A DISCUSSION OF LIABILITY ISSUES ASSOCIATED WITH AUTOMATED HIGHWAY SYSTEMS

by

Krista Ann Lienau

Professional Mentor
David H. Roper, P.E.
Roper and Associates, Inc.

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Course Instructor
Conrad L. Dudek, Ph.D., P.E.

Department of Civil Engineering
Texas A&M University
College Station, Texas

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SUMMARY

One of the rapidly developing areas within Intelligent Transportation Systems (ITS) is that of Automated Highway Systems. Automated Highway Systems (AHSs) will essentially provide fully automated control through a system of instrumented vehicles and highways, under a concept similar to auto-pilot in aircrafts. With the rise of this new technology there exists the uncertainty associated with prediction of social, economic, and legal outcomes. In particular, it is difficult to budget properly for liability costs associated with new technology which will certainly affect the safety of its users. Until liability is clearly understood, manufacturers and operators cannot properly budget legal costs into the system. These costs can include insurance premiums, costs of legal defense, the cost of operating a claims department and legal staff, and the cost of the actual claims.

The objective of this research was to determine the liability issues surrounding AHS and available options for risk management of these issues. In order to accomplish this objective, the rail transit industry was investigated through a telephone survey to determine current practices in managing liability in the transit industry. Through examination of the transit industry's management of liability, insight was be gained into the possible methods through which AHS liability may be managed. The end result was a listing of the possible outcomes of these liability issues and a discussion of the various advantages of the disadvantages of the options for managing these liabilities.

The majority of the transit systems surveyed deal with two types of liability: Non-operational and operational. Non-operational liability includes construction and installation of new equipment. With regard to equipment and its installation, the agencies require contractors to accept liability for a three-year period. Liability insurance is either procured and paid for by the agency for the contractor or the contractor is required by the agency to provide it. The agency essentially is covered for any faulty equipment from a supplier for a period sufficient for any defects to be detected. With regard to operational liability, transit agencies are liable for any damages due to their negligence. In order to cover these claims, the agencies are self insured for small frequent claims. In addition, insurance policies are purchased for events which are extremely severe and infrequent.

Several options for the distribution of liability related to AHSs have been identified. The options are drastically varied, ranging from government assistance in assumption of liability and granting of sovereign immunity to new insurance policies for drivers. This preliminary analysis of the options therefore covers many possibilities. As AHSs develop, and the precursor analysis moves forward, options will become progressively limited, narrowing the range of liability distribution. As the selection of a Representative System Configuration (RSC) takes place, the role of the manufacturers and government in AHS will become more defined.

Upon the determination of the RSC which will be implemented and tested according to the Intermodal Surface Transportation Efficiency Act of 1991, the role of manufacturers and government in AHS will evolve quickly. If the first AHS is to be operational by 1997, the regulations regarding equipment manufacture, design, and implementation will need to be in place so as to encourage suppliers, developers, and contractors. Without some understanding of their

liability, they will be hesitant to enter the market, particularly with respect to vehicle-based control systems.

Liability is an important issue which shapes the way in which an industry is formed and grows. Without extensive analysis of the situation and a reasonable understanding of what role liability will play in an industry, involved companies, organizations, and investors will be reluctant to participate. Therefore, additional research in this area is strongly recommended in order to erase the uncertainty surrounding liability in AHSs.

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INTRODUCTION

It has long been fantasized by engineers, public officials and commuters to have a highway system which is automated. The benefits dreamed of included improvements with respect to safety, predictability, mobility, air quality, commuter frustration, throughput and many others. With the highway system today being under considerable stress to provide safe yet efficient operations for the growing traffic demand and with significant breakthroughs in Intelligent Transportation System (ITS) technology, the futuristic notion of Automated Highway Systems (AHSs) is becoming a part of today's transportation system.

With the rise of any new technology there exists the uncertainty associated with prediction of social, economic, and legal outcomes. In particular, it is difficult to budget properly for liability costs associated with new technology which will certainly affect the safety of its users (1). Until liability is clearly understood, manufacturers and operators cannot properly budget legal costs into the system. These costs can include insurance premiums, costs of legal defense, the cost of operating a claims department and legal staff, and the cost of the actual claims.

With an examination of the liabilities of the risks associated with AHSs, some of this uncertainty may be erased. If the risks are identified, and potential liabilities explored, methods through which to manage these risks and liabilities can be determined. These methods can then be analyzed to determine the best approach to liability and risk management for AHSs.

Objectives

The objectives of this research were to

1. Identify the risks associated with AHSs;
2. Determine the current liability issues and current practices in risk management in the transit industry through a telephone survey;
3. Develop a table showing the various AHS failure scenarios and the degree of liability exposure by various parties; and
4. Develop a table showing the methods through which the risks and liabilities associated with AHSs could be managed.

Scope

The scope of this paper is limited to a specific Representative System Configuration (RSC). There are a multitude of RSCs under examination in the Precursor Analyses, each slightly different from the others in infrastructure impact, traffic synchronization, instrumentation distribution, or operating speed (2). Even though only one RSC will be directly examined in this paper, many of the conclusions can either be applied to other RSCs or provide a starting point for liability analysis of other RSCs.

The system configuration discussed in this paper will be as follows:

- Dedicated lane(s), physically separated from normal freeway lanes;
- Operation totally under control of system (driver has no control);
- Driver has no driving chores or responsibilities;
- Vehicles are travelling in platoons of 10 - 20 vehicles;
- Speeds are 70 to 80 miles per hour;
- Vehicle spacing is approximately 1 meter;
- Driver indicates destination as he enters the system;
- System tracks vehicle and exits at appropriate ramp;
- System has merge lane as vehicle enters platoon;
- System has exit lane as vehicle leaves platoon
- Check-in procedure will check vehicle, give O.K. to enter system; and
- Check-out procedure will check driver for readiness to take control of vehicle;

Organization

The report will be organized into five sections so as to orderly present all aspects in a logical fashion. The introduction section provides an overview of the problem statement, the study objective, and the scope of the report. The following section provides background on AHSs, liability, and risk management. The third section highlights the risk management approaches of the surveyed transit organizations to dealing with liabilities. The fourth section draws conclusions from the survey of the transit industry, and the final section makes recommendations as to what the potential liabilities are for the AHS RSC under study and provides the available options to deal with these liabilities.

