Evacuation software finds best way to route millions of vehicles

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Yi-Chang Chiu wants to move people efficiently — lots of people, millions of people — in response to a terrorist attack or natural disaster.

Suppose, for instance, that a disaster occurred in Southern California and suddenly 700,000 vehicles headed for the Arizona border? How would transportation officials generate the best traffic management strategy to cope with the traffic?

One very good option would be to use the computer simulation package that Chiu, an assistant professor in The University of Arizona Civil Engineering Department, has been developing since 1995, when he was a graduate student at the University of Texas in Austin.

"Solving large-scale evacuation problems is overwhelming," Chiu said. "No one can just sit down with a map and draw lines and figure out the best answer to problems like these."

No single plan or even series of plans is sufficient, he added. "We're not focusing on a script because a disaster scenario is very unpredictable. You can't have one plan that fits all situations, and you can't evaluate hundreds of scenarios or your 'plan' will end up looking like a phone book."

Instead, Chiu and his colleagues have focused on developing software that can react to a situation in real time, adjusting as conditions on the ground change.

Planning on the Fly

"If we're reacting to a hurricane, we have 72 hours to plan," he said. "But what if an unforeseen disaster occurs" We need to make a decision in 15 minutes."

The software package depends on detailed traffic census data that is collected by state and city transportation departments in conjunction with real-time traffic surveillance data. "The cars aren't just randomly placed on the streets in our simulations," he said. "We know where every car has come from, where it's at and where it's headed, and vehicle movements follow rigorous traffic flow theories. So the simulation is very realistic. It's not just a random process."

It's also very complicated. The software considers decisions each driver might make on factors such as when to leave, which route to take, if they listen to radio reports and change their route, if they are slowed by congestion and change routes, or if they react to freeway message boards that carry routing advisories.

Responding to Airborne Hazards

The model also can be combined with an air-plume dispersion model to predict how traffic will respond to airborne hazardous material.

"We have a scenario that says a refinery caught fire and every 30 minutes the wind plume is progressing according to the wind speed and temperature," Chiu said. "So we can calculate the health risk. In the case of an extremely toxic substance, we can also calculate the number of casualties and where they will occur."

The model isn't finished when the disaster ends. It also has post-disaster applications. For instance, Chiu and his colleagues analyzed a high-rise, multi-level interchange in El Paso, Texas where I-10 and US 54 meet.

If that interchange were completely destroyed, what would be the immediate and long-term impact to the city and what would be the best scenario for recovery?

"If you have only limited funds or time, which project will do the most good for recovery"" Chiu asked. "Do you open I-10 first or US 54? The model allows us to make those kinds of after-disaster recovery decisions based on the detailed, day-to-day traffic-flow data that has been collected by the City of El Paso and the projected traffic patterns from the model."

Value Pricing on Toll Roads

Chiu and his colleagues also have used the software to model what's called "value pricing" on toll roads. The idea is to use a sliding toll scale to manage congestion. When traffic increases, the toll notches up incrementally to a maximum amount. This information is broadcast to drivers in various ways, with the hope that they will choose a different route, use public transit or delay their trip.

"The real research focus here is to develop a fair method for calculating tolls," Chiu said. "It can't be arbitrary or people won't accept it. You need to do very careful planning."

The traffic software, which Chiu and others began building line-of-code by line-of-code back in 1995, has undergone several software engineering cycles since then and now is a mature product that will soon be ready for state transportation and emergency medical agencies.

The next generation of the software, which is now under development, is called MALTA (Multi-Resolution Assignment and Loading of Traffic Activities). It is being designed to run even faster, to handle networks with much larger sizes, and to respond minute-by-minute to real-time emergencies. Instead of running on a single computer, it employs parallel processing, in which several computers work together on the problem. The National Science Foundation and Arizona Department of Transportation are funding the development and field testing of MALTA.

Source: University of Arizona

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