Advancing Pedestrian Safety at Rail Grade Crossings

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ABSTRACT

Contrary to the declining number of fatalities due to train-vehicle collisions at highway-rail grade crossings, the number of pedestrian and bicycle fatalities at highway- and pathway-rail grade crossings has remained relatively unchanged in the last ten years. While engineering solutions and education and enforcements initiatives have been proposed and implemented, little is known as to their effectiveness to mitigate such incidents. This paper reports on findings from the literature and discussions with professionals in the public and private sectors involved in safety at rail grade crossings. The paper highlights the multitude of factors related to pedestrian safety in this context, and provides an informed discussion for researchers and practitioners involved in advancing safety initiatives.

Keywords: safety, pedestrians, non-motorists, rail grade crossings
INTRODUCTION

In the United States, despite a 69% reduction in road-rail crossing accidents from 1978 to 1994, hundreds of fatalities still occur every year, resulting in economic losses amounting to more than US$1 billion in medical costs, insurance payments, legal fees, and damages to railroad property (1). Goldberg et al. (2) calculated that the annual direct cost to society in the United States exceeded $300 million annually. In addition, indirect costs – medical costs, insurance payments, legal fees, and damages to property – must push such estimates into billions of dollars, not to mention the human tragedy that each accident represents.

In contrast to the declining number of fatalities due to train-vehicle collisions at highway-rail grade crossings, the number of non-motorist fatalities at rail grade crossings remains relatively unchanged. Indeed between 1994 and 2007, incidents at highway-rail grade crossings declined 44%. However, between 2003 and 2007 the number of pedestrian incidents remained unchanged (3).

Clearly, pedestrian crossing incidents occur in different settings requiring the coordination of different stakeholders with context sensitive solutions. For example, incidents involving violations at rail grade crossings are different than trespassing incidents away from such crossings. Even more, pedestrian crossing incidents at exclusive pedestrian crossings (including rail stations) are different than those occurring at highway-rail grade crossings. Furthermore, incidents in crossings with commuter rail or light rail would require different countermeasures than those occurring in crossings with freight rail. In addition to pedestrians, pedestrian crossings serve other types of non-motorized users including cyclists and wheelchair users, although cyclists may mostly travel on the main highway as opposed to pedestrians and wheelchair users on the sidewalk. Other types of users include pedestrians on skateboards, rollerblades and equestrians.

This paper will examine a host of issues contributing to the difficulties associated with further reducing the number of pedestrian incidents at rail grade crossings. However, particular details about incidents and specific treatments for various types of pedestrian users in different environmental conditions will not be discussed.

In this regard, the paper will highlight thematic areas, specific issues and context sensitive countermeasures related to pedestrian safety at rail grade crossings based on literature findings and discussions with expert professionals in the public and private sectors. The objective of the paper is to offer an informed and focused discussion for researchers and practitioners involved with safety at rail grade crossings. Researchers
could treat the paper as a resource for important safety issues. Practitioners could also become better informed, especially by the discussions with their peers.

BACKGROUND

It should be noted that non-motorized incidents at rail grade crossings are not to be confused with incidents involving trespassers. Trespassers are individuals who are encroaching on railroad rights-of-way, private property at locations other than authorized grade crossings, including overhead and underground crossings. The Federal Railroad Administration (FRA) reports data in two sub-categories, suicide and probable suicide to explain an incident. Probable suicide is a classification that is subjective in nature based on a description of the trespasser’s activities. Based on a recent FRA survey, 23% of trespasser deaths are suicides or probable suicides (4).

Until recently, railroads were not required to report suicides that had been confirmed by a coroner or other public authority to the FRA (see Title 49 Code of Federal Regulations CFR Section 225.15). As a result, reported suicides inflate the trespass problem. Effective June 2011, railroads are now required to report suicides at crossings including the casualty count on the FRA forms 6180.55 and 6180.57 (USDOT/FRA, 2011).

