INTRODUCTION

As societies become more affluent their levels of mobility also increase. While greater mobility is to be encouraged, there are risks associated with travel. Measures need to be taken to decrease the propensity to incur accidents. This is a common practice in nations that have been motorized for many decades and transportation-related accidents and fatalities have been studied and modeled for decades.

The purpose of this paper is to examine the recent history of rail-highway accidents and to examine some of the steps taken to mitigate these incidents. The focus is on both national experiences in the United States and how the national experience relates to activities in the Chicago area. Specifically two items will be examined, (1) the efforts to decrease collisions at grade crossings in the Chicago Metropolitan area and (2) the experiences with vehicle arrest barriers (VABs) in moving toward high-speed train operations between Chicago and St. Louis.

BACKGROUND

For the last thirty years the United States has experienced a general decline in transportation-related fatalities (Table 1). This applies to highway-rail grade crossings, highways, pedestrians, general aviation, recreational boating and pedal cyclists (bicyclists). It does not apply to truck occupants; the number of fatalities among truck operators have more than doubled in thirty years. Much of this may be attributed to large increases in exposure levels. Overall passenger car kilometers increased by 38 percent while truck kilometers increased by 230 percent.
Table 1. Change in Fatalities by Mode, 1970-2000

<table>
<thead>
<tr>
<th>Mode</th>
<th>1970</th>
<th>2000</th>
<th>Percent change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck occupant</td>
<td>5.817</td>
<td>12.280</td>
<td>+111.1</td>
</tr>
<tr>
<td>Motor cycle</td>
<td>2.280</td>
<td>2.897</td>
<td>+27.1</td>
</tr>
<tr>
<td>Pedal cycle</td>
<td>760</td>
<td>693</td>
<td>-8.8</td>
</tr>
<tr>
<td>Highway**</td>
<td>52.627</td>
<td>41.945</td>
<td>-20.3</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>8.954</td>
<td>4.763</td>
<td>-46.8</td>
</tr>
<tr>
<td>Recreational boating</td>
<td>1.418</td>
<td>701</td>
<td>-50.6</td>
</tr>
<tr>
<td>General aviation</td>
<td>1.310</td>
<td>593</td>
<td>-54.7</td>
</tr>
<tr>
<td>Highway-rail crossing</td>
<td>1.440</td>
<td>425</td>
<td>-70.5</td>
</tr>
</tbody>
</table>

Population increase by 38% during this period, VKT by 145%

* Includes truck occupants and motor cycle fatalities


The trends are not monotonic with periodic upswings or downswings. Most recently, after many years of decline from over 5,000 in 1980 to 2,116 in 1997, motorcycle fatalities have increased and have accounted for increases in total highway fatalities when non-motorcycle fatalities have declined. In fact just the increase in annual motorcycle fatalities from just 1997 to 2001, more than a thousand, is more than twice the annual fatalities at highway-rail crossings.

Perhaps most encouraging is that much of this discussion has centered on the decrease in the number of fatalities, at a time that population and travel have steadily grown. Highway fatalities per million vehicle kilometers in the U.S. are an excellent example of a negative exponential relationship, declining 50% every twenty years. For rail-highway fatalities the decline is also dramatic but it is much more difficult to compute a comparable statistic.

There are numerous reasons for the decline in fatalities at highway-rail crossings. Using a negative binomial regression analysis Mok and Savage (2004) found that nationally the increase in highway traffic (VKT) has contributed substantially to increases in fatalities while there are other factors that contributed to a decrease in fatalities. General improvements in highway safety seem to be the most important factor accounting for a saving of over three hundred lives (Table 2). This includes enhancements in automobile technology and more rapid and improved medical responses to accidents. Other contributing factors include ‘Operation Lifesaver’ and continued installation of warning devices at rail crossings. These two factors together appear to be as important as improved highway safety. Operation Lifesaver is the product of a non-profit organization promoting railroad safety education and is assessed as a dummy variable in the regression model. Improved warning devices, typically installing gates, can be traced to Section 130 of the Federal Highway Act of 1973 that has allocated over $6 billion dollars to improve rail crossings over the last thirty years.
Table 2: National Factors Contributing to Changes in Fatalities, 1975-2001
(decrease of 471 fatalities and probable reasons)

<table>
<thead>
<tr>
<th>Action</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crossing closures</td>
<td>-53</td>
</tr>
<tr>
<td>Increase road traffic</td>
<td>+166</td>
</tr>
<tr>
<td>Active warning devices</td>
<td>-155</td>
</tr>
<tr>
<td>Improved highway safety</td>
<td>-329</td>
</tr>
<tr>
<td>Operation Lifesaver</td>
<td>-171</td>
</tr>
<tr>
<td>Minor factors</td>
<td>+20</td>
</tr>
<tr>
<td>Unexplained</td>
<td>+91</td>
</tr>
<tr>
<td>Total</td>
<td>-471</td>
</tr>
</tbody>
</table>


The evidence presented in Tables 1 and 2 do not call for an immediate and dramatic change in the course of action taken at highway-rail crossings. Table 1 shows that fatalities have decreased dramatically and Table 2 suggests that improved highway safety has translated to fewer highway-rail fatalities. Clearly there is room for further improvement. Active warning devices should be installed where increased traffic warrant. While it cannot be argued that saving lives is not a worthy goal, policy decisions always need to be taken based on prospective alternatives. Perhaps motorcycle safety or drunk driving could be more lucrative targets than highway-rail crossings and the rest of the discussion in this paper should keep this in mind when evaluating appropriate action.

