Research

EXECUTIVE SUMMARIES : EDITED BY CANDACE YANO AND JOSEPH HARTMAN

Julie Swann and Serhan Duran prove that sometimes inventory should be held back for future high-priority customers rather than being sold to lower priority customers.

This month we highlight two articles that appear in September's scheduling and logistics edition of IIE Transactions *(Vol. 39, No. 9). Both are concerned with better allocation of available inventory when a firm has customers in different priority categories. The first paper focuses on situations in which customers who pay a price premium when purchasing a product receive higher priority. The second paper focuses on the management of spare parts inventories at a provider of after-sales service when customers have service agreements that differ in their promised response times.*

Profitability through inventory

Flexibility is important to manufacturing companies. Flexibility on the supply side may be gained from traditional techniques such as cross-training workers or having multi-purpose machines. Flexibility can also be increased by better management of the demand side of the business. In particular, if companies could route available inventory or allocate production capacity to customers who need it most and are willing to pay the most for rapid delivery while delaying delivery to customers who are willing to wait in return for lower prices, they could operate their businesses with much less inventory.

According to the U.S. Census Bureau, current inventories at manufacturers totaled $513.5 billion in April 2007. If an improvement of even 1 percent could be achieved, the impact would be staggering. The authors were motivated by the automobile industry, in particular, which currently has tens of billions of dollars worth of inventory in the United States even while many customers are waiting for their orders to be filled.

In "Optimal Production and Inventory Policies of Priority and Price-Differentiated Customers," Serhan Duran and Julie Swann of the Georgia Institute of Technology, Tieming Liu of Oklahoma State University, and David Simchi-Levi of Massachusetts Institute of Technology study such a demand management problem. They examine a system in which a firm can give one group of customers priority for production and inventory resources at a price premium. They devise an approximate method for determining the best production decisions and inventory allocations considering the current set of waiting customers and statistical assumptions about the arrivals of future customers.

Alper Sen knows that spare parts can be leveraged to serve critical customers first.

A key feature of this method is that it sometimes indicates that inventory should be held back for future high-priority customers even when there are low-priority customers waiting. The authors call this "tactical inventory."

Numerical experiments show that tactical inventory can result in significant profit improvements even when the average price paid by customers is less than when such a tactical inventory strategy is not employed. The authors also find that tactical inventory is most helpful when the manufacturer's capacity utilization is high.

For automakers, the tactical strategy might translate into reserving production capacity for high-priority dealer orders rather than immediately filling production slots with lower-priority orders from dealers who ordered in advance for a discount. The strategy could also apply to producing high-priority custom-ordered vehicles before lower priority orders for vehicles that dealers will put on their lots. If the automakers' factories are agile enough to accommodate this arrangement, much of the mismatch between what customers want to buy and what dealers have available to sell could be eliminated.

The method is more likely to help manufacturers of models for which capacity may be tight, such as for popular vehicles. The tactical inventory could also be used to improve decisions for other products such as laptop computers, as companies in this industry also sell to multiple customer segments that pay different prices.

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Spare parts inventories

After-market service plays an important role in the competitiveness of a company. According to recent surveys, some businesses earn up to 45 percent of their gross profits from spare parts and related services. Service divisions often have to deal with spare parts requests that differ in their criticality due to differences in service level agreements and the nature of the need. For example, a platinum service customer who needs a replacement part for a broken machine would have a higher priority than a silver service customer who is looking for the same part merely for maintenance. In addition, not every request needs to be satisfied immediately. Some orders, such as the maintenance order in the previous example, may only need to be satisfied within a promised delivery interval.

In "Spare Parts Inventory Management with Demand Lead Times and Rationing," doctoral student Y. Levent Kocaga of the University of Southern California and professor Alper Sen of Bilkent University in Turkey study the problem of managing a common stockpile of spare parts to serve customers with different criticality and promised delivery intervals. They propose a prioritization rule in which all customers are served when the inventory is above a threshold level but only critical customers are served when it is below that level.

They also develop a method to calculate the minimum inventory to keep in the system and the corresponding threshold level. Their study shows that saving inventory for critical customers and considering promised delivery intervals in making these decisions may yield significant reductions in the total inventory that needs to be carried.

In a case study with a large capital equipment manufacturer that was the motivating force behind their study, the authors' method was able to reduce inventory by up to 14 percent while satisfying service contract requirements. The authors have found that the greatest benefits occur when most of the demand is from non-critical customers, the service level requirements differ significantly between critical and non-critical customers, and critical customers must be served quickly.

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The most recent issue of The Engineering Economist *(Vol. 52, No. 3) focuses on a variety of topics, including investing in RFID systems, habitat conservation, new product development, estimating oil prices, and product planning. Below are highlights of two articles from that issue. The first examines whether managers are using real options methodology to make investment decisions, and the second looks at the use of real options for analyzing product development decisions.*

Are real options an option?

It has been shown that classical discounted cash flow analysis techniques fail to capture all available options for an investment and therefore tend to undervalue many investments. For example, their flexibility is often associated with many investments — such as the ability to aban-

don or shutter a facility before its intended useful life — which may increase the value of the investment because the flexibility reduces risk. In order to capture this value, advanced analysis techniques such as real options analysis are required.

While it has been predicted that real options analysis would become status quo with respect to making capital investment decisions, results of a survey of 279 Fortune 1,000 companies in "Are 'Real Options' Actually Used in the Real World?" show that only 14.3 percent use real options analysis to make capital budgeting decisions.

According to those respondents using real options, common applications include new product development, research and development, and mergers and acquisitions in sectors including technology, energy, and utilities. It should be clear that these applications carry much greater uncertainty and flexibility than other common investments such as capacity expansion. Interestingly, the top reason that real options are not used at more companies is apparently a lack of acceptance from upper management.

Despite the current lack of acceptance for real options analysis, the 14.3 percent usage rate by the surveyed companies is higher than previously published data. On a more positive note, 43.5 percent of the non-users from the survey said there is a good chance they will consider the use of real options in the future; 15.9 percent indicate a positive but less committed response; and only 26.3 percent totally reject the use of real options in the future. Until then, the option is still open.

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Product planning

Companies rely on the introduction of new products and variations of current products to maintain and grow market share. These decisions are complex as they must account for numerous uncertainties about the future. While many people view uncertainties in a product planning project as problematic, it can also be viewed as a source of new opportunities when captured with real options analysis.

In "Evaluating Product Plans using Real Options," product planning decisions, including platform and product variation decisions, are analyzed. The platform decision involves the strategic selection of a concept product platform from various possible alternative concept

platforms. The product variant decision involves deciding how long a company should continue to offer its current product variant in the marketplace and whether the existing product variant should be discontinued, scaled down, or scaled up with additional product features.

To address the two aforementioned decisions, a real options-based method that considers technical, project implementation, and market uncertainties is developed. The current work can be extended by including the consideration of concurrent selection of multiple product platforms at a given point in time, while including the effect of cannibalization of competing product variants from both within a company and its competitors.

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