LITERATURE REVIEW

In this paper unless otherwise noted, the term ‘pedestrian’ will be used to characterize all non-motorized users of rail grade crossings. The literature findings will discuss issues with trespassing, warning devices, accessible non-motorist signals, engineering, education and enforcement, engineering standards and guidelines, intelligent grade crossings, and cost considerations. Such issues have received considerable attention and remain central in the discussion of pedestrian safety.

Trespassing

Observations from both domestic and international studies seem to agree that pedestrians involved in trespassing fatalities were often under the influence of alcohol and/or drugs (5, 6, 7, 4), and predominantly male (5, 6, 8, 7, 4). Domestically, a national FRA study (4) analyzed 936 fatalities and revealed that the typical trespasser killed in a railway incident from 2002 to 2004 was 38 years old, male and Caucasian. Two-thirds of those were under the influence of alcohol and/or drugs.

Overall, in the same study, the gender split was 13 percent female. Moreover, 16 percent had Hispanic ethnicities. Trespasser fatalities were racially diverse, i.e., 78 percent White, 16 percent Black, 5 percent Native American, and 1 percent Asian. The study
also found that 23 percent of the fatalities could be described as a suicide. The authors conducted a market analysis to define the type of households and neighborhoods where these individuals would be most likely to reside. They identified neighborhoods that “are largely urban or suburban, relatively low-income and ethnically, culturally, and racially mixed neighborhoods with older, single-family housing units occupied by families slightly larger, but younger, than the general population.”

Silla and Luoma (9) investigated the effect of three countermeasures – building a fence, landscaping, and prohibitive signs – on the frequency of trespassing and the characteristics of trespassing behavior. The study found that each measure proved effective at reducing the instance of trespassing; however it was unable to differentiate the effectiveness between the measures. Trespassers continued to meet the demographic profile of the most frequent trespassers – adult men. The study also examined the characteristics of those trespassing after the implementation of the interventions and found that those who were carrying an object (such as a stroller, or walking a dog) were far less likely to trespass after the installation of a fence.

**Warning Devices**

An FRA report (10) on existing pedestrian safety devices at grade crossings discusses active and passive devices both in and not included in the Manual on Uniform Traffic Control Devices (MUTCD). Examples of devices illustrated include: audible/visual devices, such as low-rise flashing pedestrian signals and multi-use path flashing light signals; highly reflective passive warning signs; short gate arms; channelizing devices, such as different types of fencing, swing gates, and zigzag or Z-gates; and second-train-coming electronic warning signs. According to the report, various factors that should be examined during device selection include: (a) collision experience, if any, at the crossing, as it involves pedestrians; (b) pedestrian volumes and peak flows, if any; (c) train speeds, numbers of trains, and railroad traffic patterns, if any; (d) sight distance that is available to pedestrians approaching the crossing; and (e) skew angle, if any, of the crossing relative to the railroad tracks.

A study evaluating the effects of the installation of a train-activated signal intended to warn pedestrians when two or more trains are approaching a highway-rail intersection was conducted in Los Angeles by Khawani (11). The study found that the installation of the signal reduced the incidence of risky pedestrian behavior as measured by the time elapsed between the pedestrian entering the tracks and the arrival/departure of a train.

A “Second Train Coming” warning sign demonstration project was conducted by the Los Angeles County Metropolitan Transportation Authority (12). In that case, the pedestrian sidewalk crossed two light rail transit (LRT) tracks and two freight rail tracks. The study
found that the warning sign was effective in reducing risky behavior as measured by an overall 14 percent reduction in the number of pedestrians crossing the LRT tracks at less than 15 seconds in front of an approaching LRT train. Additionally, the number of pedestrians crossing the LRT tracks at 6 seconds or less before an LRT train entered the crossing was reduced by about 32 percent. Finally, the number of pedestrians crossing the tracks at 4 seconds or less in front of an approaching LRT train was reduced by 73 percent.