HIGHWAY-RAIL CROSSINGS IN THE CHICAGO AREA

The Chicago’s metropolitan area encompasses thirteen counties and includes three states (Wisconsin, Illinois and Indiana). For political reasons much of the planning and analysis in the region includes only the Illinois portion and for historical reasons the collision data examined cover a six-county region that constituted the Chicago metropolitan area until the 1980s. This six-county area includes over 8 million inhabitants and is sufficiently large and diverse to justify special attention. It constitutes a major portion of the national economy and more importantly the national railroad activity. Its population and GDP exceed that of roughly half of the countries in Europe. Moreover, since Chicago is the largest hub in the national railroad network, a high portion of the national freight traffic passes through the region. It has over a dozen commuter rail lines and is the largest hub in the Amtrak network.

Like other branches of US DOT, the Federal Railroad Administration (FRA) has been on a mission to decrease railroad-related accidents and fatalities. The FRA action that most effects the Chicago area is the proposed rule to address gated highway-rail crossings. These are crossings at which a long arm (gate) is lowered to prevent vehicles and pedestrians from proceeding when trains approach. Accidents can occur when pedestrians or vehicle operators ignore the gates and pass around them or if they stop on the tracks before the gates are lowered (the analysis in this paper only considers collisions between vehicles and trains). In most of these cases a collision could have been avoided.
The FRA has concluded that nationally gated crossings where locomotives do not routinely blow their horns have a 68 percent higher collision rate than gated crossings where horns are routinely used. They recognized that the Chicago area is a substantial part of the national rail network and deserves special attention. Their analysis focused on the Chicago area finds that at crossings where locomotive horns are not routinely used have 17 percent higher rates than crossings were they are routinely used. The FRA constructed numerous models and advanced the 17 percent as the most appropriate goal for reduction in fatalities.

Unfortunately the regression coefficient that yielded the 17 percent figure was not significant (significant at the 0.31 level). Such a conclusion is not sufficiently compelling to Chicago area policy makers to allocate scarce safety resources to highway-rail crossings. Given the impact of the pending FRA rule on the Chicago area it is essential that it be based on sound statistical work.

We therefore used the same data to try to verify the FRA results and to ascertain whether another model may fit the data better, with significant results. All our models use the FRA's Accident Prediction Formula (APF) as a vital aspect of the analysis. The APF is a long-standing effort to estimate the probability of a collision at rail crossings and is based on a substantial national database. The data are so extensive and comprehensive that some of the numbers are subject to challenge either due to the variety of organizations that tallied and reported the data and the timeliness of the information. The characteristics of highway-rail crossing change periodically and the data may not be adequately updated. Nevertheless APF is based on the most current available data and are consequently used by both the FRA and us.

We constructed six models and found that all of the models showed a lower rate than the 17 percent level advanced by the FRA. One of the models had a statistically significant result and in that case the figure was a negative, indicating that crossing where horns are not routinely used had lower collisions rates. Perhaps the result is counterintuitive but some conjecture that since most Chicago area motorists routinely encounter trains at rail crossings they respect trains and are not as likely to take chances, as might be the case for motorists in rural areas where trains move more slowly and motorists may be more prone to take chances. Over 80 percent of the fatalities at crossings with active warning devices occur when the driver has ignored the warning device. This, by itself, makes the modeling process very difficult. We typically do not have the data that would reveal why some motorists are prompted to violate driving rules by ignoring lowered gates. This further mitigates the seeming counterintuitive result.

The difference in the FRA models and our models has prompted a lively exchange at public hearings and on the FRA docket. The FRA web site is at http://dms.dot.gov/search/searchFormSimple.cfm (Docket number 6439). We suggest examining the site in 'reverse order' (click on the tab in the upper center of the page) and viewing posting 6439-3863 dated October 13, 2004. This includes a cover letter submitted on Chicago Area Transportation Study (CATS) letterhead, our original work, the extensive FRA comments and our rejoinder. It is the most current overview to the disagreement over interpretation of collision data.

To date FRA this site has in excess of 4700 comments. The 'Interim Final Rule' prompted many of these comments. The interim rule essentially calls for either locomotives to sound their horns or the installation of advanced devices that would prevent vehicles from reaching the tracks when the warning is activated. There is considerable disagreement about the cost of such devices. The concern is that it would exceed the ability of many municipalities to
collect these resources. Moreover, issues concerning maintenance and liability are worrisome. Who is responsible and what are the long-term costs?

This discussion has been instrumental in postponing the adoption of the final rule regarding gated crossings. Most recently the October 28, 2004 date for announcing the final rule has been postponed indefinitely.

