

How Technologies Will Bring Us Safer and Smarter Railroad Crossings

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Railroad crossing

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In a terrible accident at a railroad crossing, a train smashed into a car and pushed it nearly 400 yards down the track. Though no one was killed, the driver took the train company to court. At the trial, the engineer insisted that he had given the driver ample warning by waving his lantern back and forth for nearly a minute. He even stood and convincingly demonstrated how he'd done it. The court believed his story, and the suit was dismissed.



"Congratulations," the lawyer said to the engineer when it was over. "You did superbly under cross-examination."

"Thanks," he said, "but he sure had me worried."

"How's that?" the lawyer asked.

"I was afraid he was going to ask if the lantern was lit!"

INTRODUCTION

The total rail system in the United States today comprises over 110,000 miles of track with about 280,000 railroad crossings nationwide. The presence of at grade railroad crossings has always been a potential safety hazard to motorists and pedestrians since early days of vehicular travel. According to the Federal Railroad Administration (FRA), nearly every 2 hours, a pedestrian or a vehicle is hit by a train. Among the rail-related fatalities, 90% are connected with railroad crossing and trespassing incidents [1].

Most railroad crossing accidents are caused by motorists or pedestrians ignoring warning signs or attempting to beat the train. Nearly half of the total accidents occur at the 62% of public railroad crossings in the U.S. equipped with passive crossing devices such as crossbucks, stop signs, advance railroad warning signs and pavement markings. At such crossings, drivers often ignored signs or missed seeing a train, especially at night in rural areas. The other half of the accidents are accounted from the approximately 38% of public railroad crossings equipped with active traffic control devices such as flashes and automated gates [3]. Many of these accidents occurred when drivers ignored flashing lights or navigated around lowered gates. In addition, accidents due to vehicle brake-down, and people and/or animals stuck in the rails are not rare.

Over the past 3 decades, substantial efforts have been made to improve the safety at railroad crossings by the installation of active warning devices and safety protection devices. A number of new solutions to improve railroad crossing safety have been proposed. Testing and evaluations are underway on many of them. The solutions include retroreflective treatment of passive crossing signs, reflectorization of trains, median barriers, flexible traffic separators, self-extension gate arms, four-quadrant gates, sliding safety walls, LED flashing signals, in-pavement flashing red LED lights and vehicle arrest barriers [4-8]. Although these methods address the issues in collision protection and train warning, solutions to protect motorists and pedestrians who deliberately violate railroad

crossing traffic controls are lacking. This essay addresses the improvement to railroad crossing safety in two aspects. First, it presents a proposed system incorporating advanced laser and audio technologies to mentally create a situation that violators are reluctant to cross. Secondly, it introduces intelligent railroad crossings integrating ITS technologies that provide train arrival and delay information in advance, which could greatly reduce the waiting time. As a result, the cause of most railroad crossing violations, “to save waiting time”, will no longer be a big issue.

A PROPOSED DEVICE: OPTICAL LASER BARRIER

Is there any device that could catch more eyes and be more formidable for deliberate violators? Yes! How about a virtual **laser barrier** system? If you are a movie fan, you have been amazed by the laser sword in “Star Wars” and the fancy laser alert systems in “Entrapment” and “Oceans 12”. Compared to the normal alerting system such as flashing lights, this proposed bright and mysterious laser barrier system will warn motorists and pedestrians of the dangerous crossing in the dark and cast a strong mental threat onto the violators.