**Accessible Non-Motorist Signals**

Accessible pedestrian signals (APS) are devices that communicate information about pedestrian timing in nonvisual formats such as audible tones, verbal messages, and/or vibrating surfaces (MUTCD, Section 4A.01) (13). APS can provide information to pedestrians about the existence and location of the pushbutton; the onset of the walk interval; the direction of the crosswalk and location of the destination curb; the clearance interval; intersection geometry through maps, diagrams, or speech; intersection street names in Braille, raised print, or speech; and intersection signalization (14). Description of such features is given in the published guidelines by the U.S. Architectural and Transportation Barriers Compliance Board (15). Korve Engineering (16) found only limited research testing APS under field conditions and no additional research other than Blasch (17) comparing the effectiveness of different APS in normal traffic conditions. In addition, in the United Kingdom, Delmonte and Tong (18) conducted a comprehensive analysis to identify solutions for improving safety and accessibility at level crossings for disabled pedestrians.

**Engineering, Education and Enforcement**

Under the Rail Safety Improvement Act of 2008 (P.L. No. 110-432), the U.S. Department of Transportation has developed model railroad trespassing, vandalism, and highway-rail grade crossing warning device violation prevention strategies to assist State and local governments, and railroads. These strategies fall under three broad categories: 1) expanding educational outreach, 2) energizing enforcement, and 3) fostering engineering and sight improvements. Educational outreach involves public awareness programs helping non-motorists to safely navigate grade crossings. Consistent enforcement of traffic safety laws by State or local police, and a sustained effort by the courts to impose penalties on violators, discourage and deter non-motorists from making poor decisions at grade crossings. A recent report has published the latest compilation of state laws and regulations affecting highway-rail grade crossings (19). Moreover, engineering improvements greatly reduce or prevent the potential for non-motorist-train collisions (20).
The Illinois Commerce Commission (ICC), and the FRA initiated the Public Education and Enforcement Research Study (PEERS) to measure the before and after change in the public’s adherence to traffic safety laws (27). The study demonstrated a reduction in crossing violations and a dramatic reduction in the most dangerous pedestrian behavior.

Internationally, a study of a suburban railway crossing in Auckland, New Zealand (22) looked at education and environmental interventions targeted at reducing illegal and unsafe crossings. The interventions included repair and treatment of fences along the corridor, educational talks given to workers at nearby factories and students at nearby schools, distribution of leaflets indicating the safety risk of the crossing, and new warning signs indicating the illegality and danger of crossing. The study found that subsequent to the interventions, there was a significant and sustained decrease in illegal and unsafe crossings.

In addition, a study of interventions at a school in Auckland, New Zealand (23), examined the effect of a public awareness campaign, education, continuous punishment and intermittent reinforcement, and intermittent punishment and intermittent reinforcement. The study found statistically significant decrease in unsafe crossings for three of the four interventions. The study did not find any significant reduction in unsafe crossings from the public awareness campaign.

### Engineering Standards and Guidelines

The Federal Highway Administration’s Railroad-Highway Grade Crossing Handbook (24) provides guidance about pedestrian crossings. Additional guidance is provided by the MUTCD (13, Part 8), American Railway Engineering and Maintenance of Way Association (AREMA) Communications & Signal Manual (25), and Code of Federal Regulations 49 (Part 234). In addition, the FHWA’s Handbook identifies pedestrian crossing treatments and provides recommendations for flashing light signals, second train coming signals, dynamic envelope markings, pedestrian automatic gates, swing gates, bedstead (maze) barriers, z-crossing channelization, and combined pedestrian treatments.

