Research

EXECUTIVE SUMMARIES : EDITED BY CANDACE YANO

Yariv Marmor (left) and David Sinreich were able to classify emergency room patients into eight types, which allows them to develop a unified patient process flow chart to aid efficiency.

This edition of Research highlights two articles that focus on tools to help decision makers design effective and efficient manufacturing and service businesses. The first article summarized below presents a comprehensive approach based on mathematical optimization for analyzing the choice between a supply chain with focused factories and one with vertically integrated factories. The second describes the development of a simulation model that can be applied to a wide variety of hospital emergency rooms with only modest data requirements. Both articles can be found in the March 2005 issue of IIE Transactions *(Vol. 37, No. 3).*

Emergency room simulation

Hospital emergency room administrators, like managers in many other types of organizations, think their environments are unique and that they need customized decision support tools for operational decision making. But in their study of emergency rooms at five hospitals, Technion - Israel Institute of Technology faculty member David Sinreich and doctoral student Yariv Marmor found that the various emergency rooms have a great deal in common.

From an extensive study of more than 16,000 patient visits to emergency rooms, Sinreich and Marmor found that it was possible to classify patients into just eight types (for example, trauma and walk-in orthopedic). More important, it was possible to design a single unified patient process flow chart that covered all eight patient types. The process flow chart represents the full collection of examinations and laboratory tests a typical emergency room patient might need to undergo and the sequence in which they should be performed. Each type of patient needs a particular subset of the full collection. So, for example, an orthopedic patient would likely need an X-ray but not an electrocardiogram, whereas a person with chest pain would need an ECG.

Analysis of patient visits also led the authors to conclude that the time required to perform each of the examinations and tests for each particular type of patient were similar enough from one emergency room to the next that default values could be established for use in the simulation. This reduces or eliminates the need for detailed time-and-motion studies that would usually be required.

With this understanding and quantification of emergency room processes, the authors developed a method to forecast patient arrivals that could be applied to all five hospitals with different parameters to reflect differences in hospital size and patient mix. Putting all of this together, Sinreich and Marmor now have a generic simulation tool that requires only a modest amount of data input. The simulation model can be used to aid decisions regarding staffing and equipment, with the ultimate goal of reducing patient waiting times and hospital operating costs.

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To pool or not to pool?

A manufacturer of telecommunications equipment and a manufacturer of hard disks faced the same problem: Should they set up focused factories for components and separate assembly facilities to achieve economies of scale in production and inventory or should they set up product-focused plants in which the production of components and final assembly would take place, thereby saving on logistics costs?

Shailesh Kulkarni, a professor at the University of North Texas, along with Michael Magazine and Amitabh Raturi, professors at the University of Cincinnati,

Michael Magazine and his co-authors learned that various capacity decisions are related in complicated and sometimes unexpected ways.

took on the challenge of answering this question. They were especially interested in situations where final products share common components because of the well established benefits of inventory risk pooling in these circumstances. That is, by centralizing inventory into fewer locations and pooling customer demands, manufacturers can take advantage of the fact that high and low demands from different locales will offset each other, thereby reducing the total amount of safety stock needed.

The authors developed an optimization model to determine the best configuration of the supply chain — where raw materials should be sourced, where subassemblies and components should be produced, where assembly operations should be performed, how subassemblies and components should be routed for assembly, and how finished goods should be routed to geographically disperse markets. Their comprehensive optimization model considers uncertainty of demand and seeks to minimize the overall cost, considering the cost of purchased goods, transportation, manufacturing and assembly, inventory, lost sales, and the cost of capacity for manufacturing and assembly.

By applying their optimization model to various scenarios, Kulkarni, Magazine, and Raturi came up with some general principles and observations to guide decision making. One key observation is that the benefit of inventory risk pooling is reduced when the cost of capacity for producing the common component is either high or low. With a lower benefit from risk pooling, firms prefer product-focused factories because of efficiency in logistics.

The authors' study also indicates that the various capacity decisions are related in complicated and sometimes unexpected ways. The optimization model can aid in avoiding pitfalls and guide the search for a solution that is best for the entire supply chain. A decision support system based on the proposed method is running at several processing and distribution centers. Results indicate that annual savings on the order of $1.6 million per facility can be achieved. The system is expected to be implemented nationwide at all 275 facilities over the next three years.

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