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Introduction to the Special Issue on Practice-Focused Research

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When Steve Graves first approached us with the idea of serving as guest editors-in-chief for a special issue on practice-focused research, the appeal of this idea was immediate. We were very excited by this opportunity to highlight and promote the crucial role practice-focused research fulfills in our profession, and in society as a whole. At its core operations management (OM) concerns making life better: reducing waste, doing more with less, delivering services that meet people's needs, and answering fundamental questions about how our society, and the business and service constructs we have created, operate. The papers in this special issue provide excellent examples of all of these characteristics.

As we, and Steve, discuss in the forum piece at the start of the special issue, "Practice-Based Research in Operations Management: What It Is, Why Do It, Related Challenges, and How to Overcome Them" (Gallien et al. 2016), there are different strategies OM researchers can use to guide their research activities. Sometimes an OM researcher attains results through the use of mathematical constructs, which have the benefit of great generality and flexibility due to their abstraction of reality. Unfortunately, research of this type may be *too* abstract, and thus demonstrate limited validity in practice. Other times an OM researcher may directly address an extant problem in industry or society. One potential drawback of this latter research strategy is that such work may be too specific, limited in its application to the idiosyncratic problem context, and possibly other very closely related settings.

What we sought for this special issue were those select few papers that captured the best of both of these streams of research; this coupling of generality born from abstraction and validity born from application became the defining principle we embraced about practice-based research. This principle is common to all of the papers in the special issue: They both utilize analytical sophistication to develop general insights and results, and yet also are able to establish their validity and relevance to practice. This is done through an application that yields verifiable and quantifiable results, or through an examination of a business phenomenon that again yields verifiable and quantifiable insights. We are very pleased to be able to present to you a set of nine papers that exemplify these goals, spanning a variety of industry sectors.

The first three papers address novel manifestations of classical OM concerns, all within the swiftly evolving technology sector. The first of these, "Optimization in Online Content Recommendation Services: Beyond Click-Through Rates" by Besbes et al. (2016), addresses the fundamental question of which products to offer to customers. But when evaluating the products they can choose from—content recommendation (links) at the end of Web pages—they recognize the need to consider not only whether the product will be appealing to the customer, i.e., whether the content will entice the reader to click on it ("clickability") but also whether the product will be likely to entice the reader to consume a subsequent product, i.e., whether it is likely the reader will click *from* it to yet another article ("engageability"). The authors show that by combining these two concepts the algorithm they develop can arrive at superior recommendations. This paper provides an admirable combination of analytical work deriving and then demonstrating the near-optimality of their algorithm, and validation work in a controlled pilot with their industry partner, Outbrain, illustrating when consideration of engageability can be most valuable.

The second paper within this set, "Proactive Customer Education, Customer Retention, and Demand

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for Technology Support: Evidence from a Field Experiment" by Retana et al. (2016), evaluates a new customer support program initiated by a "major public cloud service provider." In this article the focus is on customer retention— a fundamental driver of success across almost all industries. But it is a particular concern within the cloud services sector, where revenues are earned only when customers actually use the service, not when they sign up, and for which barriers to defection to other service providers are extremely low. Thus, it is imperative that companies transform "sign-ups" into "users," and then hold onto their users once they have made this transition. To facilitate these efforts, Retana, Forman and Wu's partner firm initiated a *proactive* education program on a subset of new sign-ups in a controlled field experiment. The research team analyzed the effects of this program, finding that it significantly drove down defections, increased conversion from sign-ups to users, and likewise reduced queries to customer support. And, although the effects of this program on customer behavior decay quite rapidly (within about a week), the researchers make the point that many defections occur within this very timeframe, which explains the significant effect of the efforts over the long term.

Xue et al. (2016) provide the third paper within this technology domain, "Pricing Personalized Bundles: A New Approach and an Empirical Study." In it they address the ubiquitous problem of pricing—in this case of service bundles for a "major IT service provider." What makes this problem particularly challenging is the fact that within the service industry there are a potentially unlimited number of possible service bundle combinations, making the traditional notion of a "price list" seem somewhat quaint by comparison. At the time of the project's initiation such bundles were priced by a team of pricing experts, who relied on personal experience to provide quotes to customers in a timely fashion. But this process was both inefficient and subject to personal variability in prices. Recognizing this, the company worked with the researchers to provide a pricing algorithm that first decomposes each bundle into components, values them, and then aggregates it back together to determine segments for the bundle and the customer. Using these valuations and segmentations, the algorithm then provides a price. Proof of concept experimentation and a controlled implementation demonstrate that the new algorithm improves revenues and profits compared to the legacy pricing method.