Different standards apply to at-grade crossings of light rail transit (LRT). LRT has at least five different categories of operational alignments all of which have criteria for the type of warning systems needed at intersections based on the maximum operating speeds. Usually at speeds under 35 mph, LRTs use the existing street traffic signal controls in conjunction with priority and preemption controls (26). At speeds above 35 mph Active Warning Railroad systems are used in conjunction with adjacent traffic signal controls (27). Additional guidelines for improving pedestrian and motorist safety along LRT alignments are reported in (28).
At the state level, in California, CalTrain developed their own design criteria regarding grade crossings and began implementing them in 1999 (29). These standard practices utilize active warning devices similar to those at vehicular crossings: signal equipment modified from that of vehicular crossing, crossing gate arm, and a crossing configuration which channels pedestrians. Different design criteria apply for pedestrian crossings in general regarding warning time, center fence, warning devices, safety buffer zone, warning assemblies, gate recovery, as well as pedestrian crossings at stations, at stations and roadway, and crossings between roadway crossings.

In addition, also in California, the SCRRRA (aka Metrolink) Highway-Rail Grade Crossings Recommended Design Practices and Standards Manual (30) is a comprehensive single document that incorporates current and applicable highway-rail and pedestrian-rail grade crossing design standards and recommended design practices. Regarding pedestrian rail grade crossings, the manual finds that pedestrian treatments work well with proper channelization and signs, as well as sidewalks on either side of tracks and/or through the track area. Moreover, pavement striping continued across the track portion of roadway is a good visual and effective. In addition it is important to add extra pedestrian treatments near stations for riders running to catch trains. Finally, the manual provides a decision tree to determine the designs of pedestrian-rail grade crossings and appropriate warning treatments.

The American Public Transportation Association (APTA) provides guidance for rail transit systems for selecting, installing and operating highway rail transit grade crossing warning systems and includes minimum requirements for highway rail grade crossing warning devices, highway traffic signs and other highway traffic control appliances (31). Particular recommendations are made for pedestrians at rail grade crossings.

The California Public Utilities Commission (CPUC) has published extensive design guidelines for pedestrian-rail crossings within the state of California (32). Their review of design considerations and installations includes recommendations for swing gates, detectable warnings, and pedestrian gates, flashing light signal assemblies, signage, crossing surfaces, channelization design and other treatments. Signage must conform to the state MUTCD. The report makes a particular reference to the Transportation Research Board’s TCRP Report 69 Section 3.8.3 (27) which provides a decision tree as a tool to determine appropriate pedestrian-rail at-grade crossing treatments. The tool has been adopted by TriMet in Portland, Oregon but otherwise has not been validated by research (private communication with Brent Ogden, one of the co-authors of the study, 11/17/2011). In addition, a risk-scoring methodology to evaluate safety factors at station pedestrian crossings is in use in the United Kingdom (33).
A risk-assessment methodology for pedestrian grade crossings is part of the Australian Level Crossing Assessment Model (ALCAM) still under development (34, 35). The model is an assessment tool used to identify key potential risks at level crossings and to assist in the prioritization of railway level crossings according to their comparative safety risk. ALCAM uses a scoring algorithm which considers each level crossing’s physical properties (characteristics and controls) including consideration of the related common human behaviors, to provide each level crossing with a "Likelihood Factor" score. This score is then multiplied by the level crossings "Exposure" score (a factor taking into account the volumes of Vehicles / Pedestrians & Trains) & finally multiplied by the Consequence score (which is set to be one for pedestrians) to give the ALCAM Risk Score.

The ALCAM model is designed to apply for both active and passive grade crossings, whereas the Risk Assessment of Accident and Incident at Level crossings (RAAILc) model can be used for predicting accidents at passive level crossings only. A review by Little (36) has categorized ALCAM under a simple weighted factor, and RAAILc as a statistically driven approach. Note that the ALCAM model is different than the All Level Crossings Risk Model (ALCRM) that was developed in the United Kingdom and was categorized as a complex weighted factor model in the same review by Little (36). In his 2007 review, Little found only four operational models that take into account the number of pedestrians using the crossing (36). Newer approaches based on simulation methods such as Petri nets are still developing (37).

