FINAL REPORT

TORT REFORM AND "SMART" HIGHWAYS: ARE LIABILITY CONCERNS IMPEDING THE DEVELOPMENT OF COST-EFFECTIVE INTELLIGENT VEHICLE-HIGHWAY SYSTEMS?

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Standard Title Page — Report on State Project

Report No.	Report Date	No. Pages	Type Report:	Project No.:
VTRC 94-R6	March 1994	50 pages	Final Report Period Covered:	9227-040-940 Contract No.:

Title and Subtitle

Tort Reform and "Smart" Highways: Are Liability Concerns Impeding the Development of Cost-Effective Intelligent Vehicle-Highway Systems

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Key Words

intelligent vehicle-highway systems
tort liability
tort reform
risk discounting
smart highways

Supplementary Notes

None

Abstract

Highly automated vehicles and highways—which permit higher travel speeds, narrower lanes, smaller headways between vehicles, and optimized routing (collectively called intelligent vehicle-highway systems or IVHS)—have been generally conceded to be the most promising solutions to our existing, and future, highway transportation problems.

Although IVHS may eventually revolutionize surface transportation, their development is proceeding slowly in part as a result of concerns over the potential impact of tort liability. Specifically, IVHS developers note that although at present, the cost of automobile accidents are for the most part borne by drivers, increased automation may shift accident cost liability to IVHS developers and operators.

This study uses a three-step process to evaluate the IVHS tort liability risk problem. The first part evaluates the claim that IVHS are likely to shift accident liability to highway departments or system manufacturers. The second part examines the appropriateness of government intervention as a means of addressing the IVHS liability problems identified in part one. The third part outlines the potential methods of government intervention that have been proposed in the IVHS literature and indicates which solutions are optimal for each type of IVHS technology.

The study finds that significant liability problems are unlikely to arise with many forms of IVHS, or if they do, they are not the type of liability that should be addressed through government intervention. However, there are plausible reasons for government intervention for automatic vehicle navigation, collision warning, collision avoidance, speed and headway keeping, and automated highway/guideway systems.

The forms of intervention considered in this report are

- state/federal regulation
- statutory liability limits
- federal government indemnification
- liability disclaimers, liability insurance, and mandatory risk pooling.

Approaches to these potential solutions are described in the paper.

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(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

Virginia Transportation Research Council
(A Cooperative Organization Sponsored Jointly by the Virginia Department of Transportation and the University of Virginia)

Charlottesville, Virginia

March 1994
VTRC 94-R6

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ABSTRACT

Highly automated vehicles and highways—which permit higher travel speeds, narrower lanes, smaller headways between vehicles, and optimized routing (collectively called intelligent vehicle-highway systems or IVHS)—have been generally conceded to be the most promising solutions to our existing, and future, highway transportation problems.

Although IVHS may eventually revolutionize surface transportation, their development is proceeding slowly in part as a result of concerns over the potential impact of tort liability. Specifically, IVHS developers note that although at present, the cost of automobile accidents are for the most part borne by drivers, increased automation may shift accident cost liability to IVHS developers and operators.

This study uses a three-step process to evaluate the IVHS tort liability risk problem. The first part evaluates the claim that IVHS are likely to shift accident liability to highway departments or system manufacturers. The second part examines the appropriateness of government intervention as a means of addressing the IVHS liability problems identified in part one. The third part outlines the potential methods of government intervention that have been proposed in the IVHS literature and indicates which solutions are optimal for each type of IVHS technology.

The study finds that significant liability problems are unlikely to arise with many forms of IVHS, or if they do, they are not the type of liability that should be addressed through government intervention. However, there are plausible reasons for government intervention for automatic vehicle navigation, collision warning, collision avoidance, speed and headway keeping, and automated highway/guideway systems.

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INTRODUCTION

Over the past several decades, population growth, suburbanization, and the increase in two-income families have worked to greatly expand both the number of cars on the highways and the distance of the average commute. This in turn has led to heavy congestion or gridlock in many urban and suburban areas, resulting in increased energy consumption, accident costs, and pollution. The traditional solution to congestion has been new road construction and the development of mass transit systems. However, given the high cost of road expansion in developed areas, the difficulty of providing cost-effective mass transit in and between suburban population centers, and community resistance to public transportation, these measures have proved increasingly ineffective. For example, one study shows that from 1970 to 1987, there has been a 70 percent increase in the number of vehicle miles traveled in the Washington, D.C., area, whereas there has been only a 6 percent increase in real dollar expenditures on roads.[1] Thus, a number of new methods are being examined for reducing congestion.