BACKGROUND

In this background section, several aspects of AHSs are first discussed, focusing on several risks associated with the system which pose liability issues. Liability both in general and with regard to public transit are then reviewed. Finally, a discussion of risk management techniques which are available for use by parties involved with AHS is presented.

Automated Highway Systems

Automated Highway Systems will essentially provide fully automated control through a system of instrumented vehicles and highways, under a concept similar to auto-pilot in aircrafts (2). This controlling system is referred to as Automated Vehicle Control, and includes lateral control, longitudinal control, and other system control elements. AHS is foreseen to be the next major evolutionary stage of surface transportation, and thus the focus of United States implementation efforts in the early 21st century. In the Intermodal Surface Transportation Efficiency Act of 1991, Congress stated that

> "The Secretary of Transportation shall develop an automated highway and vehicle prototype from which future fully automated intelligent vehicle-highway systems can be developed. Such development shall include research in human factors to ensure the success of the man-machine relationship. The goal of this program is to have the first fully automated roadway or an automated test track in operation by 1997. This system shall accommodate installation of equipment in new and existing motor vehicles."

The Department of Transportation has established an AHS program to manage this provision. The goal of the AHS program is to significantly improve the safety and efficiency of the nation's surface transportation system through a national effort that best ensures the early, successful development of automated highway systems. In order to investigate the issues and risks related to the design, development, and implementation of Automated Highway Systems, the Federal Highway Administration has awarded fifteen Precursor Systems Analyses (PSA) research contracts. These contracts focus on sixteen activity areas which are listed below.

1. Urban and Rural AHS Comparison
2. Automated Check-In
3. Automated Check-Out
4. Lateral and Longitudinal Control Analysis
5. Malfunction Management Analysis
6. Commercial and Transit AHS Analysis
7. Comparable Systems Analysis
8. AHS Roadway Deployment Analysis
9. Impact of AHS on Surrounding Non-AHS Roadways
10. AHS Entry/Exit Implementation
11. AHS Roadway Operational Analysis
12. Vehicle Operational Analysis
13. Alternative Propulsion Systems Impact
14. AHS Safety Issues

15. Institutional and Societal Aspects
16. Preliminary Cost/Benefit Factors Analysis

For the PSAs to identify issues and risks associated with AHS systems, they will need to concentrate on a group of possible designs, or Representative System Configurations. There are several distinguishing factors between the RSCs being studied, with four primary characteristics being varied: Infrastructure Impact, Traffic Synchronization, Instrumentation Distribution, and Operating Speed (2).

Infrastructure impact, encompasses factors dealing with the effect of implementation on existing structures. Items considered include modification of existing roadways, new roadway construction, new lane construction, entry and exit point construction, and lane use requirements. Traffic synchronization may vary from a synchronous system, a supervisory system, or an a asynchronous system. Synchronous systems would use the platooning concept with short headways. Supervisory systems would entail the assignment of space/time headway slots on the roadway. An asynchronous system would rely on each vehicle to negotiate with adjacent vehicles to perform lateral and longitudinal control. The distribution of instrumentation between the vehicle and the roadway is may range from concepts where all instrumentation is within the infrastructure, and all instrumentation is in the vehicle. Lastly, the operating speeds of the system under analysis span from 55 miles per hour up to 100 miles per hour (2).

There exist several other categories which distinguish the RSCs. The vehicle class (light or heavy) is one such variable. The interaction between the vehicle and the road may be accomplished by either the tires of the vehicle or by a pallet transporting the vehicles and thus is another system characteristic. Some remaining RSC distinguishing factors are the type of power (on-board or roadway provided electric), headway strategy (singe vehicles only or platoons), later and longitudinal control strategy (passive or active infrastructure) and control location (mostly vehicle, mostly infrastructure, or combined). The final factor involves the AHS lanes and access to the AHS. There might exist a transition lane parallel and adjacent to the AHS lane allowing vehicles to transition from automated to manual control or manual to automated control. Another option is that vehicles may enter and exit the system through dedicated AHS ramps. The last option is for automated vehicles and manually operated vehicles to operate together on a non-dedicated AHS (2).

One of the most important decisions to be made in the selection of the RSC for deployment which are two of the activity areas under examination by the AHS teams is that of the use of a check-in and/or check-out system. The importance of a check-in system is due to the desire to operate a system as safe as possible. A check-in system would examine each vehicle and operator to ensure that it can safely operate on the AHS. Preliminary analysis identified several vehicle and operator functions which may be tested at check-in. Vehicle specific tests include brakes, steering, communications, automatic braking and steering systems, and vehicle longitudinal and lateral position sensors. Driver specific tests include name or identification number, driver's license, driver and vehicle AHS certification, driver sobriety and alertness and driver's medical record. If the location of the instrumentation for AVC is within the vehicle, these systems and other mechanical systems might be checked for proper functioning. A check-out system is necessary to ensure that the driver and vehicle are fit to safely exit the AHS and resume manual control (3).

Risks Associated With AHS

The risks associated with AHSs are plentiful, as with any vehicular travel, and currently there is an attempt to adequately identify these risks and design a system such that these risks are eliminated through reliability and redundancy. Risks internal to the system fall into four categories: vehicle components, infrastructure components, roadway design, and communications (4). External risks include uncontrollable events including issues such as weather problems (2).

Several risks have been identified though a fault hazard analysis along with the likely effects of the risks on the individual vehicle and AHS (5). Vehicle type failures include brakes, steering, engine, drivetrain, power, suspension system, fuel pump, emissions system, electrical system, lighting system, exhaust system, and vehicle control computer, sensors, and central processing unit. Roadway based failures associated with AHS include computer, datalink, communication system, sensors, pavement surface, and obstacles. External conditions include wet weather, snow or ice accumulation, uneven snow accumulation, lighting conditions, and crosswinds. In addition, the driver may initiate improper commands, be impaired by alcohol, illness, alcohol, fatigue, or distracted, or there could be a deliberate system override or sabotage of the system.

