INTEGRATION OF FREIGHT RAILROAD OPERATIONS IN ADVANCED TRAFFIC MANAGEMENT SYSTEMS

by

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SUMMARY

The concept of managing traffic is as old as traffic itself. Traffic management is simply the application of administrative tools and techniques on a transportation system in such a way as to get the most effective use from the existing network. Advanced Traffic Management Systems (ATMS) and their application as a management tool have been around in the United States since the 1960s. As traffic congestion and environmental concerns regarding the addition of new roadway capacity have escalated, the emphasis on more efficient management of the existing transportation network has also increased. The increased interest in systemwide efficiency and safety has made the successful implementation of ATMS a multi-jurisdictional and multi-agency problem. The basic objective of ATMS is to include use advanced computer and communications technologies to improve traffic operations on the existing network. In order for ATMS to be successful to the greatest extent possible, ATMS should include all entities which have a significant impact on transportation on the freeway and arterial street system being managed. This paper investigates the concept of integrating freight railroad operations into ATMS.

Freight railroad operations can significantly influence the flow of traffic around railroad grade crossings in an urban area. Trains can block grade crossings causing considerable delays to automobiles, transit vehicles, and emergency service vehicles. Currently, no ATMS has the freight railroad industry involved as an active player in the operation of the system. Therefore, information on train movements in the urban area is unavailable to Advanced Traffic Management Centers (ATMC). The basic concept of integrating freight railroad operations relies on the notion that traffic operations at intersections on roadways adjacent to railroad grade crossings could be improved if the traffic management system could utilize information regarding the location, speed, length, and cargo of freight trains.

This paper provides an investigation of the historical relationship between freight railroad companies and highway agencies and a state-of-the-art review of advance technologies being developed and applied by the freight railroad industry. A survey of railroad operations personnel, state Department of Transportation railroad liaison personnel, Traffic Management Center (TMC) employees, and transportation researchers was performed to identify:

1. Perception of the historical relationship between freight railroads and highway agencies;
2. The use of advanced technologies;
3. The willingness to participate in information exchange;
4. The potential benefits of integrating freight railroad operations into ATMS;
5. Institutional and legal barriers to integration of freight railroad operations into ATMS; and
6. Concerns regarding the integration of freight railroad operations into ATMS

The most significant result of the survey showed that a strong majority (87 percent) of the respondents indicated a willingness and interest in freight railroad operations being integrated into ATMS. The identification of several interesting potential operational and safety benefits also demonstrated that the integration of freight railroad operations could help better manage traffic.
Several state-of-the art applications which demonstrate the integration of freight railroad operations were reviewed as part of this research. The strategies and technologies proposed in the three applications examples were used to formulate a hypothetical application. This application used several hypothetical operational scenarios to illustrate how the integration of freight railroad operations can improve the ability to efficiently manage traffic in an urban freeway corridor adjacent to a railroad line.
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INTRODUCTION

Background

As the transportation system becomes more congested and the concern for the environment increases, innovative approaches to transportation management will become more important. Historically, individual components of transportation systems have been planned, designed, and operated in isolation with little attention given to system operations. A need exists to integrate freight railroad operations into Advanced Traffic Management Systems (ATMS) in order to improve systemwide efficiency and safety.

Railroad grade crossings can significantly affect traffic flow and safety on the arterial street system. Often, trains can block intersections for several minutes during the peak period of flow, resulting in long queues that can block or impede traffic flow on other streets and access driveways to commercial and private property. This blockage can also adversely affect major bus routes and routes frequently used by emergency vehicles. Information on train movements is currently not available to Advanced Traffic Management Centers (ATMC). Interconnection and signal preemption represent the maximum degree of integration presently achieved between railroad and adjacent roadway operations.

From a traffic management standpoint, trains can also cause interference on routes used during diversion when incidents occur on freeways. Traffic operations at intersections on roadways adjacent to railroad grade crossings could be improved if the highway “traffic management system” can be fed information about the location and arrival time of a train (1).

Another application of railroad information is in the area of effective response to freight train accidents involving hazardous materials. Several of the new Traffic Management Centers (TMCs) involve police, fire, and emergency agencies as partners in the ATMS. These agencies could potentially benefit from the railroad operations information by being more informed prior to arrival at the accident scene.

Railroad Technology

The freight railroad industry has historically been progressive with its use of advanced technologies. The railroads were early pioneers in the use of computers in the transportation industry to facilitate the provision of efficient, customer-responsive services. The railroads are profit-oriented like any other business and have looked for advanced technologies to improve their operations and moneymaking ability. The freight railroad industry also initiated work in area of automatic equipment identification (AEI). In recent years, much of the technological innovation within the freight railroad industry has been focused on the development and implementation of sophisticated communications, command, and control systems.

In many respects, there are similarities and parallels between the development and application of advanced technologies for railroad operations and systems for operating highway transportation systems (commonly referred to as Intelligent Transportation Systems). The basic technologies being
used in the two industries are similar which suggests the opportunity for the creation of a truly integrated railroad and highway traffic control system.

**Barriers to Information Exchange**

The historical relationship between highway and railroad agencies could be an institutional barrier that hinders the cooperation required for information exchange. In order for freight railroad operations to be successfully integrated in traffic management systems a willingness to participate by all parties involved must be present. There may also be additional institutional and legal barriers which inhibit the integration of freight railroad operations into ATMS.

**Objectives**

The five primary objectives of this paper are to:

1. Establish the need (i.e., reasons) for inclusion of railroad operations in ATMS;

2. Identify railroad industry’s current use of advanced technologies which are similar to Intelligent Transportation Systems (ITS) technologies being implemented in ATMS;

3. Identify institutional/legal barriers to information sharing and exchange between railroad operators and ATMS member agencies;

4. Identify which advanced technologies and what type of information has the greatest potential for integration into ATMS; and

5. Make recommendations based on findings regarding the system design for integrating railroad operations into ATMS.

**Scope**

The primary purpose of this paper is to establish specific reasons for including railroad operations in Advanced Traffic Management Systems. Common uses of technology between railroads and ATMS will be identified and the most promising will be recommended for integration. Telephone interviews with Traffic Management Center (TMC) personnel, railroad operations personnel, state department of transportation railroad liaison personnel, and transportation researchers will provide expert information on this subject. Using a review of three state-of-the-art application examples and a hypothetical application, recommendations for integrating freight railroad operations into ATMS will be made.
Organization of Report