Pricing decision in an emerging business environment is also the central problem in the next paper, "Analytics for an Online Retailer: Demand Forecasting and Price Optimization" by Ferreira et al. (2016). Working with online "flash sale" retailer Rue La La, the research team was asked to determine appropriate prices for designer apparel and accessories which would be sold on Rue La La's Web platform in limited quantities and for a limited time. Unfortunately, due to the idiosyncratic nature of their sale offerings, Rue La La has only limited historical data with which it can forecast demand and set prices. To overcome this shortfall, the team adapts machine-learning techniques and a math programming formulation to solve the complex multiproduct forecasting and pricing problem (with substitution) faced by Rue La La. A field experiment shows that their algorithm can increase sales and profits by pricing some offerings more aggressively and others less so, in effect better anticipating—and matching—prices with demand.

The next paper in the issue, "Improving Store Liquidation" by Craig and Raman (2016), confronts a quite similar problem, but in a very different setting. Once again they face the task of making forecasting and pricing decisions over a finite horizon event, but this time the event is a managed liquidation operation over one or many retail stores. In addition to pricing decisions, the researchers can also influence inventory transfers from one store to another, and the timing of store closings. As the first work to present this problem to the OM literature, the paper does a nice job of introducing the main drivers of the liquidation decisions, and demonstrating the importance of the problem in industry. They describe how, working with Gordon Brothers Group (a firm that manages large liquidation operations), they develop a dynamic programming-based heuristic for the problem, and apply it to field studies demonstrating different aspects of liquidations (i.e., markdowns, inventory decisions, closing decisions). Doing so not only demonstrates the improvements available through the use of their algorithm, but also provides insights into the new (or at least newly introduced) store liquidation problem in OM.

The next paper in the issue, "Stockout-Based Substitution and Inventory Planning in Textbook Retailing" by Lee et al. (2016), confronts another classical OM problem—inventory optimization—within a unique and challenging business environment. In this case it is the Cornell Bookstore, which faces the problem of determining ordering levels for textbooks, taking into account uncertainty in supply (in this case of a substitutable product, returned used textbooks) and demand (due to course enrollment), while also confronting censored demand (due to stockouts) and a short selling season (only until classes start). The authors use experiments with historical data embedded into utility-based choice models to demonstrate that they are able to forecast demand extremely accurately, even in the presence of significant stockouts (and thus censoring). Armed with this experimental

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support, they implement a controlled field experiment in the bookstore, providing demand forecasts as well as inventory recommendations for a selection of titles. They show that their forecasts improve human ordering decisions significantly, and their ordering decisions increase profits further still. This both increases revenues and profits for the bookstore, and utility for students seeking texts.

From inventory we move next to manufacturing, specifically the extremely complex capital-intensive manufacturing involved in the production of lithography equipment used to produce semiconductors. Atan et al. (2016) describe this problem as it faces ASML, in "Setting Planned Leadtimes in Customer-Order-Driven Assembly Systems." Due to the capital intensity of the industry as well as the risk of obsolescence, ASML chooses not to hold component inventories for their lithography machines. Instead they assemble them to order, inserting leadtimes into the assembly plan to enable them to source components as needed. Unfortunately, this raises the prospect of holding partially assembled items or missing promise-dates for assembled products, which are both very costly. So in some sense ASML's planned leadtimes give rise to a basic newsvendor problem—but a potentially very costly one—and an important challenge stems from the interconnected nature of these decisions. Using this observation the researchers derive recursive cost equations, and, using a Newsvendor conjecture, develop a heuristic algorithm to set planned leadtimes that enjoys some theoretical support. Besides numerical testing they report the implementation of a pilot program with ASML as part of a large and highly successful initiative to reduce cycle times.