In current AHS hazard analysis, risks associated with AHSs are being divided into categories for severity and probability as shown in Tables 1 and 2.

Liability

Transit systems operators face many types of liability in their course of operations. They may experience general liability, public official, professional, and director and officer liability, liability to employees, contractual liability, and liability for employees actions (6). These liabilities are briefly discussed below.

Table 1. Hazard Severity Conditions (5).

Description	Category	Mishap Definition
Catastrophic	1	Lead to fatal accidents, system stoppage
Critical	2	Lead to accidents causing severe injury and/or significant property damage, major traffic slowdown
Marginal	3	Lead to accidents causing minor injury and/or minor property damage, traffic slowdown and delay
Negligible	4	Lead to accidents causing less than minor injury, or negligible property damage

Table 2. Hazard Probability Conditions (5).

Description	Level	Specific Individual Vehicle	Along Specific Stretch of AHS
Frequent	A	Likely to occur frequently	Continuously experienced
Probable	B	Will occur several times in life of a vehicle	Will occur frequently
Occasional	C	Likely to occur sometime in life of a vehicle	Will occur several times
Remote	D	Unlikely but possible to occur in the life of a vehicle	Unlikely, but can be reasonably expected to occur
Improbable	E	So unlikely, it can be assumed occurrence may not be experienced	Unlikely to occur, but possible.

General Liability

General liability refers to personal injury, bodily injury, and property loss or damage of a third party as a result of negligence of the transit system. Personal injury includes libel, slander, defamation of character, and invasion of privacy. Bodily injury refers to sickness, injury and death. Property loss is simply damage or destruction of property belonging to a third party (6).

Public Official, Professional, and Officer and Director Liability

Public official liability is incurred by public service agencies primarily in the areas pertaining to hiring and firing of employees, such as sexual harassment, racial discrimination, and wrongful dismissal. Professional liability holds liable any transit operator for any negligence which causes injuries to the general public. In additional, engineers, architects and other white-collar professionals are forced to exercise extreme diligence not to be negligent in their responsibilities to the client (6).

Liability to Employees

An employer is liable to its employees for job-related accidents or occupational illnesses. Currently all states have worker's compensation laws that require employees to provide benefits to employees who are disabled from work-related accidents or occupational disease. Buying a worker's compensation policy from a private insurer is the primary means for employers to meet these obligations. This is a social insurance program which provides medical care, cash benefits, and rehabilitation services to workers injured on the job. The employer is held liable for such an injury or illness, regardless of who is at fault. Employer's liability is an additional portion of a typical workman's compensation policy. This section of the policy covers employers against lawsuits by employees who are injured in the course of employment, but the injuries are not compensable under a state's laws, or due to a third party action (7).

Contractual Liability

An agency can become exposed to additional liability through contracts with other parties, including leases or rental agreements, construction contracts, service contracts. The general procedure through which contractual liability is handled is by transference of responsibility to the other party and by avoidance of assuming additional responsibilities of the other party (6).

Liability For Employees Actions

If an employer-employee relationship exists where the employee is acting on behalf of the employer, negligent acts of an employee can be imputed to the employer. In order for an employer to be held liable for the negligent acts of the employees two requirements must be filed. First, there must exist a legal status as an employee. This usually entails the person being provided with detailed instructions on how to complete a specific task, furnished tools or supplies by an employer, and paid a wage or salary at regular intervals. Second, the employee must be engaged in furthering the employer's business interest. Presently. there is a very broad standard applied, with the employer being held liable even is there is a reasonably foreseeable deviation from the employer's instructions (7).

Defenses To Liability Claims

In order for a injured party to collect damages, they must prove that the tortfeasor is guilty of negligence. In order to prove negligence there are five items which must be satisfied: an act (or omission of an act), existence of a duty, failure to perform that duty, damages or injury to the claimant, and proximate cause relationship between the negligent act and the infliction of damages (7). There are three main defenses which may be used by an organization to defeat a claim for monetary damages. These are contributory negligence, comparative negligence, and the assumption of risk. If an injured individual contributed to the injury in any way, that person cannot recover for his damages according to the contributory negligence law. As this law is harsh, several jurisdictions have enacted a comparative negligence law which permits the injured party to recover damages even though they may have contributed to the accident or injury. The financial burden of liability is shared by both parties according to their respective degrees of fault. The assumption of risk doctrine states that a person who understands and recognizes the danger inherent in a particular activity cannot recover damages in the event of an injury. Basically, this defense will bar recovery for damages from an individual knowingly assumed a risk even though another individual's negligence caused the injury (8).

Risk Management

In order to minimize liability costs, there exists a process of risk management by which the uncertainty of risks is reduced and losses controlled. A risk is any exposure to the possibility of loss or damage to people, property, or other interest. The process became widely used in the 1980s when the liability insurance rates skyrocketed and companies were being forced to pay exorbitant premiums for little coverage. Risk management is a five step process depicted in Figure 1 and discussed below (6).

Risk Identification

Risk Identification is the first step to risk management and can be argued to be the most important. Without knowledge of what all of the risks are, they cannot be managed. The risks associated with public transit are typically liability, property loss, and business interruption. These risk categories can be turned into a list of risks through use of questionnaires, checklists, passenger input, flowcharts and outside experts.

Risk Evaluation

Risk Evaluation generally examines risks to determine what their loss potential is. This occurs in terms of both loss severity and loss frequency. The loss potential is a necessary rating of a risk in order to determine how the risk should be treated. This measure essentially predicts the probability of the event occurring in the future and its severity.

Risk Treatment Analysis

In this step, the risk alternatives are identified and evaluated. There are five common risk alternatives: risk avoidance, risk retention, risk transfer, loss control, and insurance. Risk avoidance is simply avoiding the situation having that peril associated with it. In the transit industry this might entail creation of a policy not to charter vehicles to a hazardous event. Risk retention is the management strategy of remaining all levels of risk internally within the firm. This risk alternative commonly takes the form of self-insurance. Risk transferring attempts to place as much risk within other parties court as possible while still obtaining title to an asset at minimal cost. Loss control is minimizing loss through preventative and/or reactive measures. The final alternative, which is often the most applied technique of risk management, is insurance. This is because the risk can be transferred to a risk bearer who has a greater level of sophistication in modeling the occurrence and severity of the financial cost of certain risk events.