Following the introduction, the report is organized into five additional chapters. Section 2, Background, provides information collected using a literature review on the historical relationship between railroads and highway agencies, description of ATMS goals and objectives, and the railroad industry’s use of advanced technologies. Section 3, Study Design, contains the questions and procedures used in personal, mail, and telephone interviews conducted for the research. Section 4, State-of-the-Art Applications, outlines three example applications reviewed to identify and illustrate the potential benefits and system design for integration of railroad operations into ATMS. Section 5, Study Results, presents the results of the personal interviews and surveys. Section 6, Hypothetical Application, provides a demonstration of how Automatic Equipment Identification technology can be integrated into Advanced Traffic Management Systems. Section 7, Summary of Findings, contains the significant findings from the personal interviews, surveys, state-of-the-art review, and the hypothetical application. Finally, Section 8, Recommendations, provides recommendations regarding the integration of railroad technologies and information into ATMS.
BACKGROUND

Historical Relationship Between Freight Railroad Companies and Highway Agencies

History of Freight Railroads

Many changes were appearing in American transportation in the late 1700s following the signing of the Declaration of Independence, including the construction of turnpikes, the development of steamboats, and the opening of canals. The final phase of the internal transportation improvements of that era was the appearance of the railroad in the 1820s. The industry started slowly but grew quickly in the first decades, increasing the total track miles from 23 miles (37 kilometers) in 1830 to over 9,000 miles (14,000 kilometers) in 1850. The American rail network now is one of the largest in the world with over 200,00 miles (305,000 kilometers) of track in service (2).

History of the Highway System

It was not until the turn of the century that automobiles entered the transportation arena. The automobile brought with it a rapidly growing interest in intercity highways. The first glimmerings of statewide highway planning (by the state DOTs) efforts predated the first federal-aid highway act of 1916. This act encouraged coordination among the states so that adjacent state systems would connect at state lines to provide continuous routes for interstate travel. The Interstate Highway System was approved in the 1940s and the vast majority of the lane miles have been completed to date. In the United States, the public roads system covers more than 3.8 million miles (6.1 million kilometers) and serves more than 150 million vehicles traveling almost 1.5 trillion vehicle-miles (2.4 trillion vehicle-kilometers) annually (2).

Advanced Traffic Management Systems

Traffic management is simply the administration of a transportation system in such a way as to get the most effective use from the existing network. Traffic management is not a new concept; however, the development of technology has made considerable improvements in mobility and safety real possibilities. Advanced Traffic Management Systems (ATMS) rely heavily on state-of-the-art computer technology and the latest innovations in electronics and communications to monitor and manage traffic. Information about traffic volumes (congestion levels), speed of vehicles along a roadway segment, incidents, and other valuable items can now be collected almost as they occur (known as real-time data). This data can then be assimilated and intelligent responses can be generated rapidly and effectively by traffic management personnel or computer software. Ultimately, the primary objective of an ATMS is to keep traffic operations flowing smoothly and efficiently, thereby increasing the safety and mobility of motorists using the system (3).
Traditional Players in ATMS

To be successful to the greatest extent possible, ATMS should include all entities which significantly impact transportation on the freeway and surface street (primarily arterial) facilities. Exactly which agencies are involved in an ATMS depends on the needs, laws, and customs of the urban area in question and the goals and objectives of the ATMS. Traditionally, the state Department of Transportation (DOT) is the agency which often plays the leadership role in an ATMS. Additional agencies which are commonly involved in ATMS are local traffic agencies (city and county DOTs), law enforcement agencies, transit authorities, emergency service agencies (fire and medical), research agencies, and the Federal Highway Administration (FHWA) (4).

Currently, no ATMS has the railroad industry involved as an active player in the operation of the system. The Advanced Traffic Management Systems which are currently operational and planned throughout the United States have concentrated efforts on freeway facilities. In an urban context, railroad trackage very rarely crosses a freeway facility at-grade. With the focus on freeways and the rare issue of at-grade railroad-freeway crossings, ATMSs have not yet truly considered the impact of freight rail operations on traffic management in an urban area. When more attention is given to arterial and frontage road operations (where at-grade crossings between railroads are more prominent) in the ATMS, the need for integration of railroad operations will become more apparent.

Use of Advanced Technologies in the Freight Railroad Industry

As previously noted, the railroad industry is active in the development and application of advanced technologies. A literature review was conducted to determine the state-of-the-art material available on the use of advanced technologies in the railroad industry. The following sections contain a general description and information on some of the prominent technologies being utilized by the railroad industry.

Automatic Equipment Identification (AEI)

Automatic Equipment Identification (AEI) is an electronic identification (EID) technology. EID technology identifies a moving object through the use of electronic means rather than optical or magnetic means used by the freight railroad industry in the past. A small electronic tag (transponder) is attached to an object such as a railcar. The identification code is retrieved electronically from the tag when the railcar approaches a reader station. The reader then relays the identification code information from each of the tags scanned to a computerized management system (5). AEI technology is basically the equivalent of Automatic Vehicle Identification technology being used on roadways for automatic toll collection and other applications. A graphical display of how this technology works is shown in Figure 1.

American freight railroads mandated that all freight cars and locomotives used in interline service will be outfitted with radio frequency (RF) transponder tags by January 1, 1995. The freight railroads, through the guidance of the Association of American Railroads (AAR), have adopted a standard passive transponder tag using modulated backscatter RF technology(6). Gallamore contends that passive tags have the advantage of being less expensive and the most secure type of tag. Passive tags have only an identification number stored and all changing information is obtained
from secure, central databases. The same technology standard chosen by the AAR has been adopted by several other prominent organizations including: American National Standards Institute (ANSI), the International Standards Organization (ISO), and the American Trucking Association.

As of the deadline, over 90 percent of the 1.3 million railcars have been equipped with AEI transponder tags. Approximately 1200 reader sites were also in place by January 1. A total of 3,000-5,000 readers at 2,450 sites are projected for the network (7).

Customer Location Messages (CLMs). AEI was originally developed by the freight railroad industry for operational purposes, such as verifying the standing order of cars in a train or the location of a locomotive in maintenance or fueling status. Recently, the industry has started to develop AEI applications that will offer value-added information to customers as well as internal operations information. An early customer value-added application of AEI is the use of “reads” to update car location files automatically. The car location files can then be sent to customers via electronic data interchange (EDI) for their use. The railroad industry refers to this type of service as a Customer Location Message (CLM). In the past CLMs were generated using information on location and time provided by radio communications at stops and junctions. The effectiveness of AEI-driven CLMs was studied in a two-year project involving DuPont, Union Pacific Railroad, Conrail, and Amtech Logistics Corporation. The principal finding from the pilot study was that AEI-generated CLMs are more accurate and timely than the traditional method. AEI CLMs are available to the customer from half to one and one-half hours earlier than conventionally produced CLMs and the reports were found to be essentially 100 percent accurate (6, 8).

