Evaluating electronic screening at weigh stations

Electronic screening systems at weigh stations are a key component of the Federal Highway Administration's (FHWA) Intelligent Transportation Systems for Commercial Vehicle Operations (ITS/CVO) program. The goal of electronic screening is to monitor trucks' compliance with size/weight and other regulations more efficiently.

Stations without these systems require all trucks to pull in to be weighed and checked for compliance. Queues of trucks waiting to be weighed can become quite long. When that happens, trucks are allowed to bypass the station to prevent the queue from backing up onto the mainline.

An electronic screening system identifies and checks participating (transponder-equipped) trucks for compliance *before* they reach the weigh station. The system consists of a roadside Automatic Vehicle Identification (AVI) "reader" and weigh-in-motion (WIM) scale upstream of the station. The reader and scale capture information about transponder-equipped trucks as they pass: their identity, weight, and other regulatory information. Transponder-equipped trucks that are in compliance are automatically signalled to drive past the station; all other trucks are signalled to pull in to the weigh station unless the queue is full.

As more weigh stations use electronic screening systems and more commercial vehicles become equipped with AVI transponders, commercial vehicle operations, regulatory agencies, and the traveling public should benefit:

- When compliant vehicles can bypass busy weigh stations, the stations experience fewer and shorter queues of trucks waiting to be weighed. Compliant trucks save time and fuel, and trucks that enter the station experience shorter waits, also saving time and fuel.
- Fewer full queues at weigh stations means fewer trucks are allowed to bypass the station without being checked. Weigh station personnel waste less time checking compliant vehicles and can concentrate on noncompliant vehicles.
- The traveling public should be safer. More unsafe trucks will be detected at weigh stations. With shorter queues at weigh stations, fewer trucks will be dangerously backed up onto the mainline.

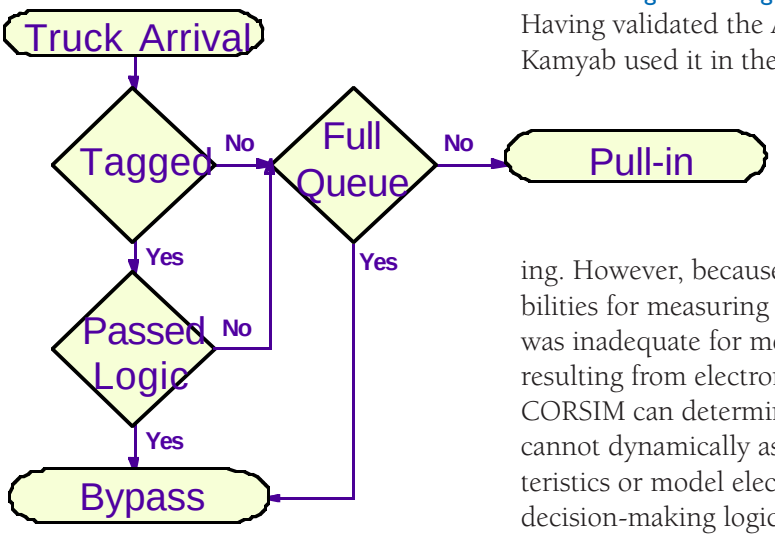
As evaluator for both the Federal Highway Administration's Advantage I-75 Mainline Automated Clearance System (MACS) project and for the Oregon Green Light initiative, CTRE was charged with quantifying the impacts of electronic screening. For the MACS project, which has been completed, travel time savings, fuel savings, station productivity, and other impacts were measured in the field. Such exhaustive field evaluations are expensive. So, as CTRE staff collected time savings data for the MACS evaluation, Ali Kamyab, transportation research scientist, began developing a simulation model to conduct the same evaluation virtually.

Measuring travel time savings

Kamyab built a special-purpose weigh station module with enhanced capabilities in Arena simulation language. Arena is typically used in the manufacturing industry to simulate manufacturing processes and has the dynamic assignment capabilities needed for this project.

Based on various inputs identified by the user (e.g., amount of traffic, number of trucks equipped with transponders, etc.),

the Arena-based module generates "trucks" coming down the mainline, then dynamically assigns characteristics (classification, axle spacing, axle weights, etc.) to the vehicles. The module includes a decision-making logic that mimics the logic of electronic screening systems, assigning "bypass" or "pull-in" signals to trucks on the mainline based on the length of queue in the weigh station, presence or absence of transponders, compliance or noncompliance, and other parameters within the logic. As depicted in the figure below, if conditions in the logic are satisfied, a truck drives by the station on the mainline. If not, it enters the station. All trucks without transponders enter the weigh station unless the queue is full.



Decision-making logic in the Arena module simulates electronic screening.

The module effectively measures travel time savings attributable to electronic screening at weigh stations and, using Arena's high-fidelity animation capabilities and Viewer software, displays truck movements through and past the station graphically (see the figure on page 1). Outputs include the number of unauthorized bypasses, travel times, queue length, average time in the system, and hourly number of trucks processed.

The logic of the Arena-based module was verified and the results validated by comparing truck travel times measured in the field for the MACS project to travel times generated by the module without electronic screening functions operating.

Although the module was built based on the geometry and traffic patterns of a specific weigh station, it can be modified to simulate a variety of weigh station designs and, if a station is part of a network of screening-equipped stations, can incorporate information written to the transponder at upstream stations.

Determining fuel savings

Having validated the Arena module, Kamyab used it in the Oregon Green Light evaluation to determine travel time savings resulting from electronic screening. However, because Arena lacks capabilities for measuring vehicle fuel usage, it was inadequate for measuring fuel savings resulting from electronic screening. CORSIM can determine fuel savings but cannot dynamically assign vehicle characteristics or model electronic screening's decision-making logic. Kamyab therefore built a weigh station module in CORSIM and interfaced it with the Arena module. The resulting model incorporates Arena's dynamic assignment and powerful display capabilities with CORSIM's network capabilities for determining fuel savings.

For each scenario, the Arena-based module generates truck traffic and assigns characteristics to the trucks. Arena's decision-making logic determines which

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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. •