This month, we highlight two articles on the design of production and distribution networks that appear in May's scheduling and logistics-focused issue of IIE Transactions (Vol. 39, No. 5). The first article looks at designing manufacturing networks when there are free trade zones and complex tariff rules in place. The second examines the impact of congestion at inbound delivery docks on inventory levels needed at distribution centers and the consequent effect of these inventory levels on how the distribution network should be designed.

**Global sourcing with local rules**

Singapore is a global hub for manufactured products and a major center for electronics production. Large multinational corporations such as Matsushita Electric, Philips, Motorola, and Seagate operate in Singapore or outsource to local electronics contract and assembly manufacturers. In recent years, these companies and their suppliers have been shifting lower-end production to low-cost countries, especially Malaysia, Indonesia, Thailand, India, and China, while focusing on higher-end products in Singapore. Components, modules, and subassemblies are shipped to Singapore from these countries and elsewhere before production is completed and finished products are shipped all over the world. Decisions regarding sourcing of components and where to perform assembly operations are complicated by the presence of free trade agreements and tariff structures.

Yanzhi Li and Andrew Lim from the Hong Kong University of Science and Technology and Brian Rodrigues from Singapore Management University were asked to study this problem by a multinational corporation based in Singapore. The company has a large market for its electronic products, especially consumer electronics, in Japan and the Asia-Pacific region.

A number of tariff agreements are in place among these countries, in particular, a bilateral Japan-Singapore Economic Partnership Agreement exempts Singapore products imported into Japan from tariff charges if material content arising from production in Singapore exceeds a minimum threshold. Since the production process for each product...
involves material contributions from a number of countries, the authors ask, What is the best way the company can rationalize its production among several countries to benefit from tariff concessions that are in effect? This question is especially relevant when zero tariffs are available through free trade agreements.

In "Global Sourcing Using Local Content Tariff Rules," the authors develop a model to optimize sourcing decisions, taking into account tariff structures as well as component and transportation costs. They devise a method that identifies near-optimal solutions very quickly. From numerical results, they discovered that common wisdom about sourcing is not necessarily true when complex tariff structures are in place. Their method can provide decision support for supply chain design for any company that produces and exports in countries where differential tariffs and free trade agreements play an important role.

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**Distribution network design**

organizations in a wide variety of industries are rethinking the design of their distribution networks as customers demand greater responsiveness and inventory availability, while product proliferation and ever-shorter product life cycles make it increasingly difficult to forecast demand accurately. Decisions such as the location of distribution centers, the volume of product flowing through each center, and safety stock levels of the various products play key roles in achieving rapid response in an economical fashion.

Karthik Sourirajan, Leyla Ozsen, and Reha Uszoy, all from Purdue University, were motivated to study these issues because of what they observed in the auto industry and at blood banks. In particular, they observed that as the volume of goods flowing through a distribution center increases, the lead-times increase at a faster-than-linear rate due to the effects of congestion in the unloading area for inbound goods. Because the amount of safety stock required to achieve a target service level depends on the lead-times, these complex interactions need to be considered in designing the system.

In "A Single-Product Network Design Model with Lead-Time and Safety Stock Considerations," the authors develop an integrated optimization model to determine the location of distribution centers and the assignment of customers to distribution centers such that the safety stocks and lead-times are kept at reasonable levels. They devise a sophisticated yet efficient method to solve the problem that leads to substantial cost reductions over simpler methods, ignoring the impact of product volumes on lead-times and the consequent effects of lead-times on safety stocks.

The next time you need a spare part for your car or a blood transfusion or even a more mundane item, remember that it is well-designed distribution systems that enable the organization to provide you fast, economical service.

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