Highway-Rail Crossing Safety Systems

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Photos: Courtesy of Natalie Villwock-Witte, WTI

Description: A traditional highway-rail crossing may consist of either a passive (crossbuck sign) or active (flashing lights, bells, automatic gates activated by a track circuit) system. These traditional approaches require that a motorist/pedestrian/bicyclist be aware of the crossing and evaluate whether it is safe to cross. The goal of applying Intelligent Transportation Systems (ITS) at a highway-rail crossing is to improve safety, enhance communications, and reduce congestion at highway-rail intersections. A variety of ITS applications can be applied to support this goal including: vehicle detection (see #TM5), access control gates (see #TM1), flashing lights, GPS tracking (see #OM3), intersection collision warning systems (see #CC7), in-vehicle sensing, traffic signal preemption (see #ES5) and integrated traveler information systems (see #TTI4). These applications can work together to create an intelligent grade crossing, which can create a more reliable signal system, alert a train operator of a stalled vehicle on the tracks, use dynamic message signs (see #TTI3) to inform drivers of an oncoming train, or give priority to emergency vehicles when necessary.

Rural Transportation Critical Needs

- ☑ Crash Countermeasures
- ☐ Emergency Services
- ☐ Operations & Maintenance
- ☐ Rural Transit & Mobility
- ☐ Surface Transportation & Weather
- ☐ Tourism & Travel Information
- ☑ Traffic Management

Issues Addressed

- ☐ Road Geometry Warning
- ☑ Highway-Rail Crossing Warning
- ☐ Intersection Collision Warning
- ☐ Pedestrian Safety
- ☐ Bicycle Warning
- ☐ Animal Warning
- ☐ Collision Avoidance
- ☐ Collision Notification
- ☐ Weather Warning

Strategies Achieved

- ☑ Road User
- ☐ Road
- ☐ Vehicle
- ☐ Safety Culture
- ☑ Engineering
- ☑ Emergency Response
- ☐ Enforcement
- ☑ Education

Applicability

- Highway-rail crossing safety systems can be applied in both urban and rural contexts. Rural areas often have longer emergency service response times, so mitigating vehicle/train collisions in rural areas brings substantial safety benefits.

Partnerships

- Applications benefit from collaboration among numerous agencies, which may include:
  - Federal Rail Administration (FRA)
  - Rail agencies
  - Departments of Transportation (local, state, federal)
  - Transit Agencies

Key Components

- Traffic Management Center (TMC)
- Traveler Information Systems
- Vehicle Equipped with Receiver
- Transmitter on Train or Detection Sensor Trackside
- Obstacle Detector
- Dynamic Message Signs (DMS)
- Camera/Video
- Warning Signs and/or Lights
- Gates
- On-Board Warning System
- Global Positioning System (GPS)
- Traffic Signal System

Examples of Implementation

- **Low-Cost Highway-Rail Intersection Active Warning System Field Operational Test**

The Minnesota Department of Transportation deployed an alternative low-cost active warning system at 27 low-volume crossings between Minneapolis/St. Paul, Minnesota and South Dakota.

- **Texas Department of Transportation (TXDOT) Advanced Warning to Avoid Railway Delay (AWARD)**

TXDOT installed acoustic sensors and radar speed guns at three rail crossings. These sensors detected the presence, length, and speed of a train approaching the crossings. Through the sensor data, the predicted traffic delay was calculated and displayed on dynamic message signs, emergency vehicles, and at the traffic management center. This information could be used to alert drivers to take alternative routes to avoid the delay.

- **German Railways KOMPAS Project**

The German research project, KOMPAS, is testing a system that would detect obstacles on the railway. This system consists of three video cameras and infrared radar, which communicate with a computer that runs detection algorithms. If an object is detected on the railway, an alert is sent to the in-vehicle computer on nearby trains, which allows the train operator to take the necessary steps to avoid danger.

- **Connecticut Department of Transportation (CTDOT) Four-Quadrant Gates**

CTDOT tested four-quadrant gates and obstacle detection at a roadway crossing along a high-speed rail corridor designated for Amtrak trains. Four-quadrant gates are designated to mitigate motor-vehicle driver violations running two-gate systems. In addition to the gates, six inductive loops were installed at the crossing to detect vehicles and other obstacles. If an obstacle is detected, an in-cab signal was sent to the coming train. If the train operator did not stop the train, the system would stop the train automatically.

Implementation Considerations (General)

- The safety of pedestrians and interactions with highway-rail grade crossings should be considered as well as vehicle interaction with highway-rail grade crossings.

Implementation Considerations (Pro)

- Increased awareness can help to reduce crashes at highway-rail intersections.
- Improved mobility.
- Improved communication between the department of transportation and the rail agencies.
- Ability to re-route emergency vehicles to avoid closed rail crossings.

Implementation Considerations (Con)

- Initial costs can be high.
- Challenging to install equipment on trains as they are frequently hauling cargo and have limited availability.
- Issues with vehicles ignoring the warning devices.

Opportunities for Future Expansion

- In the future, highway-rail systems will communicate vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) to inform the traveling public of an oncoming train or alert a train operator of a vehicle, bicycle, pedestrian, or other obstruction on the railroad tracks.

Additional Resources

- United States Department of Transportation, *Railroad-Highway Grade Crossing Handbook*, found here: https://safety.fhwa.dot.gov/hsip/xings/com_roaduser/07010/
- *An Analysis of Low-Cost Active Warning Devices for Highway-Rail Grade Crossings*, found here: http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP03-76B_PhaseIIDraftFinalReport.pdf
- *Low Volume Highway-Rail Grade Crossing Treatments for the Oregon High Speed Rail Corridor*, found here: https://ir.library.oregonstate.edu/xmlui/handle/1957/34690

Useful Tip

If there are traffic signals near the highway rail crossing that already have traffic signal preemption for emergency vehicles, a low-cost improvement would be to add preemption for trains.

Cost Range

(Cost/financial information, where noted, is based on 2016 dollars (unless otherwise specified). Cost/financial information is estimated, and will vary based on size and scope of project, number of units, etc. In general, capital costs include initial purchase costs of hardware, software, and other required equipment. Maintenance and operations costs include staff time to operate, monitor and maintain systems; data collection; system upgrades; evaluation; etc.)

Capital Costs: The total capital costs for this tool range from low (less than $50,000) to higher (above $250,000). The reported cost of a train detector ranged from $10,200 to $13,300. For example, in a cross-cutting study with seven projects that applied intelligent transportation systems at highway-rail crossings, the cost ranged from $273,000 to $13 million[1].

Operations Costs: The operations and maintenance costs for this tool are low (less than $50,000). Costs of operating and maintaining a train detector were reported as ranging from $511 to $633 per year.

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