**Intelligent Grade Crossings**

Interesting new developments in the area of Cooperative Intelligent Transportation Systems (ITS) may bring to bear applications that could dramatically affect safety for non-motorized users in grade crossings in the not so distant future. Vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle to consumer devices (V2D) are being developed to deliver more safety mobility benefits. Pedestrians and non-motorized users, in general, at rail grade crossings will be able to receive personalized advance warning of incoming trains in time to avoid injuries and fatalities.

**Cost Considerations**

The cost breakdown (2000 U.S. dollars) of the “Second Train Coming” warning sign demonstration (12) included: (a) $15,000 for the “Second Train Coming” sign; (b) $80,000 for the sign installation including track circuit modification and camera equipment; (c) $35,000 for project management and engineering; and (d) $70,000 for project evaluation.
An example of an off-the-shelf technology using motion sensors, video cameras, and infrared lighting was used in Pittsford, New York to deter trespassing on a rail bridge over the Erie Canal is presented in daSilva et al. (38). The system was installed in August 2001 and evaluated over a 3-year period ending in August 2004. The Federal Highway Administration (FHWA) calculated the value of a human life to be equivalent to $3 million, in terms of 2002 U.S. dollars (39). The benefits gained from using this prototype system can be stated as “up to four lives or serious injuries saved in 3 years,” based on the two close-call events within the evaluation period detailed above. Using these values, savings of up to $12 million over 3 years could be achieved. In contrast, the system cost approximately $213,000 (prototype cost), with an annual maintenance and operation expense of under $13,000.

The cost of the trespasser-deterrent prototype system in daSilva et al. (38) includes design, installation, component, maintenance and operating costs (in 2002 U.S. dollars). The component costs were approximately $13,500, the operating costs $5,000 per year, and the maintenance costs $10,000 per year. The design and installation costs were approximately $200,000 which can be reduced to $40,000 per site during an implementation phase.

Roop et al. (40) argue that likely candidate technologies that can reduce active warning costs at highway-rail crossings are those with significantly lower installation costs. In a fully redundant system, installation is one of the largest cost items of systems now in use, ranging from 25 to 35 percent of the total system cost.

Cost figures provided by SafeTran Systems (41) about the cost of active warning systems provide a component breakdown showing, among other things, that for a fully redundant system, installation (labor) is one of the largest cost components, ranging from 25 to 35 percent of the total system cost (for Class I railroads). Train detection, on the other hand, may only comprise 20 to 25 percent of the total cost – and train detection is where most people think the economies are to be achieved.

FOCUS AREAS FOR IMPROVING PEDESTRIAN SAFETY

We conducted telephone interviews of experts in rail crossing safety from both the public and private sectors using structured questionnaires that were based on findings from the literature. In the public sector, we spoke with two USDOT and 25 experts at state Departments of Transportation and public utility commissions with jurisdiction over transportation and rail crossings. In the private sector, we spoke with eight professionals who have had a long tenure consulting on railroad level crossing safety.
The discussion below reflects the information obtained from these conversations. It will focus on several general themes that we believe emerged from these interviews, which in turn, seem to raise a number of issues regarding safety at pedestrian-rail highway grade crossings. Some of the issues presented have already been recognized in research workshops among national and international experts (42). Other issues presented are not encountered regularly at public forums. Nevertheless increasing the awareness of stakeholders in the thematic areas and issues below could only help advancing pedestrian safety at rail grade crossings.

Prioritization of Safety Upgrades

Safety upgrades are usually prioritized based on a diagnostic review process that examines a number of criteria (e.g., number of tracks, engineering design, number of trains, train speed, etc.), but decisions are usually based on a consensus among relevant stakeholders representative of all groups having responsibility for the safe operation of crossings (24) rather on a formal cost-effectiveness methodology. However, safety upgrades at dedicated pedestrian crossings are not prioritized as highly as those at rail-highway grade crossings unless these two types of crossings are adjacent to each other (e.g., adjacent sidewalks on one or either side of a rail-highway crossing extending to the other side of the tracks).