The final two papers in the special issue treat applications within the growing intersection of OM and the medical field. The first, "Accurate Emergency Department Wait Time Prediction" by Ang et al. (2016), considers a problem faced by anyone who has found themselves in a hospital emergency department: trying to ascertain how long you will have to wait to be seen. As fundamental as this problem is, hospitals still struggle with it. The San Mateo Medical Center (SMMC) contacted the research team to help with this problem, specifically to develop a method to forecast and report expected wait times to their patients. The research team developed a hybrid prediction method, "Q-Lasso," that combines statistical learning and fluid estimators, with the specific aim of forecasting wait time for low-acuity patients (who are typically most numerous and also experience the longest waits, as higher-acuity patients have priority). Numerical test on four very different hospitals establishes the accuracy of the new method. With this validation in hand the researchers moved to implementing their new prediction system (with display) in the SMMC waiting room, garnering appreciation from both patients and staff. This paper is not only a nice success story; it also contains an enlightening portrayal of the "challenges and insights" encountered during a practical implementation.

The final paper in the issue, "Optimization and Simulation of Orthopedic Spine Surgery Cases at Mayo Clinic" by Ozen et al. (2016), also confronts the problem of service within the healthcare domain. But this time it is within the highly scheduled environment of the spinal operating theater at the Mayo Clinic. Due to the variety and complexity of orthopedic spinal surgery, both the mean and variability of the surgery durations are large, making it difficult to produce a surgery schedule that utilizes the resources effectively but does not incur overly large overtime for the surgical team. Moreover, due to the mission of the Mayo Clinic, both patient and surgeon preferences must be taken into account—a schedule cannot simply be enforced. To solve this problem the researchers use data mining and statistical analysis to pair surgeries that can potentially be completed within a single scheduled day. They then generate a schedule of the surgeries, and match surgical teams to the schedule. They implement their algorithm in a controlled experiment on a portion of the operating rooms, in parallel with the legacy scheduling system. Results are very encouraging—the algorithm leads to both an increase in utilization and a decrease in overtime.

Taken together, these papers utilize an impressive variety of analytical techniques—mathematical programming, machine-learning, optimization, simulation, empirical analysis, decomposition, and aggregation—to solve problems spanning the IT, retail, manufacturing, medical, and service industries. Moreover, the list of partner companies to this research includes both established industry leaders and novel business innovators, large companies and small, sellers and service providers: ASML, a major public cloud service provider; Cornell Bookstore; Gordon Brothers Group, a major IT service provider; the Mayo Clinic; Outbrain; Rue La La; and the SMMC.

To put the accomplishments of these papers in perspective, there is one other point mentioned in the leading forum article that bears repeating here: Conducting high-quality, practice-based research is *hard*. In addition to the standard tasks involved with any high-quality research—identifying a good problem, modeling and solving it, and then reporting your results in a clear and compelling manner—practice-focused research entails the additional burdens of interacting with an actual company, working with real data, tailoring any solutions to the idiosyncratic requirements of the partner firm, and, ultimately, validating the results in practice. For example, you may

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have to tailor your solution to accommodate patient or doctor preferences at the Mayo Clinic, dig into data to try to uncover how to model the textbook buying behaviors of Cornell students, or build software to enable IT workers to price product bundles in real time. With such additional difficulties should come commensurate rewards. It is our hope that through publication of this special issue we can draw particular attention to the remarkable accomplishments of these papers—analytical, empirical, and practical—which can help to serve as some partial reward for the researchers' excellent work (in addition to the practical good resulting from their efforts).

It has been a long process bringing this special issue to fruition, one that would not have been possible without the help of many individuals within our community. The editorial board of *M&SOM* played a significant role at the outset in helping us shape our call for papers—and thus our concepts of what this issue would and could become. We are particularly grateful to the distinguished and dedicated group of associate editors assembled for the project, namely Ravi Anupindi, Srinivas Bollapragada, Felipe Caro, Charles Corbett, Nicole DeHoratius, Feryal Erhun, Marshall Fisher, Marcelo Olivares, Erica Plambeck, Ananth Raman, Nicola Secomandi, Robert Shumsky, Lawrence Snyder, Jay Swaminathan, Geert-Jan van Houtum, and Sean Willems. Although we cannot name them here, we are also extremely grateful to all the individuals who, as referees for this special issue, generated high-quality evaluations and feedback for the papers under tight timelines. Frances Moskwa in the *M&SOM* office provided much help in getting and staying organized, and *M&SOM* Editor-in-Chief Chris Tang provided substantial support and guidance throughout the process. Finally, we want to express our deep gratitude to former *M&SOM* Editor-in-Chief Steve Graves, who provided not only the initial vision and impetus for this project, but also invaluable help and insights as advisor, reviewer, and coauthor.

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