**CHICAGO - ST. LOUIS HIGH-SPEED TRAINS CROSSINGS**

For several decades a high-speed trains have been contemplated for the Chicago - St. Louis corridor. The current passenger rail alignment in the corridor passes through small towns and crosses numerous strategic highways. In order to make the project financially feasible, as much of the current alignment would be used as possible. Therefore special warning devices would be needed where vehicular traffic crosses the tracks. The Illinois Department of Transportation selected steel-curtain vehicle arrest barriers (VABs) and began a demonstration study in 1998. Much of this discussion in this section is based on the work of Fred Coleman (see references).

Current rules require that for train speeds in excess of 110 mph (ca. 180 kph), highway vehicles must not be able to cross the tracks during approaching trains. This can be accomplished by closing the crossing or by building a grade separation. The Illinois experience in grade separation construction has been between $1.5 and $3.5 million per crossing (1.2 - 2.8 million Euros). There are approximately 300 at-grade crossings between Chicago and St. Louis.

Ultimately the justification for building grade separation and other costly improvements is largely based on the demand for the rail service. The greater Chicago area has approximately eight million inhabitants and with the three million in the St. Louis area, the populations are sufficient to consider a high-speed train. The lack of major population centers on the alignment and the absent of a strong train-riding tradition in this corridor, however, suggest that the prospective ridership would not match the levels found in other industrialized nations. Given the anticipated passenger levels, the cost of constructing exclusive rights of way without any cross traffic well exceed the potential funding available for the high-speed train. This prompted IDOT to consider alternative ways to achieve acceptable safety standards without closing the crossing or building grade separations and experiment with arrest barriers that would achieve the desired levels of safety.

Three sites were selected and the VABs were installed. The barrier at McLean, Illinois was the longest-lasting barrier and was the subject of special study. The barrier was completed and ready for service on January 4, 1999. Due to accumulation of snow in December near the towers the safety net could not be completely lowered and the start was delayed initially until February and subsequently until March when operations commenced. There is no built-in snow removal in the VAB system.

Through the end of the year the VAB was scheduled to operate for 152 days and was successfully operated on 138 or 90.8% of the days. Service was performed frequently and service hours were tallied.

Several of the maintenance calls and labor hours were for routine work. For example in February before the VAB was in full operation there were six service calls accounting for approximately thirty hours of work, some was overtime. The first month of operation, March, had the greatest number of service hours, ninety. April recorded the greatest number of service calls, eleven. One of these calls was scheduled, but eight of the
remaining ten were false alarms. The parts alone through December cost approximately $18,500.

During this time there were six incidents involving “intrusion or entanglement.” Each repair cost between $6000 and $8000. Surveillance video recorded four of these incidents that involved vehicle attempting to pass under the lowering net and either hitting the net of becoming entangled. In two cases the net dropped on top of the vehicle.

The VAB was scheduled to be down from July to October in part to accommodate the resurfacing of the roadway. Y2K compliance also complicated the software maintenance. Regrettably a fatal accident occurred during this closure. It occurred partly due to the lack of adequate monitoring of the original warning device. The collision occurred between a passenger vehicle and an Amtrak (passenger) train.

A cost-benefit analysis of all three sites concluded that the costs outweighed the benefits. Using FRA’s Accident Prediction Formula there was an anticipated reduction in accidents but the reduction was not sufficient to warrant the high cost. An important lesson here is that advanced systems are not always as reliable as the expectation. Might a similar outcome plague some of the new systems advocated for crossings where routine horn use is not currently the practice in the Chicago metropolitan area?

**SUMMARY AND CONCLUSIONS**

This paper has summarized two highway-rail crossing problems of great interest to the residents of northeastern Illinois. In one case changes inspired by FRA analysis recommend addressing gated crossing where locomotive horns are not routinely used. There is little local consensus that major changes are necessary at these crossings. In the other case, the need to for effective devices at high-speed rail crossings is well recognized. Unfortunately the VAB deployment has not produced the desired results and may have implication to new technologies applied to quiet highway-rail crossings in the Chicago area and elsewhere. Desired result do not always occur no matter how well intentioned the effort.

We concur with the substantial attention placed in the Chicago area on encouraging rail use by passengers and making it a safe experience for both highway and rail users. In these efforts there is always the question whether the use of scarce funds are best allocated for this purpose. The cost-benefit analysis for vehicle arrest barriers has shown that these devices would not be cost effective. Although a cost-benefit analysis was not presented on the use of locomotive horns or constructing more effective barriers than the gates currently in operation at rail crossings, the data in this report suggests that if the resources were available that there are many other areas where they may well be applied more effective.

These decisions must be made on considerable work and sound analysis. This analysis is essential before the decisions to commit major resources are made. Fortunately, highway-rail collisions at gated crossings are declining and fatalities are relatively rare. But the infrequency of these events makes it a particularly difficult statistical problem and this opens the door to prospective differences in the interpretation of data. Our conclusion is that there is no compelling evidence in the Chicago area that would merit the allocation of scarce safety resources on installing advanced restraining systems at gated crossings where locomotive horns are not routinely used.
REFERENCES


Railroad use data