For Karen Smilowitz and Irina Dolinskaya, the term “industrial engineering” is a bit of a misnomer. It evokes the image of the engineer in a factory with a stopwatch in hand, making sure production is as efficient as possible.

Surely some industrial engineers still do that. But these days, industrial engineering has grown beyond the factory and into the world of business. Smilowitz has taken it one step further — into nonprofits.

Smilowitz, associate professor of industrial engineering and management sciences and William A. Patterson Junior Professor in Transportation, has studied ways to optimize how freight is moved: how to reduce the distance of trucking routes, for example, or how to get companies to pool their resources and lower costs. More recently, she has taken that work and applied it to nonprofits, including finding the most efficient way to route library books and improving operations for a mobile asthma-care organization.

Now, she and Dolinskaya, assistant professor of industrial engineering and management sciences, are working together to use their operations research in a new area: disaster relief. It’s a field known as humanitarian logistics, and — as seen with disasters in New Orleans and Haiti, where workers faced roadblocks in distributing provisions to survivors — it could have far-reaching implications.

**Optimizing models — but not profit**

Nonprofit and humanitarian organizations often have operations problems they don’t have the budget or technology to solve, and their needs are different from those of for-profit companies. “When you have a nonprofit, the goals change,” Smilowitz says. “You can’t just take a commercial model and apply it, since maximizing profit and minimizing cost aren’t necessarily the goals.”

For example, in one of Smilowitz’s research projects, local libraries faced a unique dilemma: vans visited each library in the system every weekday to pick up and drop off book requests. As the economy crashed, demand for library books went up — but it was no longer feasible to provide the van service every weekday. What Smilowitz found was that instead of going only to certain distant libraries every other day, the route could be optimized so drivers would go to each library three days a week, giving every library greater service.

“We found this counterintuitive result where we can reduce transportation cost and increase service,” she says. “This opportunity is unique to

**HUMANITARIAN LOGISTICS**

**SAVING LIVES WITH BETTER DISTRIBUTION MODELS**
In a for-profit setting, if you don’t pay for a level of service, you don’t get it. But we uncovered this new variation of the vehicle routing problem, which is really exciting.”

Smilowitz and her Northwestern colleague Seyed Iravani, professor of industrial engineering and management sciences, have worked with a food bank in Chicago to find the best way to match donors and recipients and design delivery routes to serve people. And along with Sarang Deo, assistant professor of managerial economics and decision sciences at the Kellogg School of Management, they are working with Mobile C.A.R.E., a nonprofit that provides free asthma treatment to children in Chicago’s underserved communities via mobile medical units. Beginning last spring, a team of undergraduates began surveying the organization’s operations and started to create a simple model of how to make its operations more efficient.

“You need to have a model that shows how asthma progresses over time,” says Smilowitz. “And you need a capacity-allocation model that says how to best use a scarce resource when your objective function is to bring in the entire population. It’s a difficult problem.”

Responding to disasters
When Dolinskaya came to Northwestern in 2009, she and Smilowitz — whose offices are next door to each other — began to talk about collaborating. Smilowitz had done some work in disaster relief, and Dolinskaya had worked with the U.S. Navy in charting optimal courses for sea vessels using real-time information to continually update the route based on radar data about the sea’s roughness.

When the earthquake hit Haiti in January, Dolinskaya and Smilowitz started to think about how their research could apply to the relief efforts. They knew they had strengths in transportation and vehicle routing, so they began talking to relief organizations like FEMA and the Red Cross to get information on how disaster relief efforts usually work. “It seemed like a very natural coming together,” Dolinskaya says. “Karen was working on the distribution of goods. In order to distribute them, you’re trying to get to a destination, and you are learning about the environment as you are traveling — like what roads are impassable. I am interested in dynamically reevaluating a path as new information becomes available. It was a good fit.”

Their research program, which is just getting off the ground, consists of identifying best practices in relief-chain management and developing new design and operating policies that can complement those practices. They are particularly interested in last-mile relief distribution, creating optimization models that can help drivers choose routes and allocate inventory once supplies have been delivered to their destination.

“When a disaster happens, you have a set of aid recipients who are geographically dispersed,” Smilowitz says. “There is uncertainty: Maybe a road is no longer reliable, and you don’t know how long it’s going to take to get somewhere. How do you schedule visits? How do you build models that incorporate these uncertainties and take into account supplies, infrastructure, and the needs of the recipients? We don’t just want to solve one problem for one organization in one disaster. We want to create models that incorporate baseline disaster scenarios.”

Smilowitz and Dolinskaya hope to not only come up with optimization models based on baseline disaster scenarios but also to create rules of thumb that workers can use on the ground. “Relief workers can’t use a model that they have to dynamically update and optimize every day,” Smilowitz says. “I think it’s one of the fun challenges to pare down these models into simple guidelines.”

Both Smilowitz and Dolinskaya are affiliated with Northwestern’s Transportation Center and hope to work with professors there, including center director Hani Mahmassani, on extending the initiative to evacuation and disaster relief. Smilowitz says McCormick’s humanitarian logistics work is attracting graduate students with a background in quantitative research who are interested in using it for the greater good. “It is an effective way of approaching a problem, and students are learning it is one of the ways you can make an impact in the world,” she says.