One such method involves the use of highly automated vehicles and highways that will permit higher speed travel, narrower lanes, smaller headways between vehicles, and optimized routing. The new and emerging technologies that would permit these improvements are generally referred to as intelligent vehicle highway systems (IVHS). In addition, IVHS are expected to improve highway safety (through collision avoidance systems, traveler information, and computer control of traffic flow), reduce travel distances (by optimizing routes), and simplify driving (through automated navigation and control of vehicles).

1. Willis, D. "Future of Transportation Technology," Transportation Research Record 1243, p. 47, Dec. 1989.

Although IVHS have the potential to revolutionize surface transportation, the development of these systems is proceeding slowly. One reason for this slow progress may be concerns relating to the potential impact of tort liability on the cost-effectiveness of IVHS.[2] Specifically, IVHS developers note that although at present, the cost of automobile accidents is for the most part borne by drivers,[3] the increased automation that IVHS will provide may shift much of the liability to the developers and operators of IVHS. Since automobile transportation causes a large number of accidents and lawsuits, this shift in liability could be significant. Thus, even though IVHS are likely to reduce the number and severity of traffic accidents, state/local governments and IVHS equipment manufacturers could experience a dramatic increase in tort liability exposure.

The potential for IVHS to shift accident responsibility has generated considerable concern, since the increased liability risk may slow or halt investment in IVHS technology.[4] In response to this perceived problem, IVHS proponents have suggested that the government intervene[5] and mitigate the liability risk to ensure timely implementation of IVHS along with their safety and congestion-relief benefits. However, despite the intuitive appeal of this suggestion, a shift in liability for automobile accidents from consumers to IVHS developers is by itself insufficient to justify government intervention. The losses caused by automobile accidents are a true cost of driving; thus, the efficiency notions upon which much of tort law is based indicate that these losses must be internalized (i.e., placed on those benefitting from our current highway transportation system—drivers) to ensure that the marketplace produces a cost-effective level of highway safety equipment.[6] Such cost internalization is achieved with our existing transportation system, since the legal responsibility for most accidents is borne by drivers. Similarly, accident costs should also be internalized with "smart" highway systems, since any costs shifted to IVHS manufacturers will simply be shifted back to drivers through higher prices for IVHS products and services. However, liability limits, indemnification, and other forms of government intervention partially externalize accident costs by shifting them to taxpayers or accident victims. Consequently, government intervention is inappropriate,

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2. A number of other factors have also slowed IVHS development, including the difficulty of establishing engineering standards that ensure interoperability among various IVHS; uncertainty over the best institutional arrangements for system financing and development; and reservations over consumer interest in IVHS. This paper, however, focuses solely on the impact of tort liability concerns on the development of IVHS.
3. This occurs because the driver controls most aspects of the vehicle's operation; thus, unless there is a defective product or state negligence in the design, operation, or maintenance of the road system, it is difficult to shift accident liability away from the drivers of the vehicles involved.
4. See, e.g., "Strategic Plan for IVHS in the United States," IVHS America, April 24, 1992, at III-125, III-127.
5. Suggested forms of intervention include legislatively imposed liability caps, regulatory protection for IVHS developers, or federal government indemnification of developers' liability costs.
6. See generally, Guido Calabresi, *The Costs of Accidents, A Legal and Economic Analysis*, 68-75 (1970) (discussing how cost internalization leads to optimum resource allocation between different activities).

since the cost externalization would distort consumption decisions, thereby leading to overinvestment in IVHS.[7]

Even though cost internalization goals suggest that IVHS-induced liability transfers are harmless, a second phenomenon, i.e., the tendency of many consumers to act irrationally and discount the true costs of serious injuries, may provide an alternative justification for government subsidization of IVHS. Numerous studies have indicated that most individuals underestimate both the probability of suffering serious accident-related injuries and the magnitude of loss typically involved.[8] Thus, many consumers will be unwilling to pay for cost-effective[9] IVHS, since when priced to cover the manufacturer's expected liability costs, they will appear overpriced as the result of risk discounting. Consumer ambivalence, in turn, will lead to underinvestment in these technologies. In response to these concerns, the IVHS community has made numerous requests for (1) studies to quantify the expected liability burden of IVHS developers as well as the magnitude of the consumer risk-discounting problem and (2) government intervention to limit the potential liability.

However, determining the appropriate governmental response to the problem of consumer underinvestment[10] in IVHS is difficult for several reasons. First, the level of response is dependent on the degree to which IVHS actually shift liability away from drivers. Forecasting this shift in liability prior to the implementation of IVHS is very difficult because critical factors such as system reliability and the degree to which control is transferred from the driver are as yet either unknown or undecided. In addition, tort law standards are not constant and to an extent are influenced by technological changes; thus, automobile accident liability will likely evolve with the introduction of IVHS. This phenomenon further complicates the task of estimating IVHS liability especially for systems such as automated highways, which are not likely to be developed for some time. Finally, the extent of the governmental response to the tort liability problem necessarily depends on the degree to which consumers discount the risks, which defies precise measurement. Consequently, it is unlikely that the most efficient level of government intervention can ever be accurately identified. Thus, either too little liability protection will be provided manufacturers (with the result that even efficient IVHS will be priced above what consumers are willing to pay for them and hence will go undeveloped), or too much protection will be provided (causing consumers to invest not only in cost-effective IVHS but also in systems with true costs exceeding their safety and congestion-reducing benefits).

