

The primary goal of rule-based inventory planning is to minimize the E&O inventory costs in product transition. The E&O inventory risk for a typical manufacturing company can easily exceed millions of dollars, and increases accordingly to the sales volume. The E&O Inventory aggravates the cash flow of the enterprise, reduces the profit of the outgoing products sold at discount prices, and delays the new product introduction. In this process, E&O Inventory inevitably creates the vicious cycle of then-margined slow business performance. Many companies are aware of the negative impact of the E&O inventory and try to prevent it from happening with supply chain planning and execution.

There is a phenomenon commonly seen in high-tech products manufacturers: the rapid drop of the prices of final products and raw materials. At the early stage of the new product introduction, the price is usually high but it goes down rapidly as other companies jump into the market with similar products causing severe competitions. In this environment where opportunities and risks coexist, keeping higher inventory level will eventually result in higher cost structure compared to lean competitors. It is not rare to observe a price drop of 20 to 30 percent per year for some electronics components.

It requires a considerable amount of time and effort to reduce as low as 7 day inventory throughout the logistics channels within the organization. On the contrary, adding extra 7 days of inventory neither surprises us nor takes a long time. Companies having no rule-based inventory planning process or lacking the close collaboration between the functions in their organization are easily exposed to the risk of having E&O Inventory. The demand forecast of sales often turns out to be exaggerated and it also causes extra purchase of raw materials by the procurement person who is under great pressure to never cause the production line to stop. The longer the purchase lead time is, the higher the probability of keeping buffer. Also, a volume discount makes the problem worse. Any company lacking accuracy and visibility on outgoing products and the associate materials is at the risk of having E&O inventory, which makes the firm heavier and slower, the opposite direction of competitiveness enhancement: lean and agile.

6. Conclusion

Company 'S' in the experiment reduced the inventory cost for the outgoing products as low as 49% of its peak level of its preceding product version in just 5 month after the adoption of rule-based inventory planning process and system. Like Company 'S' example, the effect of rule-based inventory planning can be quantified in most of cases.

Frequent meetings after detecting the increased E&O inventory can also reduce the E&O Inventory but these post-incident efforts do not last long because of no changes in business processes and supporting IT systems etc. It is also like to compare the temporary effect of sales boost through a promotion with the improved profit margins through reduced production costs and fundamental improvement in SCM practices. Rule-based inventory planning is not a whimsy campaign on inventory reduction, but a dimension of a continuous improvement on SCM. In the example, the company consolidated NPL and EOL schedule, built a system that realizes transition visibility and early warning, and finally defined a new roles and responsibilities. It might be true that astonishing inventory reduction is not of sole contribution of rule-based inventory planning but the involved people all agree that it would not have been possible without the adoption of rule-based inventory planning.

Before introduction of rule-based inventory planning, the work process of product transition such as new product development, end-of-life and engineering change management was separately described in documents and considered separate event as well. For example, an EOL qualification condition includes 'no product demand for at least 4 consecutive months', 'only upon customer request'. These are passive way of EOL execution and there is little for the company to manage. Under these EOL conditions, it is very unlikely to expect sales function would initiate a voluntary EOL in the face of lost sale and customer complaint. That is how sales personnel are motivated. Well aware of this inefficient EOL initiation practice, rule-based inventory planning consolidates NPL and EOL, therefore, it enlightens people to starts viewing NPL and EOL processes at the same time in one single product transition horizon and let them realize that executing NPL and EOL of the same product group is like a see-saw game; lift of one end means down of the other. This consolidate product transition planning process is the first approach to solve many entangled issues of Product with a holistic and dynamic viewpoint.

There are many documents inside of a firm that define the processes of product development and end-of-life and regulate the concerned activities. However, this kind of paper provisions do seldom govern the processes they should follow at work because there are too many contents and too inflexible to apply to fast-changing and complex real business matters. Therefore they might become a mere book of outdated, if not obsolete, guidelines people do not really care about unless a transitional problem occurred and they try to find some clauses with which they blame others. rule-based inventory planning, in the case of company 'S', is built into its SCM system UI to provide precise product transition information such as development schedule, demand fluctuation, material procurement status, estimated E&O Inventory, therefore, people can look up the transition information in the web-based SCM system. Most of Product Transition Issues can not be identified and solved by a single department. Usually the departments that cause product transition events differ from the recipient one (e.g., When incorrect information about the development completion date results in misleading demand forecast and extra or shortage of the raw materials for production. The modification in sales forecast for the product in EOL causes off the target from the E&O inventor). Although the product transition issues must be discussed cross-functionally such as in sales and operation meeting, a department with ownership and the person in charge of coordinating product transition discussions must be specifically selected. Continuous Monitoring of product transition followed by regular problem discussion for drawing fast counter action is in the core of successful rule-based inventory planning [8].

In conclusion, we should note that the best performance of rule-based inventory planning is not guaranteed from one-time campaign of process improvement along with system development. For the best performance, rule-based inventory planning requires decision maker's continuing support and attention even without seeing any upcoming business crisis. It is necessary to make a habit the collaborative decision making process in form of S&OP. Revenue, profit, and market position are optimized only when the right products can be sold at the right time at the right price. The prevention of E&O inventory and the maximized product life-cycle profit from agile product transition will be a payoff for the efforts.

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ORCID

Hyoungtae Kim | http://orcid.org/0000-0001-9506-9446