Engineering Standards

States with substantial passenger, commuter and freight rail operations are leading the effort to develop guidelines and engineering standards for safety improvements. Moreover, it is likely that pedestrian safety at rail grade crossings will benefit in the longer term by the increasing consistency in standards for warning devices and treatments among organizations responsible for this task. As an example of standards consistency, the definition of advance preemption in MUTCD looks the same as the one in AREMA and ITE documents as well as in APTA standards.

The requirement for extra warning time for pedestrians and motorists in grade crossings of high speed rail operations is emerging as an additional issue for safety upgrades at such crossings. Currently, the typical warning time at crossings where pedestrians may be present is between 20 and 30 seconds for conventional speed trains. In an environment with 110 mile an hour trains there would be a need to provide confirmation signals to the train crew and the onboard computer that the crossing is clear likely requiring a warning time of at least 80 seconds. The question about how pedestrians will react to such extended warning times at pedestrian crossings remains to be determined. This is because currently most of the warning time is built into the time that the train occupies the crossing. When high speed trains begin to operate most of the warning time
is going to be built into the time for the train approaching the crossing. Therefore, there
would be an extended warning time where the crossing remains unoccupied while a high
speed train cannot even be seen on the horizon. This situation will require “reeducation”
of the public, especially in areas where crossings are very near to each other.

Reliability of Cost Estimates

Cost estimates and/or actual costs of the warning systems already installed are not readily
available despite federal requirements, under the Safe, Accountable, Flexible, Efficient
Transportation Equity Act: A Legacy for Users (SAFETEA-LU) program (formerly
known as “Section 130”), to the contrary. This is probably due to the fact that such funds
are usually absorbed into much larger projects (e.g., grade separation). Moreover, a cost
breakdown for design, installation, component maintenance, and operating costs is rarely
finalized considering the actual costs keep changing as they move from the planning
stage, to the design stage, to the design & build stage. Additional reasons are presented
elsewhere (40).

Such difficulties, in addition to lacking dedicated funding for cost-effectiveness studies,
result in the general lack of cost-effectiveness information of pedestrian safety
treatments. On the other hand, given that the number of fatalities at grade crossings is
relatively low it would be very difficult to assign a cost-effectiveness value to a particular
treatment. In any case, cost oversight from state departments of transportation may be
needed to effectively manage targeted funding for grade crossings safety improvements.

Funding Availability

The vast majority of funding available for safety improvements is programmed for rail-
highway crossings, and very rarely exclusively for dedicated pedestrian grade crossings.
It would be critical that Section 130 funding remain exclusive to railroad safety and not
rolled back with other highway funds. Continuing this source of support would help
maintain the level of expertise for rail safety at the FRA as well as state departments of
transportation.

Selection Criteria

A number of criteria are used for the selection of warning devices for deployment at
pedestrian-rail grade crossings including: pedestrians collision experience at the crossing,
frequency of inclement weather, pedestrian volumes and peak flows, train speeds,
numbers of trains, and railroad traffic patterns, surrounding land-uses, sight distance for
pedestrians approaching the crossing, skew angle of the crossing relative to the railroad

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tracks, multiple tracks, vicinity to a commuter station, and installation/maintenance costs.

Furthermore, to discourage trespassers at or in the vicinity of grade crossings, communities apply fencing, landscaping, prohibitive signs, video monitoring, education/outreach, and enforcement.

However, very few existing methodologies allow for assessing trade-offs between these factors during the selection process (e.g., similar in functionality to the FRA’s Accident Prediction Formula), and the potential of newer approaches is not well understood. Despite the absence of a formal cost-effectiveness evaluation process, in practice the process is realized as a consensus-building exercise among the diagnostic team members.

A way to formalize this process would be to ask, first, whether the particular crossing under consideration may be closed or consolidated with neighboring crossings. This is an important decision because a crossing closure may be helpful to limiting the number of automobile exposures but is nearly ineffective in limiting pedestrian exposures. Unless additional treatments to prevent pedestrian use are done pedestrians would likely continue to cross where they always have, except now as trespassers. Once such considerations have been resolved then the process would continue by examining the cost of various safety treatment options available versus the expected benefits.