Figure 1. Description of Automatic Equipment Identification Technology (5).
Dynamic tags. Dynamic transponder tags are being considered in several “special” applications. Dynamic tags have the advantage of being able to report real-time information (when within the range of a reader station) by acting like an “electronic clipboard” (6). The disadvantages of these tags are the possibility of becoming corrupted and the higher cost (a dynamic tag system requires sensors, a power source, and a microprocessor). These tags are being considered for applications such as monitoring fuel level and consumption of locomotives, measuring temperatures in refrigerated cars and containers, regulating tank car pressures, and tracking the impacts of switching operations (9). Dynamic AEI tags are being used by Burlington Northern Railroad which has 100 locomotives equipped with Rockwell’s locomotive analysis reporting systems.

Advanced Train Control Systems (ATCS)

Advanced Train Control Systems (ATCS) use digital data communications and computers to manage and control the dispersed elements of the railroad, locomotives, track forces, and field devices to the dispatch office and railroad management systems (10). An ATCS system can be used for a variety of business and safety functions.

ATCS is not a system adapted from a set of requirements or specifications from some other industry, rather, it is a system designed to meet railroad needs. The basic structure of the ATCS architecture is open and non-proprietary (i.e., no company will have ownership over any components within the system architecture). Components are designed to meet specific physical, logical, and electrical standards. The primary components of the ATCS system include:

- ATCS interface computer;
- Dispatcher console;
- Front end processor;
- Data radio base station;
- Wayside interface unit;
- Train position monitor (GPS-based or transponder-based); and
- On-track equipment outfitted with ATCS hardware.

This system design has several advantages (10):

1. Cost savings over a proprietary system built to meet the same requirements is estimated at 30 percent;
2. Components can be upgraded to more advanced technology while still maintaining backward compatibility (i.e., as more powerful and efficient computers are added to the system they will have the ability to work with the remaining system technology);
3. The system platform allows each railroad to determine its applications and pace of implementation; and
4. The system platform allows for early applications to establish the communications “backbone” network for future applications which can effectively reduce cost and improve the overall return on investment.
Advanced Railroad Electronics System. The Advanced Railroad Electronics System (ARES) is a state-of-the-art application of ATCS developed and demonstrated by the Burlington Northern Railroad. The Global Positioning System (GPS) satellite-based train control system can provide accurate real-time information on locomotives, trains, crews, and field devices. The system utilizes an automatic digital data link to facilitate communications between field operations (trains and signal systems) and the train dispatchers and traffic managers. The GPS equipment located within the locomotive calculates train position and speed and transmits the information to the central control center. The ARES system was successfully tested in Minnesota in the late 1980s by the Burlington Northern Railroad. Although the system was successful, it was removed at the request of the railroad due primarily to concerns about cost of large scale implementation (11).

Positive Train Separation. Positive Train Separation (PTS) is a promising scaled-down version of ATCS dedicated to controlling the movement of trains in a manner that prevents the occurrence of collisions. A joint demonstration project involving Burlington Northern (BN) and Union Pacific (UP) Railroads, the Washington Department of Transportation, and the Federal Railroad Administration is being initiated to develop and evaluate PTS technology. The PTS multi-year test project will be conducted on 845 miles of BN and UP tracks in the Pacific Northwest which average 160 crew starts per day. The project is scheduled to begin in 1996 and will include radio frequency (RF) standards, both UHF and VHF; GPS for train location; on-board displays, alerts, and enforcement; and an expandable and open technical infrastructure (11). The railroad industry and Federal authorities are using this demonstration to determine whether further development and implementation of PTS systems should be pursued.

Centralized Train Control

Several freight railroads have developed state-of-the-art centralized dispatch/control centers capable of managing their entire fleet of trains and track maintenance vehicles. These network operation centers (NOCs), sometimes referred to as train control centers (TCCs), allow for the consolidation of dispatchers together with network management personnel at a single location so that improved operations efficiency and a service-oriented approach to management can be achieved (12). The NOC facilities (Burlington Northern in Ft. Worth, Texas and Union Pacific in Omaha, Nebraska) are very similar to Advanced Traffic Management Centers (ATMCs) in many respects. Each type of facility uses state-of-the-art computer and communications technology to manage traffic within a network. However, one primary difference between an NOC and a ATMC is that an NOC manages the operations of a nationwide fleet of trains while the ATMC manages traffic in an individual urban area.

Most NOCs have four major service functions associated with daily operations: Network Operations Management, Locomotive Distribution, Crew Management, and Road Operations Management (13). All four major service functions are managed using computers which apply algorithms and artificial intelligence to optimize the functions being performed. Table 1 provides a description of each of the four major service functions:
Table 1. Major Service Functions of a Network Operations (Train Control) Center (13).

<table>
<thead>
<tr>
<th>Service Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Operations Management</td>
<td>Plan, control, and monitor the flow of trains over the network for optimal service delivery with minimal cost</td>
</tr>
<tr>
<td>Locomotive Distribution</td>
<td>Manage assignment of locomotives to trains with a view to service delivery and cost control</td>
</tr>
<tr>
<td>Crew Management</td>
<td>Balance crew supply and demand with a view to service delivery, cost control, and employee quality of life</td>
</tr>
<tr>
<td>Road Operations Management</td>
<td>Control train movement across local planning areas safely and efficiently, subject to network goals, with a view to service commitments and network throughput</td>
</tr>
</tbody>
</table>
STUDY DESIGN

State-of-the-Art Application Examples

Three applications examples related to the integration of freight railroad operations information in traffic management systems were reviewed for this research. These applications show three different approaches for integrating railroad operations in traffic management systems. Application #1, Houston IVHS Railroad Grade Crossing Monitoring System, is a proposed demonstration project utilizing Automatic Equipment Identification/Automatic Vehicle Identification technology to monitor train movements in priority corridors. Application #2, Operation Respond, is an operational project which allows fire and emergency service dispatchers to directly access railroad databases through a modem. Application #3, Texas Transportation Institute Advanced Traffic Management Center/Laboratory, is a cooperative project in the early stages which hopes to integrate Positive Train Separation locational data into the ATMS.

Surveys

In order to gain insight into the issues, concerns, potential benefits, and willingness to participate associated with the integration of freight railroad operations into ATMS, a survey of traffic management center (TMC) personnel, railroad operations personnel, state department of transportation railroad liaison personnel, and transportation researchers was conducted. The survey questions used for the railroad personnel were slightly different than the questions for the state DOT and traffic management personnel.

The survey of railroad operations personnel was conducted using a 6-question telephone session. The contacts for the telephone survey were developed from TTI Rail Research Initiative connections and through the use of a catalog containing phone numbers of management personnel for all major railroads in the United States. A good representation of the major (Class I) railroads in the survey was desired. The six questions used in this survey are provided in Figure A-1 located in the Appendix of this report.

