Responding to the Unexpected: Development of a Dynamic Data-Driven Model for Effective Evacuation

What Was the Need?
By their very nature, no-notice emergency events such as chemical spills and unanticipated structural failures are unexpected and unpredictable. Predetermined evacuation scenarios may not apply given a no-notice emergency’s unique set of circumstances, when things can change quickly and driver behavior is difficult to predict. To address this dilemma, emergency managers need a tool that manages evacuation traffic efficiently in real time—in just seconds to only a few minutes—and allows for adjustments as facts on the ground change.

What Was Our Goal?
The objective of this research is to develop a decision-support tool for smaller-scale emergency evacuation traffic management, with the primary objective of minimizing the total system travel time. The tool will be used to develop models for evacuee routing calculations and optimal intersection control through the placement of limited numbers of police officers to guide traffic at critical network locations.

What Did We Do?
Researchers developed algorithms and software along with a user’s guide to create a framework with three components:

- A prescriptive model that represents the desired response of traffic under evacuation. This model creates only short-term traffic forecasting of a few minutes, with a rolling time horizon.
- A descriptive, real-world model that describes, in a short-term fashion, the real-world traffic flow pattern under evacuation as accurately as possible.
- An adaptive control system that integrates output from the prescriptive model—the desired state of traffic—and the current prevailing traffic conditions described by the descriptive model to generate a traffic control strategy for evacuation.

What Did We Learn?
The adaptive control system developed is a heuristic algorithm for staged traffic evacuation, or HASTE, that determines evacuee departure rates, time schedules, shortest paths and critical intersections for police officer deployment. The tool provides substantially improved network clearance times.

Researchers developed an evacuation software tool for small-scale, no-notice evacuations that determines evacuee departure rates, time schedules, shortest paths and critical intersections for police officer deployment. The tool provides substantially improved network clearance times.
“Our testing demonstrated that HASTE evacuation routing solutions provide substantial improvement in network clearance times when compared to an all-or-nothing assignment. All routing computations were completed within two minutes, illustrating the efficiency of HASTE.”

—Henry Liu, University of Minnesota Department of Civil Engineering

“The evacuation software tool is designed to address smaller-scale evacuations. Emergency managers can use the tool to place officers at critical intersections and identify locations for detour signs to implement contraflow traffic.”

—Ernest Lloyd, Director, Financial & Support Services, Mn/DOT Office of Maintenance

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What’s Next?
Mn/DOT will provide the evacuation software tool and its accompanying user’s guide to emergency managers in the seven-county Twin Cities metropolitan area for additional testing of evacuation scenarios and future application. Since the system addresses small-scale evacuations, it may be further developed for city and county use with the support of the Local Road Research Board.