Lack of Accessible Pedestrian Signals

The lack of Accessible Pedestrian Signals at pedestrian-rail grade crossings is mainly due to the shortage of dedicated funding for such crossings. Such signal treatments need not convey the type of messages needed in regular intersection street crossings with more complicated traffic patterns. Occasionally, there are situations in grade crossing improvement projects where certain options are not available. For example, in the absence of adequate right of way, it usually becomes impossible to produce accessible sidewalks of the proper ADA width. Another reason for the infrequent use of accessible signals (other than detectable strips and detectable yellow tiles just ahead of the pedestrian gates) at rail grade crossings is the lack of standardization among manufacturers.

Education and Enforcement Campaigns

Strong local advocacy is probably the most important factor other than adequate funding availability behind effective education, outreach and enforcement safety campaigns at pedestrian-rail grade crossings. Moreover, such campaigns should continue unmitigated with additional service improvements in different geographic locations. Furthermore, campaigns for light rail grade crossing safety can be relatively more effective with the
active participation of a transit agency and a captive local audience exposed to the frequency of transit operations.

In 2003, the Operation Lifesaver (OL) organization has issued a draft “Community Trespass Prevention Guide” that was published in its final form under the title “Trespassing on Railway Lines – A Community Problem-Solving Guide” by the Direction 2006 partnership in Canada (43). The Community Trespass Prevention Program incorporates a problem-solving model designed to provide a step-by-step approach for dealing with trespassing issues in communities. Development of this program and its supporting materials is based on actual community problem solving projects. The Volpe Center used the guide developed as a baseline strategy to initiate a three-year research project, which started in July 2009 and is expected to report on findings in the near future. The methodology is centered on working with the South Florida Regional Transportation Authority (SFRTA) stakeholder partnership to demonstrate potential benefits, including documenting best practices and lessons learned, of implementation and evaluation of trespass prevention strategies on the rail network in West Palm Beach, Florida and all of its rights-of-way.

Risk Management

There is no consistent approach for managing the risk at pedestrian-rail grade crossings that could assure: (a) the uniformity and continuity of data collection programs and administration of related databases on all such crossings; (b) the analysis of risks at such crossings; (c) the prioritization of crossing upgrades; (d) the introduction of suitable risk controls; and (e) the assessment of cost effectiveness of such measures. Perhaps the FRA could promote a national campaign to this end with all states committing to the approach.

Experts seem to agree on a five-point program of risk management (affectionately called the five ‘Es’ – ‘Engineering’, ‘Education’, ‘Enforcement’, ‘Enabling’ and ‘Evaluation’) to increase safety at pedestrian (and vehicular) rail grade crossings. The first three ‘Es’ have been key underlying principles of Operation Lifesaver in the USA. ‘Enabling’ was added during the formation in Britain of the National Level Crossing Safety Group (NLXSG) in 2002, and is concerned with providing resources, people and systems to facilitate progress with improving level crossing safety (44). ‘Evaluation’ was added more recently, and has become of particular interest in Europe where attention is being paid to developing common reporting methods for level crossings (i.e. types of crossings, numbers and risk measurement), and being able to measure the effectiveness of programs. Little (2007) defined these five ‘Es’ as follows:
• Enabling: The provision of resources through people, procedures, and systems to allow the other ‘Es’ to be effective.
• Education: Increasing public awareness of the dangers of crossings and educating pedestrians, road vehicle drivers and other users how to use them correctly.
• Engineering: The protection fitted to level crossings through lights, horns, barriers, telephones and signs together with research into innovative means of increasing safety.
• Enforcement: The use of laws to prosecute those who endanger themselves or others by misuse of crossings.
• Evaluation: The idea as envisaged by the NLXSG is to encourage organizations to set a baseline before embarking on new initiatives so that the before and after can be properly compared.

