Research and Management Insights

Inventory Planning for a Modular Product Family
Anand Paul, Yinliang Tan, Asoo Vakharia

Anand Paul, Yinliang Tan, and Asoo Vakharia model the problem of maximizing expected profit for a modular product family subject to an aggregate fill rate constraint as well as variant-specific individual fill rate constraints under a make-to-stock setting. They extend their benchmark model to study the impact of correlated market preferences over options, price-dependent demand, and alternative probability distributions for characterizing uncertainty in market preferences or aggregate demand. Through extensive computational analysis, they demonstrate that precise estimates of market preferences for various modular options constitute extremely valuable information that transcends the usefulness of forecasts of aggregate market demand. From a practical perspective, this hints at a marketing-operations trade-off. Offering more options for consumers would be preferred by marketing managers since this would reach more consumers and potentially enhance product sales. On the other hand, it is hard to get reliable forecasts when the number of options increases. Hence, from an operational perspective, it is preferable to limit option choices since this would lead to lower stocking costs and hence, higher profits.

E-Procurement Infusion and Operational Process Impacts in MRO Procurement: Complementary or Substitutive Effects?
Seunghee Yu, Abhay Nath Mishra, Anandasivam Gopal, Sandra Slaughter, and Tridas Mukhopadhyay

Understanding how e-procurement technologies can impact the procurement process performance of organizations is critical for making investment and technology use decisions. It is particularly important in the context of the procurement of maintenance, repair and operating (MRO) goods by organizations in the service industry. The authors study how the use of e-procurement technology infusion can be conceptualized along two dimensions – intensity and acceptance – and further investigate the impact each has on procurement process performance. More importantly, the authors show that there is a significant substitutive effect between the two use dimensions on performance. In other words, as the level of intensity (acceptance) increases, the marginal impact of acceptance (intensity) on procurement process performance decreases. Thus, while each dimension of use is individually beneficial, together they exhibit a lack of synergy. The authors do find that the relationship is complementary for high performance firms. The negative interaction between the intensity and acceptance in low-performing firms suggests that procurement managers in these firms should not attempt to exploit resources at their disposal toward both depth and breadth dimensions of e-procurement infusion simultaneously. It may be more advantageous for these organizations to improve one usage dimension before turning attention to the other.

Implications of Channel Structure and Operational Mode Upon a Manufacturer's Durability Choice
Sreekumar R. Bhaskaran, Stephen M. Gilbert

Durability is an important dimension of quality in many industries including automobiles, consumer electronics, and home appliances. Firms routinely tout their reliability and durability as a testament to the quality and workmanship of their products, and consumers are often willing to pay more for a product that they believe will last longer. However, durability has implications for the interactions among an original equipment manufacturer, a retailer (s) and consumers that are quite different from those of other dimensions of quality.

Sreekumar Bhaskaran and Steve Gilbert examine how an original equipment manufacturer's decisions about channel structure (direct interaction with consumers vs. through an intermediaries and mode of operations (leasing vs. selling) affect its incentive to increase the durability of its products. As is known from existing literature, they confirm that an isolated change from direct consumer interaction to the use of intermediaries or from leasing to selling can decrease a firm's willingness to improve durability of a product. As with other forms of quality, durability involves a trade-off between cost and value of additional utility, and the double marginalization that is introduced by using an intermediary tends to reduce

a manufacturer's incentive to invest in durability. Similarly, because consumers' anticipation of lower future sales prices (time inconsistency) dampens their willingness to pay for a more durable product, a manufacturer is less willing to invest in durability if it sells its product than if it leases.

However, Bhaskaran and Gilbert find that, by simultaneously introducing an intermediary to the distribution channel and selling instead of leasing, the optimal durability of the firm can increase. This is because double marginalization and time inconsistency counter balance one another in a decentralized channel; the incentive of intermediaries to add their own margins (mark-ups) dampens consumers' anticipation of the rate at which prices will decline and the competition from existing durable products discourages intermediaries from claiming large mark-ups.

The density of the dealer networks also plays an important role in the manufacturer's durability choice. In fact, because of the interplay between double marginalization and time-inconsistency, higher density of dealer networks is not necessarily associated with higher durability. Analysis of durability ratings of automobiles confirms some these interesting interactions between channel structure and operational mode.

Flexibility Structure and Capacity Design with Human Resource Considerations

O. Zeynep Akşin, Nesrin Çakan, Fikri Karaesmen, E. Lerzan Örmeci

Service systems typically respond to multiple types of service requests, relying on servers having different capabilities. Managing capacity in these systems requires determining the capabilities or skill sets of the servers along with the number of servers in each skill group. The authors focus on the design of the skill sets as a flexibility design problem, and explore different flexibility designs found in call centers and/or recommended by the literature. Their analysis confirms earlier findings that a little flexibility is all a system needs. It further reveals that for a given flexibility design, once capacities in terms of the number of agents in each skill set pool are optimized, the profit difference between the structures diminishes substantially. This shows that while flexibility design may have different implications on the human resource side in terms of career paths or training progression, optimized capacity overcomes their differences in terms of flexibility benefits. Another important finding is that flexibility designs that rely on specialist (one skill) pools along with some flexibility in multi-skill pools are the best performers, and

this superiority is robust under different demand variability and cost structures.