The survey of TMC and state DOT railroad liaison personnel was conducted using a 6-question mail-out survey. The contacts for the survey were developed from a list of state DOT liaison personnel utilized during a previous TTI research project. Surveys were mailed to 30 of the 50 state DOTs. The questions asked were basically the same as those asked to the railroad personnel with the exception of question #2. The six questions used in this survey are provided in Figure A-2 of the Appendix. A copy of the instructions distributed with each set of survey questions is also provided in the Appendix of this report.

Finally, the survey of transportation researchers was performed by personal interviews. The contacts for the survey were TTI personnel who were active in research in the railroad and Intelligent Transportation Systems arenas.
STATE-OF-THE-ART APPLICATION EXAMPLES

The following sections contain an overview of three applications examples investigated in this research. A general description of the status of the projects and the technologies utilized will be provided for each application example.

Application #1: Houston IVHS Railroad Crossing Monitoring System

This project proposes to monitor railroad train movements along three priority corridors in the Houston area: the Union Pacific rail line that parallels the IH-10 Katy Freeway and the Southern Pacific rail lines that parallel the IH-610 West Loop Freeway and US-290/Hempstead Road. The trains will be monitored using Automatic Vehicle Identification (AVI) readers at eight to ten locations along the rail lines. The monitoring systems will determine the position and identification, the travel times (length of the train), and average speeds of the trains. The Automatic Equipment Identification (AEI) tags used by the railroads on over 90 percent of the rail cars are compatible to the AVI readers being used to monitor highway traffic.

The railroad operations information collected by the AVI readers will be used in a variety of applications. Information and traffic management strategies to be investigated in the demonstration are:

1. Installing and operating changeable message signs (CMS) and other information systems on the arterial street approaches to the grade crossings;
2. Providing train and grade crossing status information on radio and television traffic reports for critical intersections;
3. Notifying agencies responsible for traffic signal operations so that timing of signals near grade crossings may be adjusted to compensate for the roadway blockage;
4. Coordinating the operation of the frontage road and ramp metering systems with train movements that parallel the freeway;
5. Increasing the capacity of the frontage road intersections by dynamically altering the lane assignment of the approaches as the train moves through the corridor;
6. Notifying emergency services of train location so routing to emergencies can select the route which minimizes their response time; and
7. Notifying transit services so that they can account for train location in their scheduling and routing of buses and other vehicles.

The precision and quality of the information gathered by the demonstration project will not be very exact. The AVI readers will be sufficiently spaced to provide a reasonable estimation of train length and arrival at the subsequent grade crossing. However, the trains will only be able to be monitored at the reader stations which can lead to problems when a train stops or slows significantly. Another concern is whether the information displayed to the motorists via the CMS and other media will be utilized.

Dick McCasland, Texas Transportation Institute (TTI) Houston Division Head, believes that the goodwill between agencies and the information supplied to motorists will be the basic benefits.
of the demonstration. The cost of the technology needed to support the project is relatively inexpensive. Eight to ten AVI readers costing approximately $8,000 - $10,000 each. So far, the railroad companies are willing to cooperate to make this demonstration project a reality; however, funding is still being pursued at this time (14).

**Application #2: Operation Respond**

Operation Respond is a project sponsored by the Federal Railroad Administration which provides software to help state and local officials respond effectively to train accidents involving hazardous materials in the Houston metropolitan area. Operation Respond involves a partnership of Transportation Department agencies, Houston police and fire departments, Houston-area railroad companies, and chemical manufacturers. Operation Respond will use Windows-based software to give police and fire dispatchers a direct line into railroad databases to access information on what a train is carrying and how it should be handled (15).

*First Responder Emergency Information System (FREIS)*

The First Responder Emergency Information System (FREIS) is the software developed for Operation Respond which allows emergency dispatchers to “tap into” railroad databases and then relay necessary information to police and fire units arriving at the scene of a train mishap. FREIS allows dispatchers to directly query the railroad databases, as Dow Chemical or any customer might, to track the progress of a shipment. The software reformats the information contained in the databases to make it easy for dispatchers to quickly access and download. The information can then be relayed by the dispatchers to emergency crews so that they can respond in a safer, more efficient manner when they arrive at the accident scene.

The technology used to provide connectivity for the project is relatively simple and low-cost. Connectivity is provided through Operation Respond central stations that have telephone lines into railroad data centers. Dispatchers need only a 386 computer with a 1200 bit/sec modem to access and download the necessary data from the railroad databases.

*Information Sharing*

Operation Respond was created in response to emergency crews concerned with a lack of timely information before they arrived at the scene of a train crash involving hazardous materials. Emergency crews had problems dealing with accidents involving chemicals because they did not have information about what chemicals were in question, whether to evacuate, what protective gear to wear, and how to deal with the resulting fires. The logical answer was to form a partnership, called Operation Respond, of agencies and corporations who had a vested interest in these crashes.

Operation Respond’s real task was not developing technology to facilitate information sharing but getting access to the databases with the important information. The railroad companies maintain extensive computer records in almost real-time which they provide to their customers for information on shipments. Until recently, the railroad companies only allowed customers using their services access to the records contained on their mainframes. The basic idea of Operation Respond was to make the same information databases available to the first responder, in essence make the first
responder another class of customer. The railroads have cooperated because they would rather have more information go to the dispatchers and are in favor of anything that can enhance safety.

Application #3 - TTI Advanced Traffic Management Center/Lab

The TTI Advanced Traffic Management Center (ATMC) will be a facility that demonstrates the benefit of seamless integration of a multi-jurisdictional, multi-functional, multi- and inter-modal information and control system in urban and rural applications. The ATMC will provide advanced transportation control systems, advanced traveler information systems, advanced public transportation systems, advanced railroad control system interface integration, airport information systems, port information systems, advanced police and fire transportation information and control systems, and international transportation management systems (16).

Under the auspices of the Texas A&M IVHS Research Center of Excellence, TTI is presently developing a “smart” intersection controller capable of adaptive signal operation to account for, among other functions, the presence of a train. The project proposes to integrate train “status” inputs into the system by establishing a data-link to the Union Pacific/Burlington Northern PTS computer information. The information from the railroad database would provide train position with respect to a fixed point (i.e., grade crossing), train speed, and direction of travel of the train. This information would then be used to help the “smart” controller implement timing plans and phase sequences which optimized traffic flow in the area. This project is still very early in the process and is several years away from the demonstration how of real integration of the two systems will occur.
STUDY RESULTS: SURVEY

This section presents significant findings from the survey of traffic management center (TMC) personnel, railroad operations personnel, state department of transportation railroad liaison personnel, and transportation researchers. Specifically, the historical relationship between railroads and highway agencies, willingness to exchange information, potential benefits of information exchange, institutional/legal barriers to information exchange, and concerns regarding the integration of railroad operations in ATMS are presented.