Decision and Implementation

In this step, the risk alternative discussed above, or combination thereof, which best meets the organization's needs is selected and implemented.

Monitoring

The continual monitoring of the risk management program is a vital step to its success. New risks may arise, as may new safety equipment, new training courses, and insurance coverage may change. Therefore, these must all be considered and assessed. The five step process to risk management is a continual cyclic process.

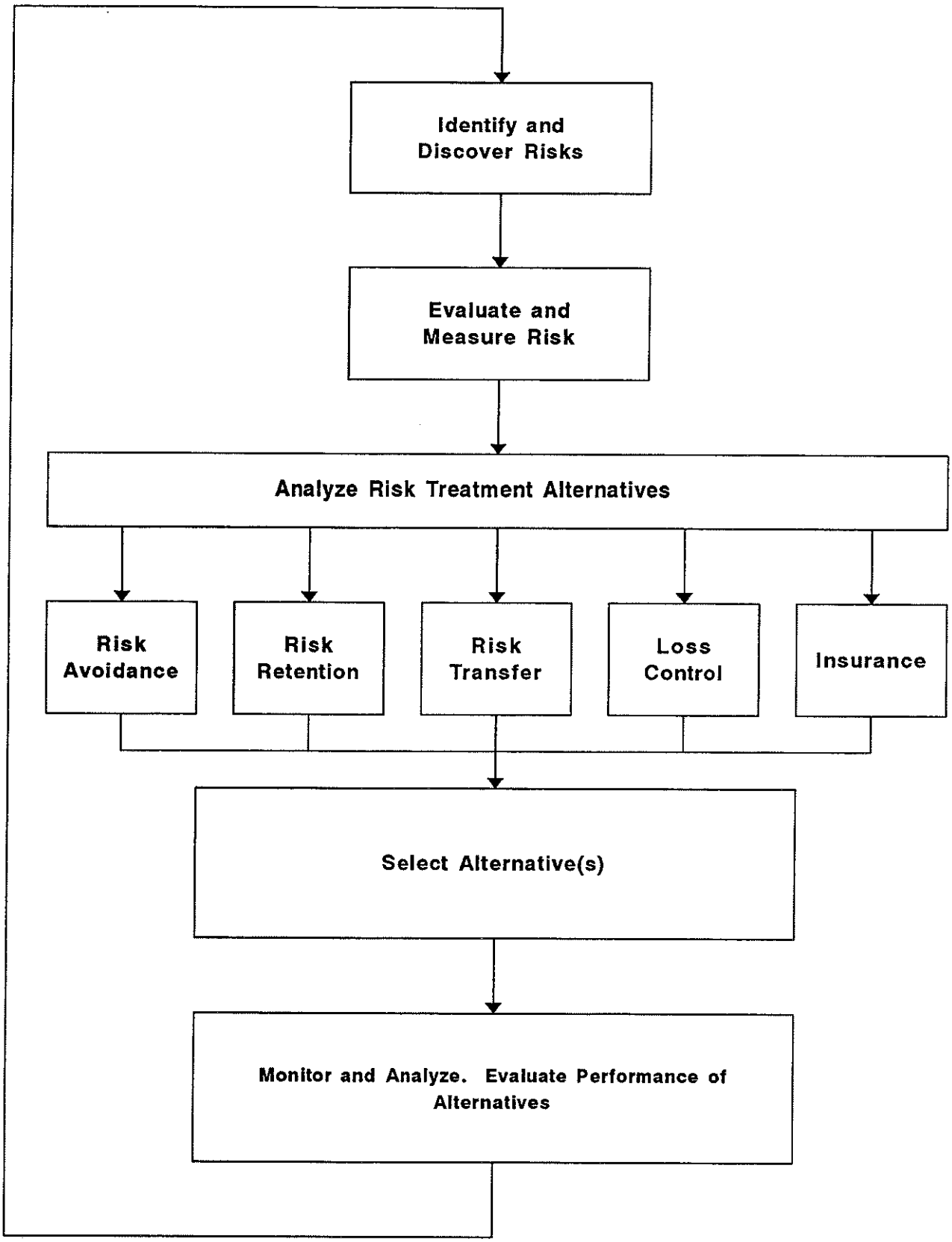

Figure 1. Risk Management Process (6).

Risk Retention and Insurance

Self-insurance is one method of risk retention, whereby a company maintains reserves or budgets for losses instead of the purchase of insurance (7). Another method of risk retention is that of pooling. In pooling, a number of similar agencies, such as transit systems, agree to jointly fund each others losses (6). Agencies contribute to a trust fund in return for coverage for certain risks. Claims management, record keeping, and loss control are typically handled by a pool, just as they would be handled by an insurance company. Therefore, even though pooling is a form of risk retention and is similar to self-insurance, from the agencies point of view, it operates like insurance.

Insurance is defined by Black's Law Dictionary as "a risk management mechanism that uses the pooling of fortuitous losses by transfer of such risk to insurers who contractually agree to indemnify the insureds for such losses, and to provide other pecuniary benefits on their occurrence, or to render services connected with the risk." (9) This basically is the concept of financing fortuitous losses through a medium of risk transfer to a stronger financial mechanism. This method is commonly used to purchase coverage for catastrophic losses that a self-insurance program might not be able to cover.

It should be noted that many transit agencies use a combination of self-insurance and purchased insurance. The self-insurance covers low loss severities occurring at high or low frequencies that can be budgeted for and have a high degree of predictability, and thus a low variance. Excess insurance is purchased on top of this self-insurance in order to cover the company in the cases of high severity risks occurring at a low frequency that is relatively unpredictable.

LIABILITY IN EXISTING TRANSIT SYSTEMS

In order to assess the liability issues surrounding AHSs, a survey was taken of existing transit organizations. The survey was intended to extract information as to what the liabilities are in the transit industry and how the transit authorities deal with this liability. Contacts were identified within five transit organizations utilizing rail transit who had knowledge of the liability issues in their system.