Staffing Call Centers with Uncertain Arrival Rates and Co-sourcing

Yaşar Levent Koçağa, Mor Armony, Amy R. Ward

For many companies, the call center is a primary point of contact with customers. Therefore, it is natural for companies to desire control over their call center operations. However, this can be costly, which motivates considering cheaper outsourcing alternatives. Unfortunately, there is often degradation in quality when calls are outsourced. One potential solution is to outsource only part of the call volume, a practice known as co-sourcing. In this setting, the client company retains control of its call center operations and routes calls to an outsourcing vendor as needed. In order to implement a co-sourcing strategy, the client company needs to decide an upfront staffing level before the call volume is known, and to then make real-time decisions regarding which calls to route to the outsourcing vendor. Yaşar Levent Koçağa, Mor Armony and Amy R. Ward show that a simple square-root safety staffing rule combined with a threshold outsourcing rule (that outsources calls when congestion is high) is a robust rule that performs universally very well; that is, the performance is nearly optimal under a wide range of system size and costs. The analysis may be used to examine the implications of various values of per call outsourcing costs and thus can help call centers negotiate outsourcing contracts.

Fractional Price Matching Policies Arising from the Ocean Freight Service Industry

Chung-Yee Lee, Christopher S. Tang, Rui Yin and Jae An

When facing uncertain shipping needs and uncertain spot market shipping price, customers are reluctant to pre-commit their shipping needs with a carrier even though the regular freight price is known in advance. To entice customers to pre-commit, the authors examine whether the carrier should offer a "fractional price matching" contract that can be described as follows. The shipper pays the regular freight price in advance; however, the shipper will get a refund if the realized spot price is below the regular price, where the refund is a "fraction" of the difference between the regular price and the realized spot price. By modeling the dynamics between the carrier and the shippers as a sequential game, the authors show that the carrier can use the fractional price matching contract to induce a higher demand from customers in equilibrium. More importantly, by selecting the fractional price matching contract optimally, they show that the carrier can

afford to offer this price matching mechanism without incurring revenue loss: the optimal fractional price matching contract is "revenue neutral."

Up then Down: Bid-Price Trends in Revenue Management
Zhan Pang, Oded Berman and Ming Hu

Bid price is a key concept which drives pricing and capacity allocation decisions in Revenue Management. This paper aims to enhance the understanding of the intertemporal behavior of bid prices in dynamic revenue management environments. It provides a probabilistic characterization of the optimal policies from the perspective of bid-price processes. Pang, Berman and Hu show that an optimal bid-price process has an upward trend over time before the inventory level falls to one and then has a downward trend. This up-then-down pattern of bid-price processes is related to the resource scarcity effect and the resource perishability effect. The demonstrated upward trend implies that the optimal bid-price process is mainly driven by the resource scarcity effect while the downward trend implies that the bid-price process is mainly driven by the resource perishability effect. They also demonstrate how optimal bid price and consumer valuation, as two competing forces, interact over time to drive the optimal-price process. Their findings shed new light into the revenue management and provide theoretical justifications for some empirical observations in the literature.

Maximizing Revenue Through Two-Dimensional Shelf-Space Allocation
H. Neil Geismar, Milind Dawande, B.P.S. Murthi, Chelliah Sriskandarajah

The authors propose a new method of displaying products on retailers' shelves. In this scheme, a product's display may be two-dimensional, i.e., it may extend across shelves at different heights in a shopper's visual field. The units of each product must be displayed in a contiguous rectangle, i.e., its display on one shelf is directly above its display on another shelf, and these displays have the same length. Obvious applications include products whose varieties all have the same shape and size, e.g., canned goods, spices, potato chips, DVD's. Computational studies show how these displays generate more revenue than current practice. The authors also demonstrate how the results can be applied to webpages, mobile devices, and feature advertising. Other extensions include product interactions (how displaying two products near one another can improve their sales) and displays for products with different dimensions.

Balancing Production and Distribution in Paper Manufacturing
H. Neil Geismar, Nagesh Murthy

Paper manufacturing, like many process industries, traditionally focuses on minimizing production costs. The resulting production schedule imposes costs on the distribution function, which delivers to customers with dedicated railcars. Geismar and Murthy determine how distribution can minimize its costs, given production's schedule. The resulting reduction averages 25.8%. They also demonstrate how the operational coordination of production and distribution via scheduling can further reduce costs significantly. The method for minimizing overall costs requires little additional computational time and can be easily understood and implemented. The authors also provide suggestions for aligning incentives for the production and distribution functions to coordinate in a fashion that maximizes and equitably shares overall profits. Their work also provides foundational insights for optimizing distribution via trucking or multi-modal transportation.

Concerning Workload Control and Order Release: The Pre-Shop Pool Sequencing Decision
Matthias Thürer, Martin J. Land, Mark Stevenson, Lawrence D. Fredendall, Moacir Godinho Filho

This study improves management's ability to regulate the flow of orders to the shop floor, enhancing understanding on how order release methods should be designed. Order release initially withholds jobs from the shop floor and places them into a pre-shop pool from where they are released to meet certain performance targets. The release decision has two major parts. First, a sequencing decision establishes the order in which jobs are considered for release. Second, a selection decision determines which jobs are released. Using job shop simulation, the study uncovers the potential for performance improvement in the sequencing decision. In prior research, it has been implicitly assumed that the sequencing decision is only responsible for the timely release of jobs while results show it can also contribute to load balancing. However, a sequencing rule focused exclusively on load balancing increases mean tardiness and, paradoxically, requires high workloads. Further analysis reveals the sequencing decision should only focus on load balancing when multiple orders run behind schedule and give priority to the most urgent orders otherwise. This study concentrates on the Workload Control concept, but the findings are expected to help improve the load balancing capabilities of other concepts, such as ConWIP, Kanban and Drum-Buffer-Rope.