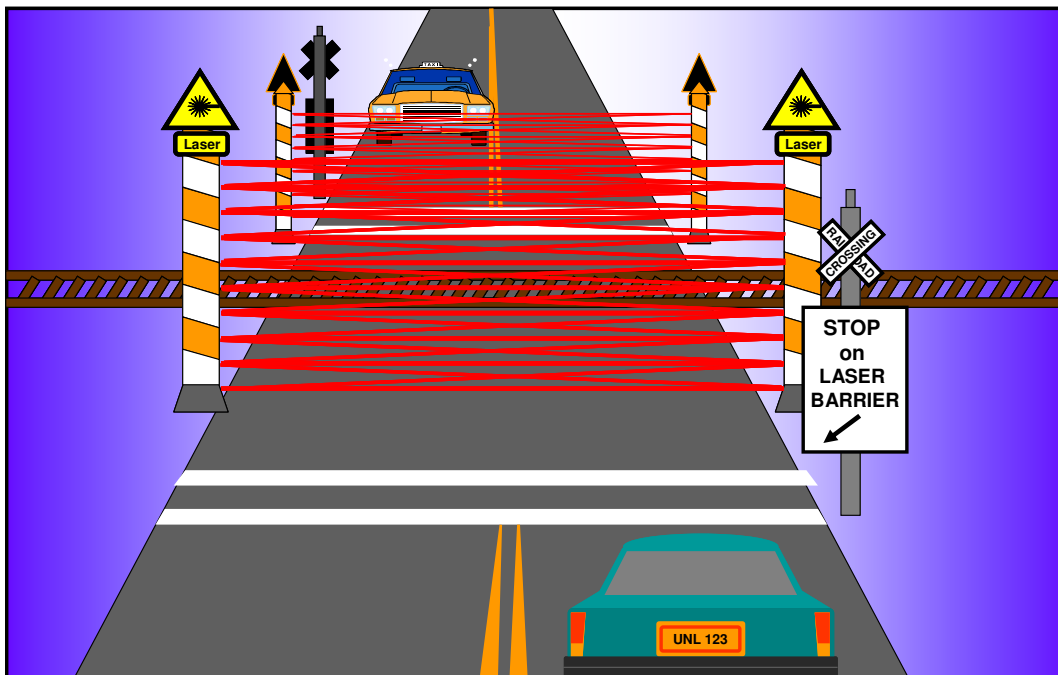


Figure 1 Proposed Optical Laser Barrier Wall at Railroad Crossing

But, wait a minute... will this so-called virtual **laser barrier** system be very costly and also harmful to human beings? You will find the answers to the questions in the following sections.

The System

The virtual **laser barrier** system consists of 2 major components: 1) laser projectors and mirror boxes, which are the key parts of this device. One or two low power, visible lasers can irradiate in a continuous or pulse mode and form multiple beams in the two parallel mirror boxes. Due to the diffraction of dust, a barrier of bright laser beams will appear. A second major component would be an audio device providing a sound alert. If the pedestrians and vehicles go beyond the warning line and break through the light beams, an audio system installed on a pole will be triggered and produce a sound alert to trespassers like many other security systems do. These two components can be integrated on a vertical pole. Each side of the railroad crossing is installed with a pair of two poles, one on each side of the road (as shown in Figure 1).

When a train is approaching the railroad crossing, the laser projectors on the two poles are activated and start transmitting visible light beams to each other. Once the train passes the railroad crossing, the laser projectors are deactivated and the laser barrier disappears immediately. Although the virtual barrier does not physically block the railroad crossing when drivers intentionally drive across the barrier, the laser wall could significantly affect drivers' behavior, some may feel obliged to make a stop.

Safety

Some people may tend to think that a laser is dangerous and will cause injury. The fact is that some lasers are operationally safe and have been used for many commercial products in the market such as bar code scanners, laser pointers and laser liners [9].

The visible lasers to be used in the railroad warning/protection device applications must be controlled in a low energy and safe class as well as test proven so that it does no harm to motorists when viewing it or breaking through it. According to the laser safety standards (ANSI Z136.1) [10], Class IIIa lasers normally would not cause injury to the eye if viewed momentarily. A typical choice of such a laser is a helium-neon (HeNe) laser which irradiates a red light under 5 mW. It suffices the requirement on the brightness of the laser beams and guarantees the operational safety.

