Evaluating smart work zone technologies

On Interstate 80 in rural eastern Iowa, traffic often exceeds 30,000 vehicles per day during the summer construction season, and motorists have experienced very long work zone delays due to congestion. The Iowa Department of Transportation (DOT) is investigating means to better manage traffic in work zone areas along segments of rural interstate highway.

Among the methods being considered is the expanded use of advanced traveler information systems to better inform motorists of changing traffic conditions ahead and, when appropriate, to divert them to alternative routes. Prior to making any investment decisions, however, research is needed to improve understanding of traffic behavior within work zones.

CTRE has been given the task of collecting traffic and driver behavior data in existing work zones and, based on these observations, developing a simulation model for work zones. The simulation will help the Iowa DOT and other agencies better understand the relationship between traffic volume, merging discipline (e.g., forcing vehicles to merge upstream of the work zone taper (merge point)), and motorist delay.

The typical strategy for designing rural interstate work zones in Iowa has been to reduce the number of travel lanes to one in each direction while work is performed on the closed lanes. The work zone simulation model will allow users to experiment with such variables as traffic volume and traffic merging discipline and to estimate the level of diversion required to keep delay at manageable levels. The model will also allow the Iowa DOT to assess the cost trade-offs between paying contractors to work extended hours to shorten the duration of the work zone versus imposing delays on motorists.

Several state transportation agencies, including the Iowa DOT, are using ATIS and dynamic traffic control devices to

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trucks enter the weigh station, or the number of "turning movements." The turning movements are then interfaced with the CORSIM module, which compares fuel consumption of trucks passing on the mainline with those of trucks driving through the weigh station and determines the relative fuel savings attributable to electronic screening.

Users can modify various parameters before running the model. Sample parameters include hourly traffic volume, percent of trucks in the traffic stream, percent of trucks with transponders, percent of trucks subjected to a safety inspection beyond weighing, and the average duration of a safety inspection.

The Arena and CORSIM modules demonstrate that as the number of trucks with transponders increases, both the length of queues and the number of unauthorized bypasses decrease at an electronically screened station. The station is therefore more productive; it checks more noncompliant trucks and fewer compliant trucks. Relative travel time and fuel consumption are reduced not only for participating trucks that are allowed to drive by the station but also, because of shorter queues, for trucks that must drive through the weigh station. •

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reduce work zone congestion and improve traffic safety. For example, a dynamic traffic control device to improve merger discipline is being tested by the Indiana DOT. The Indiana DOT is using a dynamic no-passing zone immediately upstream of the merge point to reduce traffic stream turbulence that occurs at the lane taper immediately before a lane closure. Sonic detectors determine the formation of a queue in the open lane. When a queue forms, strobe lights on "Do Not Pass" signs are triggered upstream. Once the queue has subsided, the strobes are automatically shut off.

Computer simulation will be used to model traffic behavior at an interstate highway lane closure and to evaluate ATIS and traffic control technology like the device being tested in Indiana. Once the simulation model is built, it will be possible to investigate cost trade-offs between driver delay and traffic control policies.

As with electronic screening simulations, the dynamic assignment of characteristics to individual vehicles is an essential function for accurately modeling work zone lane closures and modifying traffic merge discipline. Ali Kamyab, transportation research scientist, is therefore again working in Arena simulation language.

When completed, the Arena-based, high-fidelity, microscopic model will simulate traffic operations in and around a work zone. Users will be able to assess different scenarios, adjusting traffic levels, driver behavior, and merge discipline. The visual animation component of Arena will allow traffic engineers to easily demonstrate the impact of various traffic management strategies and technologies to a broad audience.

Arena lacks lane-changing and car-following algorithms found in traffic simulation tools. CTRE has developed these algorithms and is customizing the Arena model to reflect these vehicle behaviors.

The work zone simulation model is based on the geometry and traffic patterns of a particular construction site in Iowa; however, the geometry may be changed to reflect varying designs (e.g., a longer taper area). The default data present existing traffic conditions within the work zone. The model will be validated to determine if

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CTRE is collecting data on traffic/driver behavior in existing work zones. These data provide the basis for an Arena-based work zone simulation model.

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For more information about the electronic screening simulation model, contact Ali Kamyab, 515-294-4303, ali@ctre.iastate.edu.

A report on the work zone simulation model will be available through CTRE or the Iowa DOT later in 1999.

it replicates the actual system at an acceptable level, including car-following and lane-changing characteristics. To validate the model, output of the model will be compared to traffic conditions and behavior recorded in the field.

The model will be completed by spring 1999. At that time CTRE will run a number of experiments using typical traffic volumes, vehicle mixes, and daily distribution of traffic volumes by time of day. The exercises will include the following activities:

- Examine the improvement in work zone capacity resulting from traffic control to modify merge behavior.
- Examine the impact of errant behavior on the part of drivers. For example, it is common for two truck operators to position their trucks two abreast at the end of the queue and move through the queue without allowing drivers to pass in the lane being discontinued. This practice creates a large gap between the two trucks and the traffic ahead, effectively diminishing the vehicle-handling capacity of the work zone.
- Examine the queue formation cycle under varying traffic volumes and truck percentages to determine a method to forecast when queues will form and when to begin recommending diversion of traffic to alternative routes.
- Examine cost trade-offs between expected delay costs and alternative construction policies. At some point it may be necessary to examine cutting construction schedules, requiring contractors to open lanes when volumes exceed a specified level, or full-depth paving the shoulder to create additional traffic lanes.

Current changes in transportation infrastructure, including the implementation of Intelligent Transportation System (ITS) technologies, may demand a new generation of universal traffic simulation models that can accommodate the algorithms in these technologies. In the meantime, CTRE's simulations of electronically screened weigh stations and work zone technologies provide examples of how existing models can be modified to accommodate today's modeling needs. •

Truck drivers commonly drive two abreast through a work zone queue to prevent "cheaters" from driving by in the closing lane. This practice diminishes the vehicle-handling capacity of the work zone.