RESEARCH

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This month we highlight a pair of articles that address planning and scheduling problems in the public and private sector. The first article looks at how to minimize losses from natural disasters by optimally prepositioning relief supplies. The second article uses an empirical modeling approach to help managers set schedules for processes that produce many products with significant changeover costs. These articles will appear in the April 2015 issue of *IIE Transactions* (Volume 47, No. 4).

Nilay Noyan, shown in her office at Sabancı University, helped design optimization models to preposition supplies for disaster relief.

Making the right preparations for natural disasters

Natural disasters lead to increasingly higher death tolls and severe material losses. The United States had an average annual death toll of 106,654 from 2003 to 2012.

Last year, United Press International reported that a panel of experts called U.S. disaster funding distribution deeply inefficient and recommended to "develop and assess measures of emergency preparedness both at the community level and across U.S. communities."

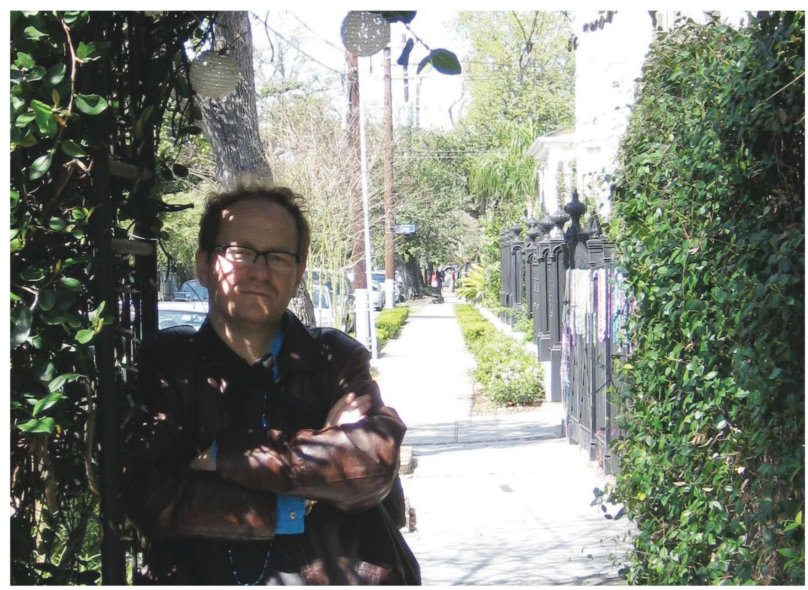
When a disaster occurs, delivering relief supplies such as food, water and shelter to people in the affected areas as early as possible is of critical importance for effective relief operations. Is there a way to be prepared in advance for alleviating the suffering of people?

The answer is yes. We could strategically position the resources in advance based on the most likely disaster scenarios. Considering the complex structure of humanitarian relief systems and the need to allocate scarce resources in a way that improves the effectiveness of the relief operations, humanitarian logistics could benefit greatly from industrial engineering methods.

There is significant uncertainty in factors such as location and severity of disaster, demand quantities and transportation infrastructure that affects how effective a response is. It is crucial to develop models incorporating the inherent uncertainty to make sound decisions. Such a stochastic pre-disaster relief network design problem is addressed via a new risk-averse stochastic programming approach in "Stochastic Network Design for Disaster Preparedness." In this paper, former doctoral student Xing Hong, professor Miguel Lejeune from George Washington University and professor Nilay Noyan from Sabancı University determine the size and location of the response facilities and inventory levels of relief supplies at each facility while guaranteeing a certain level of network reliability.

Their optimization models feature a chance constraint to ensure that demand for relief supplies across the network is satisfied with a high probability. Responsiveness and fairness also are accounted for by defining multiple regions in the network and ensuring, via local chance constraints, that each region is self-sufficient in terms of providing for its own needs.

The authors develop a computationally efficient solution algorithm using methods from network flows, Boolean programming and integer programming. Computational results for the case



Miguel Lejeune of George Washington University poses in New Orleans seven years after Hurricane Katrina.

Zhili Tian and his co-authors devised equations that could help a chemical company decide what new orders to accept.

study on the Southeastern U.S. region facing hurricane risk demonstrate the effectiveness of the proposed methods and underline the importance of long-term pre-disaster planning.

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Calculating the cost of accepting new orders

Scheduling can be a nightmare for companies that offer dozens, hundreds or even thousands of different products made from the same process. Managers need to worry not only about meeting due dates but also about potentially significant changeover times and costs incurred when switching from one product type to another.

In addition, the optimal schedule for today's set of customer orders may completely change if tomorrow's orders are added to the mix. These issues represent the concept of product line complexity. Enterprises that offer significant product portfolios need tools to help meet these daunting scheduling challenges.

A chemical manufacturing company, which prefers to remain anonymous, uses a continuous production process to make plastic films that are imbedded in auto windshields. The business produces 1,700 different products on a single continuous production line that operates 24 hours a day, seven days a week. The line continues to operate during product switchovers of sheet width, color band width, and/or roll length. Changeovers often take more than 10 minutes and may take as long as 80 minutes. During this time, capacity is lost, and the material running through the process is wasted.

The auto film company's scheduling problems are investigated in "Understanding and Managing Product Line Complexity: Applying Sensitivity Analysis to a Large-Scale MILP Model to Price and Schedule New Customer Orders." In this paper, Zhili Tian from Florida International University; Panos Kouvelis, a professor at Washington University in St. Louis and director of The Boeing Center on Technology, Information and Manufacturing; and professor Charles Munson from Washington State University use a form of global sensitivity analysis that applies novel regression techniques to a mixed-integer, linear-programming, scheduling model in order to provide decision support tools for managers.

Production costs of products vary from one production run to another. By using data from historical customer orders, the authors developed relatively simple equations that managers can use in real time, without needing to rerun the full scheduling model, in order to estimate the capacity usage and material waste that a new order would impose on the system. Managers can use these estimates to make accept/rejection decisions on the phone with customers and to price new orders properly.

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The most recent issue of *The Engineering Economist* (Volume 59, No. 4) focused on engineering economics in reliability, replacement and maintenance. Here we highlight an article in which the authors address the problem of finding minimum cost replacement schedules for each individual asset in a group of assets that operate in parallel and are economically interdependent.