Cost

When we talk about lasers, the first impression of them may be that they are high-tech and extremely costly. However, in this case, the cost might be the advantage of a laser barrier system. A visible 5 to 10 mW HeNe laser is under \$500 in the market. It's proven to be stable and long lived. If adding the electrical controls and mirror boxes, the total cost might not be above \$2000. Due to the low power consumption and simple configuration, the cost of daily operation and maintenance is also low. It is believed that this proposed optical barrier device could be a potential low-cost high-tech product to be implemented at passive railroad crossings in the future. It is a simple and easy to install solution.

Compared to the traditional crossbuck or stop sign at passive crossings, it is highly visible, especially at night, and it is hard to be ignored by motorists or pedestrians. Technically, it could provide as good a warning as flashing lights with added advantages of "blocking" the railroad crossing during the train's approaching and passing time, which will eliminate the risk that drivers may take to beat the train before it arrives. When the device is installed in place with a two-arm gate system, it adds another layer of barrier which may reduce the accidents caused by motorists driving around the gates. This device can also be installed at the pedestrian foot path to keep people from getting into

the rail track when a train is approaching.

INTELLIGENT RAILROAD CROSSING USING ITS TECHNOLOGIES

The advancement in sensor technologies and digital data link communications has created many cutting edge Intelligent Transportation Systems (ITS) applications that could potentially improve safety and mobility of the transportation network. Looking forward, the ultimate solutions for railroad crossing safety will be the intelligent grade crossings integrating ITS technologies and the Positive Train Control (PTC) systems. Many roadway ITS applications such as vehicle detection, GPS tracking, intersection collision avoidance, in-vehicle sensing, and advanced traveler information systems could all be applied at railroad crossings to enhance safety.

The main components of an integrated intelligent railroad crossing include advance detection devices, roadside warning /information display devices and on-board alert devices. Digital data link communication networks and Dedicated Short Range Communication (DSRC) will make these devices “talk” to each other in real time. A traffic control center serves as a central hub to monitor the conditions and direct information flow.

Detection Devices

Detection of train presence, actual travel speed and length information is important for determining the most appropriate time for activations of automated gate system and roadside warning devices. A variety of non-intrusive roadway vehicle detection sensors using different technologies such as video, radar, acoustic and magnetic sensors have been installed on freeways, major arterials and intersections. Sensors can collect vehicle presence, speed and classification information with high accuracy. The applications of sensors on train speed and length detections need to be explored. One potential area of development for such sensors could be that certain travel time prediction algorithms are

programmed in the sensor so that the train arrival and passing time information can be automatically generated from the sensor and sent to the traffic control center, and motorists and roadside information display devices. Besides the non-intrusive detection technologies, GPS devices on trains also provide train location and speed information.