The first interviews conducted helped to shape the subsequent interviews. It became increasingly clear that there are no direct answers for the questions "Who is liable if..." or "Who is liable for...". Contacts stressed the point that each incident is different, and that is the reason that claims turn into lawsuits; no one can decide who is liable so it must go to court. If for every case involving faulty operating equipment or involving operator negligence the same party was liable, they would not have a legal staff or need attorneys. For each claim of negligence to a transit agency, there are several defenses that can be used, and depending on the jurisdiction, the case may evolve differently. The more appropriate questions seemed to be based on what agencies did to protect themselves if they were at fault for something. Two areas of fault were identified: construction oriented and operational oriented. If faulty equipment was supplied or equipment installed improperly, that was primarily covered through some form of contractor insurance. For negligent operations, insurance companies had their own insurance policies or were self-insured.

It was expressed to the transit agencies interviewed that the information they provided would only be used for comparison purposes to draw parallels between liability and risk management issues between the transit industry and those which may develop in the AHSs area. The questions asked during the survey are listed below, however, the interviews varied according to the information the contact was willing and able to provide.

- How many claims are filed against the company in the course of one year?
- How many of these claims are settled?
- How many claims eventually turn into lawsuits?
- How much does the organization spend in claims and lawsuits per year?
- In what way is legal defense handled for the organization?
- With regard to faulty equipment, who assumes liability?
- What insurance does the organization have to cover faulty equipment or require a contractor to have?
- With regard to passenger injuries who assumes liability?

- What insurance does the organization have to cover operational liabilities resulting in passenger injuries?

As stated above, not all of the questions were able to be answered due to the reluctance of some contacts to divulge certain information. Additionally, other contacts provided information beyond the asked questions. Therefore, each interview provided a unique spectrum of information.

Bay Area Rapid Transit District

The Bay Area Rapid Transit District, or BART, is an automated transit system in California. The system operators are required to perform two primary functions: door opening and closing and speed control. The BART system experiences approximately 300 to 325 claims per year. Out of these claims, about one third end in legal action and litigation. In California, a person has six months to file a claim against BART after an occurrence. BART then has 45 days to investigate their liability, and then the claimant is allowed six months in which they may file a lawsuit. Therefore, many claimants file lawsuits in order to meet this deadline even though they may be unsure of the situation. BART spends $1,000,000 to $1,200,000 annually in legal defense and claims. They are self-insured for $10,000,000, and have excess insurance in the event of a catastrophe with insurance companies for $140,000,000. In addition, BART requires any contractors they deal with to purchase an insurance policy for $5,000,000 per occurrence, $1,000,000 in automotive insurance for a three-year period. If the project is a design-build type, they require from $1,000,000 to $5,000,000 depending on the magnitude of the project. In addition, they purchase builder's risk insurance for the cost of replacement.

Port Authority of New York and New Jersey

The Port Authority of New York and New Jersey operates the PATH system which is a rail commuter line from New Jersey to the World Trade Center. On this system, a driver operates the train and a conductor opens and closes the doors, the system is not automated. The Port Authority fights claims as opposed to settling them. They have their own claims department, trial attorneys and appeals attorneys. They are self insured for $4,000,000 per occurrence and purchase $425,000,000 per occurrence of coverage from an insurance company. In 1993, 565 claims were opened against the Port Authority with regard to the PATH system. However, 408 of these were claims by injured employees, and 157 were by injured patrons. This large number of employee claims is a unique situation due to the fact that the Port Authority is an interstate agency and, therefore, employee claims do not fall under the Workman's compensation as most other state transit employee claims would. With regard to construction, the Port Authority has an owner controlled policy for $25,000,000 coverage for liability and $50,000,000 builder's risk coverage. This policy has a $10,000 deductible, and they require the contractor to put up this first $10,000. They deal with the insurance company for this policy, but they reserve the right to take over their defense at any time.

Metropolitan Atlanta Rapid Transit Authority

The Metropolitan Atlanta Rapid Transit Authority, or MARTA, operates 140 rail cars and 600 buses during rush hour. They use an automated train control system, with an operator present to open and close doors and stop the train in the case of an emergency. Most of the claims against MARTA are settled out of court and never become full-fledged lawsuits. MARTA is self-insured for $3,000,000, and the agencies purchase insurance above that with Lloyd's of London and the U.S. Company. With regard to equipment, MARTA requires the supplier to have a minimum of $10,000,000 in liability insurance. For installation contracts, MARTA procures and pays for insurance for the contractor for 3 years. After three years, the liability and insurance costs transfer back to the contractor.

Southeastern Pennsylvania Transportation Authority

The Southeastern Pennsylvania Transportation Authority (SEPTA) is one of the largest transit operating agencies in the country, having in excess of 2000 vehicles in operation. The systems operated include commuter rail, a subway system, an elevated train system, buses and trolleys. All of these are manually operated, no automated control is used. In Pennsylvania, the laws are set up to benefit the claimant providing a difficult environment for a transit authority. They are completely self-insured, their insurance policies were phased out in 1986. They operate with a $250,000 per plaintiff cap on claims. They have an in-house legal staff and utilize top-notch law firms to settle lawsuits beyond the capabilities of their legal claims department. In 1988, 14551 claims were made resulting in 4905 lawsuits filed. $51,100,000 was spent on claims in 1988. In that year, SEPTA implemented a anti-fraud program which cut the rising cost of claims and saved the agency $70,300,000 from 1988 to 1993. Last year, there were 7304 claims filed, resulting in 2112 lawsuits. The expected figure to be spent on claims filed in 1993 is $35,400,000. The highest yearly payout for SEPTA was $59,000,000 when a catastrophe occurred resulting in several deaths many more injuries. For Railroad based construction projects, SEPTA purchases a Railroad protective policy to cover all losses. This assures SEPTA that they are getting the most reasonable price available. For non Railroad projects, the contractor is required to keep insurance at limits specified by SEPTA. Within these policies, SEPTA requires themselves to be named as an additionally insured and requires an indemnity agreement whereby the policy specifically states that even if an occurrence is SEPTA's fault, they are indemnified.