Survey Participants

A total of twenty-one surveys were completed in this effort: seven railroad operations personnel, twelve state DOT representatives, and two TMC employees. Table 2 provides a listing of the railroad companies which had representatives who participated in the survey. Table 3 shows the state DOTs which had personnel complete surveys. The TMC locations which had employees that participated in the survey are given in Table 4. Personal interviews were also conducted with four transportation researchers. Dr. William Harris (Associate Director of TTI and former AAR vice-president) (17), Mr. William McCasland (Director of TTI Houston) (14), Dr. Steve Roop (Director of TTI Rail Research Initiative) (18), and Mr. Rick Bartoskewitz (Researcher in Rail Research Initiative) (19) all took the time to participate in personal interviews.

Table 2. Railroad Companies That Participated in Surveys.

<table>
<thead>
<tr>
<th>Railroad Companies (6)</th>
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<tbody>
<tr>
<td>Atchison, Topeka and Sainte Fe</td>
</tr>
<tr>
<td>Burlington Northern</td>
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<tr>
<td>Chicago and North Western</td>
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<tr>
<td>Conrail</td>
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<td>Norfolk Southern</td>
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<td>Union Pacific</td>
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Table 3. State Departments of Transportation That Participated in Surveys.

<table>
<thead>
<tr>
<th>State Departments of Transportation (12)</th>
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</thead>
<tbody>
<tr>
<td>Arizona</td>
</tr>
<tr>
<td>California</td>
</tr>
<tr>
<td>Georgia</td>
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<tr>
<td>Indiana</td>
</tr>
<tr>
<td>Iowa</td>
</tr>
<tr>
<td>Kansas</td>
</tr>
<tr>
<td>Maryland</td>
</tr>
<tr>
<td>Michigan</td>
</tr>
<tr>
<td>South Carolina</td>
</tr>
<tr>
<td>Texas</td>
</tr>
<tr>
<td>Virginia</td>
</tr>
<tr>
<td>Washington</td>
</tr>
</tbody>
</table>

Table 4. Traffic Management Centers That Participated in Surveys.

<table>
<thead>
<tr>
<th>Traffic Management Centers (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Houston (TxDOT)</td>
</tr>
<tr>
<td>Phoenix (ADOT Traffic Operations Center)</td>
</tr>
<tr>
<td>Minnesota Guidestar</td>
</tr>
<tr>
<td>New York City/ Long Island (INFORM)</td>
</tr>
</tbody>
</table>

Historical Relationship Results

A question regarding the historical relationship between railroads and highway agencies was asked to all survey participants. The question required the respondents to describe the historical relationship by selecting a word (poor, fair, good, or excellent). The respondents were then asked to comment on why they selected the word to describe the relationship. Table 5 shows the responses for each group surveyed along with a summary of the total frequency in each category (i.e., poor, fair,
good, and excellent). Two lists containing some of the reasons why respondents rated the relationship the way they did are provided following Table 5.

Table 5. Historical Relationship Responses.

<table>
<thead>
<tr>
<th>RESPONDENT CATEGORY</th>
<th>POOR</th>
<th>FAIR</th>
<th>GOOD</th>
<th>EXCELLENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Railroad operations personnel</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>State DOT/ TMC personnel</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>TTI researchers</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>TOTALS</td>
<td>3</td>
<td>8</td>
<td>10</td>
<td>3</td>
</tr>
</tbody>
</table>

**POOR-FAIR Relationship Rationale**

- State and federal DOTs help subsidize the railroad industry’s main competition - the trucking industry. There is a “suspicion in the railroad industry that highway agencies favor the competing truck mode”
- Some railroad officials feel that there are too many grade crossing (points of potential hazard) allowed for access of highway traffic over the railroad right-of-way
- The interaction of public (local, state, and federal agencies) and private (railroad corporations) entities with different missions and cultures
- A general lack of understanding of each other’s business
- Mistrust between government agencies and for-profit corporations
- Loss of openness in relations because of fear of litigation from grade crossing accidents

**GOOD-EXCELLENT Relationship Rationale**

- Railroads and state DOTs work together to install warning devices at crossings
- Cooperative maintenance and payment for installation of active (i.e., flashing light signals and gate barriers) warning devices
- Joint effort in maintaining and updating crossing information for the National Inventory

**Freight Railroads Use of Advanced Technologies**

As a supplement to the literature review conducted on the railroad industries use of advanced technologies, railroad operations personnel were asked to identify technologies being used by their corporation to enhance operations. All six railroad corporations contacted are using advanced technologies to enhance their operations. The list on the following page provides a summary of the technologies identified during the telephone interviews:
1. Global Positioning Systems (GPS) for positive train separation demonstration
2. On-board computers on locomotives capable of real-time information transfer using GPS
3. Automatic Equipment Identification (AEI)
4. Deck-Alpha servers to run computers for scheduling and dispatching of trains and control of signal systems
5. Microwave/fiber optics communications media
6. Robots for maintenance
7. Infrared photographic enforcement
8. Infrared sensors
9. Video imaging
10. Data radio links for signal control
11. Network operations control centers
12. Geographic Information Systems (GIS)

Basically, the telephone survey confirmed the literature review results. That is, the railroad industry is applying and developing a wide range of advanced technologies.

**Willingness to Exchange Operations Information**

One of the most important aspects of the surveys conducted for this research was the establishment of whether railroad and state DOT personnel are willing to exchange operations information to help achieve total transportation management. Question 3 (would your company/agency be willing to exchange operations information to help achieve total transportation management) was asked to all survey participants. Table 6 shows that 20 of the 23 respondents (87 percent) are willing to consider the exchange of operations information. Two respondents indicated that they didn’t know at this time whether or not they would be willing to participate in an exchange of operations information. Only one respondent answered question 3 with a “no” response. The reason given for this response was that the current ATMS in the area only monitors freeways and this system contains no railroad grade crossings. These responses indicate that there is a willingness by all parties to consider establishing an interface (i.e., a “data-link”) which could facilitate the exchange of operations information such as train location and speed.