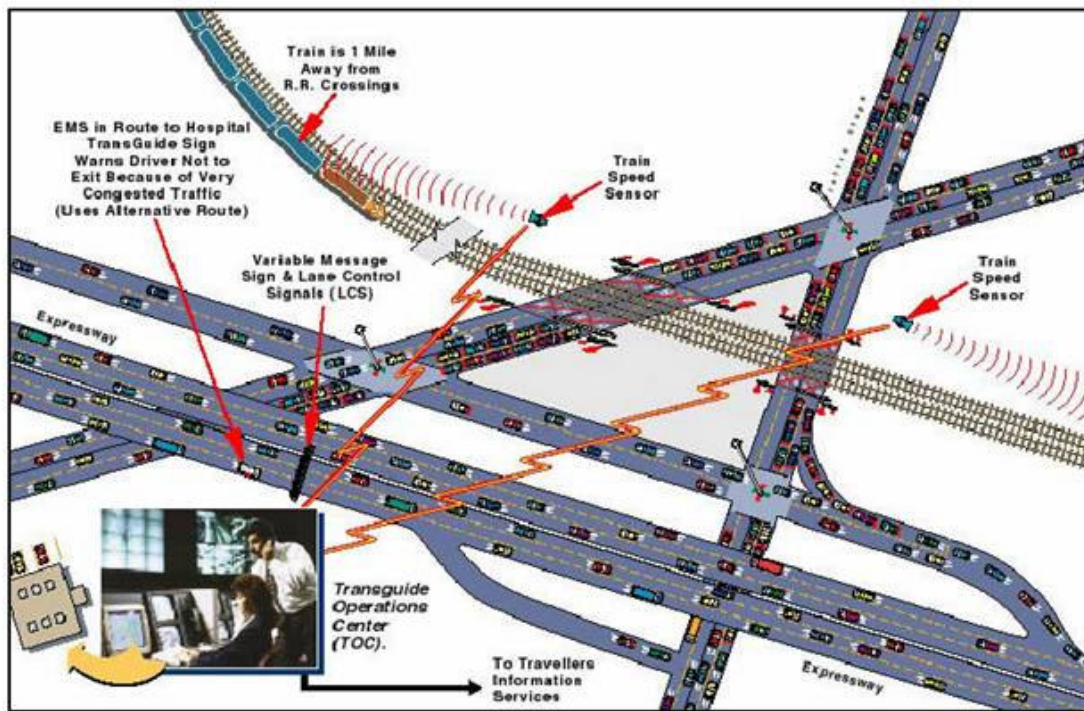
Sensors detecting the presence of vehicles and obstacles are also essential at railroad crossings. Whenever there is a stalled vehicle or an obstacle blocking the intersection, the sensors will detect it and send information to train operators and the traffic control center so that immediate actions can be taken. This task can be performed by video detection sensors and can also be used for illegal crossing enforcement.

Warning/Alert /Information Display Devices

Typical roadside information display devices are dynamic message signs placed approaching the railroad crossing to provide train arrival time and waiting time information to motorists and pedestrians. Alternate route information and second train warning messages can also be displayed. System developers may look into the following areas of improvement to extend the existing traffic information advisory message signs to train-activated railroad crossing message signs: high visibility, ease of installation, and low power consumption.

In-vehicle message display devices and audio alert devices are other potential means of receiving train warning information. A RFID (Radio Frequency Identification) tag installed on a vehicle and a train can receive message alerts sent from roadside infrastructure via Dedicated Short Range Communication. In this way, both motorists and train operators are kept alert about the status at railroad crossings. The train arrival or delay information can also be provided as a kind of cell phone messaging service to motorists and pedestrians who frequently pass certain railroad crossings.

An architecture for railroad crossings was developed as part of the ITS National Architecture, and work on the development of standards for intelligent grade crossings has begun to insure that there will be national interoperability. Demonstrations of intelligent grade crossing devices have been conducted in eight states [11]. Figure 2 shows a conceptual overview of the San Antonio Advanced Warning to Avoid Railroad Delay (AWARD) project which illustrates the idea of using ITS technologies at critical railroad crossings to enhance traffic mobility [12].



Source: <http://www.transguide.dot.state.tx.us/mdi/AWARD.html>

Figure 2 Conceptual View of AWARD Project

CONCLUDING REMARKS

Many state DOTs and railroad authorities are struggling with the safety challenges posed by railroad crossings. While the optimum solution is the separation of the highway-rail intersection; the high cost of upgrading makes the plan infeasible particularly in states with high numbers of railroad crossings and high volume crossings. More effective

warning and barrier systems at grade crossings as well as alert devices on trains and in motor vehicles can be used to mitigate ongoing safety concerns and costs to society as a result of delays and accidents at railroad crossings. Looking into future, ITS technology solutions will bring us safer and more efficient railroad crossings. However, to make all these things happen, a joint effort needs to be made between the DOTs and railroad authorities to take proactive responsibility. Standards, guidelines and testing procedures also need to be developed.

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