Washington Metropolitan Area Transit Authority

Automated control is used by Washington Metropolitan Area Transit Authority (WMATA) on their 20 year old rail system. WMATA is self-insured for $5,000,000, and they carry additional excess insurance into the hundreds of millions. They do not go through an insurance company, but defend themselves. WMATA provides and procures contractor insurance into the high millions of dollars for a period of three years. They perform this service because it provides them with three assurances: that the rates are the best, that the coverage is adequate, and that the contractors do not add the insurance to the bid cost.

Summary of Transit Industry Liability

When summarizing the liability existing within the transit industry, and how the industry manages this liability, two major differences becomes evident. In the transit industry users are not obliged to provide their own equipment. Users are also not required to be alert or pass a test for entrance into the system. Essentially, in AHS there will be a much larger responsibility placed on users, similar to current travel on the highway system.

The majority of the transit systems surveyed deal with two types of liability: Non-operational and operational. Non-operational liability includes construction and installation of new equipment. With regard to equipment and its installation, the agencies require contractors to accept liability for a three-year period. Liability insurance is either procured and paid for by the agency for the contractor or the contractor is required by the agency to provide it. The agency essentially is covered for any faulty equipment from a supplier for a period sufficient for any defects to be detected. With regard to operational liability, transit agencies are liable for any damages due to their negligence. In order to cover these claims, the agencies are self insured for small frequent claims. In addition, insurance policies are purchased for events which are extremely severe and infrequent.

ANALYSIS OF LIABILITY EXPOSURES

Based on the survey conducted of the transit industry and general concepts concerning liability and risk management, the following analysis of liability exposures was developed by the author.

Automated Highway System Potential Risks

The risks identified with respect to AHSs in the background section above are all liability exposures which may lead to claims from parties who have been injured or experienced property damage related to AHSs. The liability exposures vary drastically depending on the type of AHS: vehicle-based or infrastructure-based. The categories into which these liabilities can be divided for are listed and discussed below.

Vehicle-Based Control System Risks

- Vehicle AVC system failure due to poor maintenance.
- Primary vehicle functions failure due to poor maintenance.
- Vehicle AVC system failure due to defective product.
- Primary vehicle functions failure due to defective product.
- Check-in system failure.
- Driver not alert or acting negligently.
- Natural hazards: animal in roadway, weather conditions, etc.
- Negligent roadway design or unsafe travel conditions.

Infrastructure-Based Control Systems Risks

- Infrastructure control system mechanical failure.
- Infrastructure system operator/supervisor negligence.
- Vehicle functions failure due to poor maintenance.
- Vehicle functions failure due to defective product.
- Check-in system failure.
- Driver not being alert or improper response.
- Natural hazards: animal in roadway, weather conditions, etc.
- Negligent roadway design or unsafe travel conditions.

Automated Highway Systems Potential Liabilities

Accidents are random events, and often are the result of the negligence of more than one party. However, assuming that the situations presented above are straightforward, there are four parties who could be burdened with the liability for accidents occurring on an AHS: drivers, an AHS public operating agency (including check-in operation), and manufacturers, designers, and contractors.

It should be noted that liability is especially high for any driver of the lead-vehicle in a platoon. The rest of the vehicles in the platoon depend on that lead vehicle. If that vehicle has a failure, the entire platoon may result in an accident, not just that vehicle.

Vehicle-Based System Liability Exposures

In order to determine the liability exposures for the risks associated with vehicle-based automated highway systems, the exposures to each risk were rated for each party. The exposures were rated either high, medium, or low, and derived from the information provided in the background provided in this report and survey of the transit industry. Table 3 lists the summarizes these ratings.

Infrastructure-Based System Liability Exposures

To determine the liability exposures for infrastructure-based automated highway systems, the exposures to each risk were rated for each party as they were for vehicle-based systems. Table 4 summarizes these ratings.

Table 3. Liability Exposures For Vehicle-Based Automated Highway Systems.

Risk	Drivers	AHS Operating Agency	Manufacturers, Contractors, Designers
AVC Failure, Poor Maintenance	High	Low	Medium
Vehicle Failure, Poor Maintenance	High	Low	Medium
AVC Failure, Defective Product	Low	Low	High
Vehicle Failure, Defective Product	Low	Low	High
Check-In System Failure	Low	High	Medium
Driver Negligence	High	Low	Low
Natural Hazards	Low	High	Low
Roadway Defect	Low	High	Low

Table 4. Liability Exposures For Infrastructure-Based Automated Highway Systems.

Risk	Drivers	AHS Operating Agency	Manufacturers, Contractors, Designers
Infrastructure Control System Failure	Low	Medium	High
Infrastructure System Operator Negligence	Low	High	Low
Vehicle Failure, Poor Maintenance	High	Low	Medium
Vehicle Failure, Defective Product	Medium	Low	High
Check-In System Failure	Low	High	Low
Driver Negligence	High	Low	Low
Natural Hazard	Low	High	Low
Roadway Defect	Low	High	Low

In essence, the liability exposures associated with automated highway systems vary between the vehicle-based control systems and infrastructure-based control systems. With vehicle-based systems, the automotive manufacturers, will have the highest liability exposures. Thousands of their systems will be travelling on the automated highway system, each one being a risk for the manufacturer. With infrastructure-based systems, the public agency operating the automated highway systems will have the highest liability exposures.

RISK MANAGEMENT OPTIONS FOR AUTOMATED HIGHWAY SYSTEMS

Through examination of the liability exposures of the parties involved with AHS, the background sections presented in this paper, and the survey of the transit industry conducted in this study, the following options for the risk management of AHS liability were developed.

In order to maximize a reward, claimants and their attorneys will try to claim damages from the negligent party who has the most assets. Therefore, manufacturers will have high exposure to liability associated with automated vehicle control devices. This may seriously inhibit private sector investment in the program, as well as potential equipment suppliers, manufacturers, contractors, and designers. AHSs could shift the burden of liability from motorists to manufacturers, which upsets the present liability laws and insurance policies. There will hence be a need for new legislation and new insurance structures.