<table>
<thead>
<tr>
<th>RESPONDENT CATEGORY</th>
<th>YES</th>
<th>NO</th>
<th>DON’T KNOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Railroad operations personnel</td>
<td>5</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>State DOT/ TMC representatives</td>
<td>15</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>20</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 6. Willingness to Participate in Information Exchange Responses.
Potential Benefits to Integration of Freight Railroad Operations into ATMS

One objective of this research was to establish the potential benefits that integration of railroad operations into ATMS could achieve. Question 4 (i.e., what do you see as potential benefits or positives that your company/agency could receive from sharing information) was asked to all survey participants and during the personal interviews of TTI researchers. Some of the responses are provided according to source in the list below.

Railroad Companies

- Safety (less accidents and less potential litigation)
- Intermodal data exchange
- Could provide information on traffic patterns around grade crossings
- Operation of grade crossing warning devices by the highway agencies

State DOT and Traffic Management Centers

- Better cooperation and knowledge
- Could possibly move train operations to off-peak times
- Could help in construction scheduling
- Exchange of information is the spirit of “intermodal transportation”
- Any information is useful
- Redirection of traffic
- Improved signal timing in the area adjacent to railroad tracks
- More efficient and safer movement of people, goods, and trains/vehicles which is the primary mission of state DOTs

Transportation Researchers

- Routing of fire and emergency vehicles
- Routing of transit vehicles (buses)
- Operation (activation) of grade crossing warning devices
- Information on Changeable Message Signs (CMS) for motorists to aid their decision-making
- In-vehicle systems capable of alerting drivers of arrival of trains
- Capability to adjust signal timing for the presence of a train
- Improved safety

These responses seem to indicate that all parties surveyed see some potential benefits to sharing information. The primary benefit from the railroads point of view seems to be related to safety. Most state DOT representatives surveyed seem to indicate that the information on train location would help them provide safer and more efficient traffic management. Finally, TTI researchers indicated that having train “status” available to ATMS would provide the opportunity for significant operational and safety improvements.
Identification of Institutional/Legal Barriers

Another objective of this report was to identify institutional/legal barriers to information sharing and exchange between railroad operators and ATMS member agencies. Question 5 (i.e., are there any institutional/legal barriers which would hinder your ability to participate in information exchange) was asked to all survey participants and during the personal interviews of TTI researchers. A majority of the respondents indicated that they could not identify any institutional or legal barriers which would obstruct their ability to exchange information. Several obstacles were identified including:

1. Cost of implementation - who pays?;
2. Anti-trust issues;
3. Lack of standards for data communication;
4. Lack of physical data and communications facilities;
5. Fear of information being used to establish regulations of train movements that will adjust the schedules through urban corridors;
6. Negotiation of agreements between the two parties; and
7. Manpower needed to operate and maintain an integrated system.

Concerns Regarding Integration of Railroad Operations into ATMS

The final question asked of all survey participants and of TTI researchers during personal interviews was to identify any concerns regarding the integration of railroad operations into ATMS. This question produced several interesting responses. These responses (concerns) are presented in list below.

Concerns

- How exact (i.e., quality) is the information
- How timely is the information
- Will the information be used by motorists
- What if the train stops or adjusts schedules and no information is reported
- Who assumes the liability for accidents
- Who will be responsible for the operation of grade crossing protection devices
- Who will have access to the data being exchanged
- What benefits do the railroads get
- Traffic congestion at railroad crossings is not a critical problem - others must be addressed first
- Additional workloads for already burdened staff
- Software/hardware design and compatibility
- Maintenance and operation costs of integrated systems
HYPOTHETICAL APPLICATION

This section uses a hypothetical application with several different operational scenarios to demonstrate how the integration of railroad operations into ATMS might operate. Figure 2 illustrates the hypothetical example layout. The drawing shows a common situation where railroad tracks run parallel to freeway and frontage road facilities. The railroad tracks which run in the north-south (Track #1) direction cross each of the arterial facilities at-grade within 50 feet of the signalized intersections at the frontage road. A second set (Track #2) of railroad tracks run parallel to Arterial A in an east-west direction. This set of tracks is at-grade with the frontage road but grade-separated from the Cooner Freeway. The arterials (labeled Arterial A, Arterial B, Arterial C, and Arterial D) are six lane facilities spaced approximately 1 mile apart. Cooner Freeway is located in a large urban area which has an operational Advanced Traffic Management System. The hypothetical application will investigate the use of Automatic Equipment Identification (AEI) technology to monitor the status of trains with the example corridor.

Each hypothetical application will have several operational scenarios. These scenarios will be used to show situations where integration of railroad operations would provide operational benefits. Comments regarding the issues, concerns, and advantages of this hypothetical application will also be provided following the scenarios.

Example Situation

This hypothetical application will examine the use of AEI technology to provide information on trains in the example corridor. These scenarios show how train status data obtained from AEI technology can provide valuable information to the Advanced Traffic Management System which manages traffic in the example corridor.

AEI Reader Network

In order to obtain information about train movements in the example corridor the AEI reader network must be established. The location of AEI reader stations adjacent to Track #1 and Track #2 will provide train location information. AEI reader stations are located 2 miles south of Arterial D along Track #1 to detect Northbound trains approaching the example corridor. The two readers are placed relatively close together (approximately 500 feet) in order to operate like a speed trap formed by two loop detectors. There are also AEI reader stations 2 miles north of Arterial A along Track #1 which detect Southbound trains approaching the example corridor. The same configuration (i.e., two readers spaced 500 feet apart located two miles east and west of Cooner Freeway) is utilized on Track #2 to monitor the movement of trains in the east-west direction.

Scenario #1: Freeway Diversion

A changeable message sign (CMS) is located above the freeway mainlanes 1 mile upstream of Arterial A and a second CMS is located halfway between Arterial B and Arterial C. These signs are used to provide motorists traveling on Cooner Freeway with important traffic information. One
of the principal functions of the CMS is for diversion of traffic in the event of major accidents on the freeway facility.

A major accident involving a propane truck has occurred in the Southbound freeway lanes between Arterial C and Arterial D. The Southbound lanes will be blocked until the proper authorities respond and clear the accident scene. Diversion messages will need to be displayed on the CMS located upstream of the accident to give motorists information on how to bypass the accident. Meanwhile, the two AEI readers placed 2 miles to the east of the fire station along Track #2 detect a train. The transponders are read at each reader station and the train is determined to be traveling westbound at 25 miles per hour. The length of the train is estimated at 2700 feet by using a simple calculation which takes the first read obtained and the last read obtained at the first AEI reader station. This information is then used to forecast when and for what duration the westbound train will begin to block traffic flow at the frontage road grade crossing. It is estimated that the train will arrive at the crossing in 5 minutes and will block the frontage road traffic for 2 minutes.