It appears that the majority of the research focusing on mitigating the risk for non-motorized users at rail grade crossings has focused on the grade crossing risk as a potential cause of train accidents rather than the individual risk to such users. However, the level of risk to which an individual is exposed is a key consideration in the safety management process, but is not explicitly part of the criteria applied to deciding about whether or not to implement an action to improve safety (45).

Public and Private Stakeholders Responsibilities

Determining the most suitable mix of safety upgrades at pedestrian crossings is a challenging issue complicated by the fact that regulatory authorities make the selection while the operating railroads are responsible for the installation and life-cycle costs. The public authority is interested to select the most robust technology available to maximize the public investment in the long run. On the other hand, the private railroad is looking to minimize the life-cycle costs of a technology that is likely to become obsolete before the end of its life and thus expensive to maintain.

Quiet Zones

Non-motorized users at grade crossings within quite zones may not receive safety benefits comparable to motorists. This is because, and this is only a conjecture at this point, supplemental safety measures (SSMs), such as gates and flashing lights are mostly focusing on motorists, while alternative safety measures (e.g., non-engineering elements such as public awareness campaigns or photo enforcement technology to increase driver and pedestrian awareness at grade crossings) may not be necessary for the establishment of a quiet zones if adequate SSMs have been installed. As a result, distracted non-
motorists may not be sufficiently alerted to an incoming train, especially when a second-
train is coming from the opposite direction.

**Trespassing Mitigation**

Trespassing is mainly addressed by public outreach and enforcement initiatives using
state, local and railroad resources. Intensity and sustainability of such campaigns varies
by locale as it usually requires a strong local advocate to maintain such efforts in the long
run.

Mitigation of trespasser activity in or around grade crossings as well as within the
railroad’s right-of-way may benefit by regularly publishing the information recorded by
railroad cameras in publicly available databases, if practical. A side benefit of such an
effort would be to help avoid location misclassification of incidents thereby supporting
the proper management of risk. Recent improvements in the geographical identification
of fatal trespassing incidents by the FRA will most likely facilitate this effort.

In the absence of video monitoring information, identification of trespassing ‘hot spots’
becomes a local issue that is best mitigated by frequent community enforcement and
stronger coordination between railroad police and local police departments. It would be
essential that the support of such initiatives be continued and perhaps intensified though
dedicated federal funding sources.

It would be very important that trespassing issues become a community affair and not
continue to be perceived as mostly railroad and thus private problems. Active
participation of the enforcement personnel and judicial system would be necessary to lead
the way in this direction.

**CONCLUSIONS**

The number of incidents between trains and non-motorist users at rail grade crossings has
remained relatively unchanged in recent years despite a noticeable parallel reduction in
the number of collisions between vehicles and trains at rail-highway grade crossings.
However, the reasons for such an outcome disparity are not well understood by both
researchers and practitioners. In this paper, we have identified several areas of concern
that have received attention in the literature. We have, additionally, received and
documented feedback from expert practitioners in the public and private sectors.

We anticipate that the discussion in this paper will inform researchers and practitioners
involved with pedestrian safety at rail grade crossings in a number of issues. First, as
consistency of engineering standards improves it would be important to monitor the
impact on pedestrian safety. Second, high speed passenger rail service will require re-
education of pedestrian users regarding safety impacts at or in the vicinity of or away
from grade crossings. Third, it is increasingly important to better track the programming
and the expenditure for safety upgrades at grade crossings. Fourth, there is a need to
develop a cost-effectiveness evaluation process to facilitate the activities of a diagnostic
team. Fifth, it is important addressing the needs of users with disabilities at grade
crossings to better manage the risk for catastrophic incidents. Sixth, continuation of
adequate funding for strong local advocacy toward education and enforcement activities
is critical to pedestrian safety. Finally, the development of an appropriate risk
management approach would better support the planning, programming and
implementation of safety upgrades at pedestrian grade crossings.

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