In order to promote AHSs and transportation safety and efficiency, the government could assume liability for claims as a result of an AHS. This could encompass a range of liability ranging from all liability to specified liabilities resulting from certain circumstances. This would relieve the manufacturers from high risk, and encourage the market. The government could also assume liability above a certain threshold. This way the manufacturers, and AHS agencies would be assured that their liability expenditures would not exceed a certain level.

A reasonable premium level could also be mandated for insurance for AHSs operating agencies and manufacturers which would allow these parties to cover claims without spending a majority of their budget. The inflation of insurance rates has been a major problem of transit many industries in the past, and deterred much of the market.

Legislation could be mandated so as to condition all receipts of services and goods to submit claims to arbitration. Arbitration would cut down the cost of legal personnel and effort otherwise needed, as well as some of the claims costs.

Government standards and regulations may be set up regarding the design and manufacture of AHSs. Compliance to these standards will limit the liability of the manufacturers, and thus encourage them to enter the market. With such regulations, sovereign immunity can be extended to contractors and suppliers who comply. This extension may be viewed by many, though, as the start of a trend to grant immunity wherever it is convenient. The public transit industry does not enjoy the blanket of sovereign immunity, and thus there may be an outcry for immunity in that industry due to the similarity of the situation.

Vehicle-Based Control Systems Liability

There are seven possibilities for the distribution of liability of an AHS which is vehicle-based. The claims listed above fall into 5 general categories: AVC failure, check-in failure, vehicle failure, driver negligence, external hazards (weather, animals, etc.), and roadway failure (ruts, etc.) AVC failure refers to failure of a control system, either longitudinal, lateral, or other vehicle based system needed to operate on an AHS. Check-in system failure is the case when a test of the vehicle or driver fails to detect a defect. Vehicle failure refers to failure of a

primary part of the vehicle which was undetectable by the check-in system. Driver negligence refers to a driver being unable to perform his duties as a driver on the AHS. External hazards include inclement weather conditions, foliage or animals in the roadway, and other natural or otherwise unavoidable circumstances. Roadway failure includes ruts and potholes, or other infrastructure based failures. Table 5 summarizes possibilities for who will accept liability for these acts.

Infrastructure-Based Control Systems Liability

The infrastructure-based AHSs have similar categories for claims, however,there are two additional categories: infrastructure control failure and operator negligence. Failure in the infrastructure control system will replace much of the claims referred to as AVC failure. As opposed to thousands of vehicle based systems having the potential to fail, there will be one infrastructure system which may result in less claims for manufacturers and the AHS operators. Table 6 summarizes possibilities as to who will accept liability for infrastructure-based AHS claims.

Table 5. Division of AHS Liability For Vehicle-Based Systems.

Option	Liability	Party	Comments
1	AVC/Check-In Failure	Government	In this case, the government accepts responsibility for all liabilities. Therefore, no additional driver's insurance is required, and manufacturers will be able to enter the market with little fear of extensive liability costs. The AHS will also be covered for liability by the government. Another version of this option is to have the government accept only liability above a certain point. Small claims could fall according to one of the other options, with government accepting claims for catastrophic incidents.
	Vehicle Failure	Government	
	Driver Negligence	Government	
	External Hazards	Government	
	Roadway Failure	Government	
2	AVC/Check-In Failure	Government	The government could extent immunity to manufacturers and AHS agencies which would allow them to enter the market. This presents problems with other suppliers desiring the same luxury. Additionally, driver's insurance coverage would have to be extended, or an additional policy required upon entrance to the system to cover accidents resulting from their vehicle or their negligence. This policy may cover roadway hazards such as obstacles, animals in the roadway, or that may be the responsibility of the AHS agency operating the road.
	Vehicle Failure	Driver	
	Driver Negligence	Driver	
	External Hazards	Driver	
	Roadway Failure	Government or Driver	
3	AVC/Check-In Failure	Driver	The third option is for the driver to cover all costs through a purchased insurance policy at a reasonable rate which covers any incidents occurring while on an AHS, regardless of the reason. This would be similar to a no fault policy. However, this option is not likely as most states have repealed all no fault insurance, and insurance companies may not want to underwrite such a policy for premiums drivers could afford.
	Vehicle Failure	Driver	
	Driver Negligence	Driver	
	External Hazards	Driver	
	Roadway Failure	Driver	
4	AVC/Check-In Failure	AHS	In this case, the driver would again have an extended insurance policy covering incidents on the AHS related to their negligence or faulty vehicle equipment. The AHS operating agency would be responsible for the remainder of the incidents, assuming liability for manufacturers. This may arise if the government grants immunity to manufacturers or if there are strict regulations governing design and manufacturing of AHS equipment limiting liability of manufacturers.
	Vehicle Failure	Driver	
	Driver Negligence	Driver	
	External Hazards	Driver	
	Roadway Failure	AHS or Driver	

Table 5. Division of AHS Liability for Vehicle Based Systems (Con't).

Option	Liability	Party	Comments
5	AVC/Check-In Failure	AHS	This option would entail the AHS operating agency to assume all liability for drivers and manufacturers as well as the operation of the system. This would only be a reasonable option if the government put a limit on claims or absorbed liability after a certain level.
	Vehicle Failure	AHS	
	Driver Negligence	AHS	
	External Hazards	AHS	
	Roadway Failure	AHS	
6	AVC/Check-In Failure	Government	If the government were to assume liability for manufacturers only, the AHS operating agency be liable only for a faulty design in the system in terms of the roadway or liable for maintenance of the roadway. Drivers would still be responsible for their vehicles and their own negligence through purchase of an insurance policy.
	Vehicle Failure	Driver	
	Driver Negligence	Driver	
	External Hazards	Driver	
	Roadway Failure	AHS or Driver	
7	AVC/Check-In Failure	Manufacturer	If no immunity is granted to manufacturers, they would be responsible for a large portion of liability regarding any equipment they supply or install. Driver would still need insurance coverage to cover losses regarding vehicle failure or driver negligence. The AHS agency would be responsible for any faulty design or maintenance of the AHS dedicated lanes.
	Vehicle Failure	Driver	
	Driver Negligence	Driver	
	External Hazards	Driver	
	Roadway Failure	AHS or Driver	

Table 6. Division of AHS Liability For Infrastructure-Based Systems.