The train status information obtained from the AEI reader stations can then be utilized in the diversion messages displayed on the CMS. The traffic should not be diverted onto the frontage road prior to Arterial A because they will not be able to proceed through the frontage road grade crossing once the train arrives. By knowing the westbound train status, the traffic management center operators can post a diversion message which tells motorists to exit the freeway facility at exits to Arterial B and Arterial C instead of at Arterial A in order to bypass the accident in the most efficient manner.

Scenario #2: Adaptive Signal Timing

Information obtained on trains travelling on Track #1 and Track #2 can be used to generate adaptive signal timing plans at each arterial-freeway diamond interchange which optimize the movement of traffic. An example situation is where a train is travelling Northbound along Track #1. The train status information (i.e., the estimated time of arrival and the time of blockage at each grade crossing) can be used to allocate the optimal amount of green time to vehicle movements prior to the arrival of the train at the intersection. In reality this means giving more green time to the cross street movements (i.e., the east-west arterial movements) as a train approaches and then “making-up” the green time to the frontage road movements when the cross street movements are blocked by the presence of a train.

Scenario #3: Emergency Vehicle Routing

A four-alarm fire occurs at a factory located west of Track #1 between Arterial B and Arterial C. The fire station located just east of Cooner Freeway is responsible for responding to the situation. The fire dispatcher is linked to the ATMS and before allowing the fire trucks respond checks to see if there are any incidents or trains which would influence the route to the factory. There are no incidents which would influence the route; however, a Northbound train on Track #1 is scheduled to arrive at the crossing at Arterial B in 3 minutes and will block the intersection for an additional 3 minutes. The train location estimates also show that the train will arrive at Arterial A in 7 minutes (i.e., an additional 4 minutes to travel from crossing at Arterial A to crossing at Arterial B). The dispatcher then receives information from the best route algorithm which calculates the route with
the minimum response time for the vehicles. Without the train status information, the response vehicles my have selected a route with a greater response time because of the delay incurred by the Northbound train blocking a crossing.

**Issues With AEI Generated Train Location Data**

There are several issues involving the use of AEI generated train location data. The three scenarios discussed previously demonstrate how AEI generated train status information can be used to manage traffic in the example corridor. During the development of these scenarios and during discussions with Dick McCasland, several limitations and concerns involving the use of AEI technology to obtain train status information were formulated. The list below provides several of the more prominent concerns:

1. Positional data is only available when a car equipped with transponder tags is adjacent to a reader station. This could cause problems if a train changes speeds by a significant amount or comes to a stop;

2. There is some concern regarding the amount of data “reads” obtained from each reader station as longer trains pass by. This concern could be addressed in the design of the software which obtains the data from each reader station; and

3. The placement (location) and quantity of reader devices needed to provide reasonable coverage of train movements in the area being monitored.

Even with several significant concerns, there are advantages to using AEI to obtain train location information. Several advantages are provided in the list below:

1. Almost the entire fleet (over 90 percent) of active railcar equipment and locomotives are equipped with AEI transponder devices. The widespread deployment of this technology means that almost all trains could be detected using AEI reader stations located next to railroad tracks. The more advanced train technology such as ATCS and PTS has only limited implementation, therefore, most trains could not be monitored;

2. Establishment of new reader sites for monitoring trains in urban areas by highway authorities would provide a benefit to the railroad industry. Railroad operators which agree to participate with highway authorities in the integration of train operations information into traffic management systems could use the additional data generated by the new reader stations to provide more Customer Location Messages as their freight shipments enter urban corridors; and

3. The reader devices are now available at a relatively low cost ($8,000 - $10,000 per device), and priority corridors (i.e., corridors where grade crossings present serious traffic problems) could be equipped without substantial capital investment.
SUMMARY OF FINDINGS

After reviewing the literature, conducting surveys and personal interviews, and presenting information on three state-of-the-art applications, and a hypothetical application, several significant findings of this research are apparent:

Literature Review/Survey Findings

1. The railroad industry is ahead of state DOTs in the implementation and development of advanced technologies;

2. Many advanced technologies being implemented in the railroad industry are similar to those being deployed in Intelligent Transportation Systems (ITS);

3. In general railroad companies and federal, state, and local DOTs have a good working relationship and cooperation on installation and maintenance of grade crossing warning devices and maintaining data for the National Inventory;

4. The relationship between freight railroad companies and federal and state transportation agencies is strained by a “suspicion that highway agencies favor the competing truck mode” through a subsidization of public roadways;

5. A strong majority (87 percent) of railroad operations and the state DOT personnel surveyed indicated a willingness and interest in exchanging operations information in order to facilitate total transportation management;

6. A strong majority of survey participants (railroad operations, state DOT, TMC, and research personnel) believed that the integration of railroad operations into ATMS has potential benefits;

7. Several institutional and legal barriers to the exchange of operations information were identified including: cost, anti-trust issues, communication standards, public/private negotiation of agreements, and manpower for operation and maintenance of an integrated system; and

8. Many of the concerns expressed relating to the integration of railroad operations in ATMS involved the quality, timeliness, usefulness, and applications of the information being exchanged.

State-of-the-Art Application Findings

1. Not much can be concluded from the applications review because of the lack of real-world application of applications #1 and #3 and the limited scope of application #2;

2. The applications do indicate that a variety of integrated system designs are possible and the information provided and complexity of the system can be tailored to address the problems for the particular application.
Hypothetical Application Findings

1. The three scenarios presented in the hypothetical example demonstrate how the integration of freight train location data into traffic management systems can be utilized to improve traffic flow around the grade crossings;

2. AEI generated train location data is primarily limited by being able to provide information only when the train is adjacent to a reader site; and

3. The most positive aspects of using AEI generated train location data are the relatively low capital cost for installation of reader stations and the widespread deployment of the transponder devices on the active railcar and locomotive fleet.
RECOMMENDATIONS

This section contains several important recommendations relative to the integration of railroad operations in ATMS. The recommendations are based on the significant findings of this research and on previous research performed in this area.

1. **A user service for railroad-highway grade crossings needs to be established.**

The National Intelligent Transportation Systems (ITS) Program Plan contains 29 user services. Currently, no user service is provided for reference to safety and operational issues involving railroad-roadway grade crossings. Consideration should be given to developing a roadway-rail crossing user service which establishes standards and system architecture for real-time interactive coordination between the roadway transportation management center (TMC) and the train control center (TCC).

2. **Adoption of compatible/similar standards for advanced technologies should be considered.**

The Intelligent Transportation Systems community and the freight railroad industry should work together to approve compatible/similar standards on advanced technologies so that integration can be facilitated. Currently, the railroad industry has adopted a standard for AEI, however, the ITS community is considering a different standard. These decisions should be arrived at cooperatively so that multi modal transportation management can become a reality.