Option	Liability	Party	Comments
1	AVC/Check-In Failure	Government	In this case, the government accepts responsibility for all liabilities. Therefore, no additional driver's insurance is required, and manufacturers will be able to enter the market with little fear of extensive liability costs. The AHS will also be covered for liability by the government. Another version of this option is to have the government accept only liability above a certain point. Small claims could fall according to one of the other options, with government accepting claims for catastrophic incidents.
	Vehicle Failure/Driver Negl.	Government	
	External Hazards	Government	
	Roadway Failure	Government	
	Control System Failure	Government	
	Operator Negligence	Government	
2	AVC/Check-In Failure	Driver	The second option is for the driver to cover all costs through a purchased insurance policy at a reasonable rate which covers any incidents occurring while on an AHS, regardless of the reason. This would be similar to a no fault policy. However, this option is not likely as most states have repealed all no fault insurance, and insurance companies may not want to underwrite such a policy for premiums drivers could afford.
	Vehicle Failure/Driver Negl.	Driver	
	External Hazards	Driver	
	Roadway Failure	Driver	
	Control System Failure	Driver	
	Operator Negligence	Driver	
3	AVC/Check-In Failure	AHS	This option would entail the AHS operating agency to assume all liability for drivers and manufacturers as well as the operation of the system. This would only be a reasonable option if the government put a limit on claims or absorbed liability after a certain level.
	Vehicle Failure/Driver Negl.	AHS	
	External Hazards	AHS	
	Roadway Failure	AHS	
	Control System Failure	AHS	
	Operator Negligence	AHS	

Table 6. Division of AHS Liability For Infrastructure Based Systems (Con't).

Option	Liability	Party	Comments
4	AVC/Check-In Failure	Government	The government could extent immunity to manufacturers and AHS agencies which would allow them to enter the market. This presents problems with other suppliers desiring the same luxury. Additionally, driver's insurance coverage would have to be extended, or an additional policy required upon entrance to the system to cover accidents resulting from their vehicle or their negligence. This policy may cover roadway hazards such as obstacles, animals in the roadway, or that may be the responsibility of the AHS agency operating the road.
	Vehicle Failure/Driver Negl.	Driver	
	External Hazards	Driver	
	Roadway Failure	Government	
	Control System Failure	Government	
	Operator Negligence	Government	
5	AVC/Check-In Failure	AHS	In this case, the driver would again have an extended insurance policy covering incidents on the AHS related to their negligence or faulty vehicle equipment. The AHS operating agency would be responsible for the remainder of the incidents, assuming liability for manufacturers. This may arise if the government grants immunity to manufacturers or if there are strict regulations governing design and manufacturing of AHS equipment limiting liability of manufacturers.
	Vehicle Failure/Driver Negl.	Driver	
	External Hazards	Driver	
	Roadway Failure	AHS or Driver	
	Control Systems Failure	AHS	
	Operator Negligence	AHS	
6	AVC/Check-In Failure	Government	If the government were to assume liability for manufacturers only, the AHS operating agency be liable only for a faulty design in the system in terms of the roadway or liable for maintenance of the roadway. They would also be liable for the control of the system, and all system equipment operation. Drivers would still be responsible for their vehicles and their own negligence through purchase of an insurance policy.
	Vehicle Failure/Driver Negl.	Driver	
	External Hazards	Driver	
	Roadway Failure	AHS or Driver	
	Control Systems Failure	AHS	
	Operator Negligence	AHS	

Table 6. Division of AHS Liability For Infrastructure Based Systems (Con't).

Option	Liability	Party	Comments
7	AVC/Check-In Failure	Manufacturer	If no immunity is granted to manufacturers, they would be responsible for a large portion of liability regarding any equipment they supply or install. Driver would still need insurance coverage to cover losses regarding vehicle failure or driver negligence. The AHS agency would be responsible for any faulty design or maintenance of the AHS dedicated lanes. This differs from the vehicle based system option primarily in that there would be one main system, not thousands of in-vehicle systems which have the opportunity to be tampered with or somehow injured by the drivers.
	Vehicle Failure/ Driver Negligence	Driver	
	External Hazards	Driver	
	Roadway Failure	AHS or Driver	
	Control System Failure	AHS	
	Operator Negligence	AHS	

RECOMMENDATIONS

Several options for the distribution of liability related to AHSs have been discussed above in Tables 5 and 6. The options are drastically varied, ranging from government assistance in assumption of liability and granting of sovereign immunity to new insurance policies for drivers. This preliminary analysis of the options therefore covers many possibilities. As systems develop, and the precursor analysis moves forward, options will become progressively limited, narrowing the range of liability distribution. As the selection of a RSC takes place, the role of the manufacturers and government in AHS will become more defined.

Upon the determination of the RSC which will be implemented and tested according to the Intermodal Surface Transportation Efficiency Act of 1991, the role of manufacturers and government in AHSs will evolve quickly. If the first AHS is to be operational by 1997, the regulations regarding equipment manufacture, design, and implementation will need to be in place so as to encourage suppliers, developers, and contractors. Without some understanding of their liability, they will be hesitant to enter the market, particularly with respect to vehicle-based control systems.

Liability is an important issue which shaped the way in which an industry is formed and grows. Without extensive analysis of the situation and a reasonable understanding of what role liability will play in an industry, involved companies, organizations, and investors will be reluctant to participate. Therefore, additional research in this area is strongly recommended in order to erase the uncertainty surrounding liability in AHSs.

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Krista Lienau graduated from the University of Virginia with a B.S. in Applied Mathematics in May, 1991. During her studies, she was an active member of the Trigon Engineering Society and the Society of Women Engineers. Upon graduation, she was hired as a systems engineer for TRW, Inc. where she worked for a year on the Integrated Undersea Surveillance System project at the Naval Research Laboratory. Currently, she is pursuing a M.S. in Civil Engineering at Texas A&M University while she is employed as a Graduate Research Assistant for the Texas Transportation Institute. University activities include being a student member and officer in the Institute of Transportation Engineers. Her areas of interest include transportation planning, public transportation, and traffic impact analysis.