3. **Institutional and legal barriers to information exchange should be dealt with.**

One of the first and most prominent barriers to the successful integration of railroad operations into ATMS is the implementation, operations, and maintenance costs associated with an integrated system. The author believes that the overwhelming majority of these costs should be absorbed by funding from the local, state, and federal DOTs. The railroad industry is a private, for-profit industry which should not absorb any significant portion of the costs associated with integration, largely because they do not receive a significant portion of the benefits. One survey participant agreed with the author’s opinion stating “the railroads must be shown how providing operations information would be in their best interests...the cost to the railroads should be minimal to nothing”.

Local, state, and federal DOTs should not attempt to establish any regulations of train movements that will adjust their schedules through urban corridors. The fear of the information (i.e., train location with respect to grade crossings) being exchanged and used by TMC personnel to manage the railroads schedule should be alleviated. Again, a survey respondent stated “railroads would not willingly modify train schedules to any great extent in order to satisfy the needs of other modes”. This statement affirms the belief that the railroads probably will not cooperate in information exchange unless they have the assurance that they will be able to continue to conduct business as usual.
Finally, the railroad industry and local, state, and federal DOTs should try to better understand each other’s business (i.e., goals and objectives) to overcome the historical relationship. Integrated, intermodal transportation will only be achieved if reasonable cooperation between the two parties is achieved.

4. Integration of railroad operations in the near future should use AEI/AVI technology to obtain operational data.

The approach used in case study #1, Houston IVHS Railroad Grade Crossing Monitoring System; doesn’t provide real-time data capabilities. The AEI/AVI technology used to monitor the trains has the inherent limitation of being able to provide information only when the train is adjacent to a reader site. This restriction limits the potential benefits and number of applications that integration could achieve. Despite all of this, the integration of freight railroad operations in the short-term future (i.e., the 5 to 10 years) should utilize AEI/AVI technology to generate train location data. The primary reason is that the technology is almost fully deployed and can be taken advantage of with the installation of a reasonable amount of infrastructure.

Real-time information on train “status”, i.e., location, direction, speed of travel, and hazardous cargo of the train is needed to achieve the full-benefits of integration. GPS and other technologies capable of continuous transmission of operations information offer the most potential for providing real-time operational data. The railroad industry is still developing ATCS and PTS and these systems will not be deployed on a scale comparable to AEI in the near future. When these systems are implementation industry-wide, ATMS should integrate this information because of the ability to monitor train movements as they occur.

5. Integration of railroad operations should only be considered when a significant problem exists.

A problem must exist before a solution can be successfully applied. In the same manner, the integration of railroad operations into ATMS is not recommended in all situations. If railroad grade crossings in an urban area present no significant traffic or safety problems, the integration of railroad operations isn’t a good solution. For example, one survey respondent indicated that the integration of railroad operations into ATMS would not provide any significant benefits in Atlanta, Georgia. He based this assertion on the fact that there not many grade crossing in the urban area and the ones that exist do not create serious traffic or safety problems. The author agrees with the respondent’s reasoning and would not recommend integration. Cities such as Houston, a port city with substantial congestion and safety problems created by the hundreds of grade crossings in the city, are more likely to realize greater returns if they choose to integrate railroad operations with the traffic management systems.
ACKNOWLEDGMENTS

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The author would also like to acknowledge the professionals who took time out of their schedules to complete the survey questions for this research. Finally, the support of my beautiful wife, Pam, gave me the motivation to complete this report.
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Scott A. Cooner received his B.S. in Civil Engineering from Texas A&M University in May 1994. Scott is currently pursuing his M.S. from Texas A&M in Civil Engineering. He has been employed by the Texas Transportation Institute previously as a Student Technician and presently as a Graduate Research Assistant in conjunction with the Advanced Institute program. University activities he has been involved in included: Institute of Transportation Engineers, where he served as Corresponding Secretary in 1994, and Chi Epsilon. His areas of interest include: geometric design, ITS/APTS advanced technologies, and human factors.
TELEPHONE SURVEY OF RAILROAD OPERATIONS PERSONNEL

NAME:
TITLE:
RAILROAD COMPANY:
PHONE:

1. How would you describe the historical relationship between railroads and highway agencies?

   POOR       FAIR       GOOD       EXCELLENT

   Why?

2. What advanced technologies is your company using to enhance your operations?

3. Would your company be willing to exchange operations information with highway agencies to help achieve total transportation management?

4. What do you see as potential benefits or positives that your company could receive from sharing information?

5. Are there any institutional/legal barriers which would hinder your company’s ability to participate in information exchange?

6. What, if any, concerns do you have about railroad operations being integrated in Advanced Traffic Management Systems?

Figure A-1. Railroad Operations Personnel Survey Questions.
1. How would you describe the historical relationship between railroads and highway agencies?
   
   POOR      FAIR      GOOD      EXCELLENT
   
   Why?

2. Is there any planned or operational Advanced Traffic Management Centers within your state?

3. Would your agency be willing to exchange operations information with railroad companies to help achieve total transportation management?

4. What do you see as potential benefits or positives that your agency could receive from sharing information?

5. Are there any institutional/legal barriers which would hinder your agency’s ability to participate in information exchange?

6. What, if any, concerns do you have about railroad operations being integrated in Advanced Traffic Management Systems?
SUMMER RESEARCH SURVEY INSTRUCTIONS

I am conducting research this summer my Advanced Surface Transportation Systems class here at Texas A&M University. My topic is “Integration of Railroad Operations into Advanced Traffic Management Systems” and I am asking a few questions to railroad personnel, state and local highway personnel, traffic management center officials and transportation researchers.

I have attached the survey questions on the two pages following these instructions. You may fill out your answers directly on the survey in the blank space following each question. If you need more room to answer, please attach an additional sheet when you return the survey. I have circled the fax number on the cover sheet where you can return the completed survey. I would like to have the surveys completed by July 6th. If you have any questions, please feel free to contact me at (409) 845-9878 (direct line) or (409) 845-1717 to leave a message. I also would appreciate any literature or brochures which provide information on your operations and use of advanced technologies. This information can be mailed to the address which is also provided on the cover sheet of this fax transmission. Thanks for your time, it is very much appreciated.

Sincerely,

Scott Cooner

BACKGROUND INFORMATION ON QUESTIONS

Ques. 1: Highway agencies refers to state and local departments of transportation which deal with railroads as they operate in their jurisdictions

Ques. 3: Operations information exchange refers to allowing the highway agencies access (i.e., a data-link) to information on train location in urban corridors

Ques. 6: Advanced Traffic Management Systems are being used by highway agencies to manage vehicle traffic on freeways and major roadways in urban areas. ATMS relies heavily on state-of-the-art computer technology and the latest innovations in electronics and communications to manage traffic.