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7. Furthermore, externalization has the perverse effect of reducing manufacturers' incentives to create safe systems.
8. See *infra* notes 55 through 58 and accompanying text.
9. Cost-effective in the sense that the system's accident reduction (safety) and congestion relief features are worth more to rational consumers than the cost of purchasing the system.
10. As discussed above, this underinvestment may result because consumers underestimate the full benefits that IVHS provides in terms of increased safety.

Taken together, these problems significantly complicate the task of determining the appropriate amount of government intervention in solving the IVHS liability problem. Consequently, studies of this problem to date have been limited to examining potential *methods* of government intervention, whereas the more critical inquiries into the *extent* of the liability transfer and the *appropriateness* of government intervention have not been addressed. This study (1) identifies which IVHS are likely to experience significant liability problems; (2) evaluates the claims that this liability transfer, in conjunction with consumer risk discounting, will result in underinvestment in efficient IVHS technology; and (3) to the extent these claims are found to be accurate, recommends approaches for dealing with these liability problems.

To accomplish these goals, the following methodology is employed. Part 1 evaluates the claim that IVHS will shift accident liability. Current automobile-related tort data is examined to determine the accident characteristics that are likely to result in the liability of either the government or the manufacturer. Then, each of the proposed IVHS technologies is examined to determine the extent to which they each possess these liability-inducing characteristics, and rough estimates of their potential to shift accident liability to IVHS manufacturers are developed. Part 2 examines the claim that consumer risk discounting will lead to underinvestment in IVHS and shows that this claim serves as a justification for tort immunity with only a limited number of IVHS. Finally, Part 3 outlines potential solutions to the IVHS liability problem and using the insights developed in Parts 1 and 2 on the cause and extent of the liability problem, indicates which solutions are optimal for each kind of IVHS technology.

PART 1: WILL IVHS SHIFT ACCIDENT LIABILITY TO MANUFACTURERS AND HIGHWAY DEPARTMENTS?

In this part, the extent to which the increased automation provided by IVHS is likely to shift accident liability from drivers to IVHS developers and operators is examined. This is accomplished through a two-step process. In the first step, highway department records and existing case law are surveyed to identify the types of tort claims that are routinely successful against state or local governments and private manufacturers. Since many IVHS concepts are simply variations of systems already in use today that are more advanced technologically,[11] the characteristics identified through this survey should be reasonably representative of the system characteristics that are likely to cause liability problems with IVHS. In the second step, each of the proposed IVHS is

11. The similarity between many of the proposed IVHS concepts and current vehicle/roadway systems will be made apparent later in this section.

examined to determine the extent to which it possesses the liability-inducing characteristics identified from the current tort data.

Indications from Current Liability Data

State Highway Departments

Over the past several decades, legal changes eliminating governmental immunity and expanding safety responsibilities have exposed state and local highway departments to increased tort liability.[12] Concerns over this expansion in liability have motivated a number of risk management studies at the state level that seek to identify the types of highway-related claims that result in state compensation. This section examines data from a Virginia Department of Transportation (VDOT) risk management study[13] and from a nationwide survey of state highway departments in order to identify the highway department activities that are likely to result in significant liability exposure.

Liability Data

The VDOT study indicates that over a 5-year period (from 1983 to 1988), a total of 332 claims were filed against the state for amounts exceeding $1,000.[14] Of these claims, a total of 87 eventually resulted in compensation through settlements or court-ordered judgments. Table 1 summarizes the successful claims that were filed during this time.

Table 1 is helpful in identifying the state highway department operations that typically lead to state liability. The data show that state maintenance crew failures, the use of defective highway equipment, the failure to provide safety equipment, hazardous road designs, insufficient warning signs, and negligent highway personnel can all lead to state highway department liability. Furthermore, the data identify two additional liability-inducing highway department

12. Of course, limited sovereign immunity protection still exists in all states, and the public duty defense is capable of reducing highway departments' tort liability in at least a few jurisdictions. However, as shown in the Appendix, these defenses are typically very limited in scope; consequently, state highway departments cannot expect significant protection from these defenses.

13. In Virginia, VDOT is responsible for the design, construction, and maintenance of all public roads in the state except those located in incorporated municipalities. Thus, the VDOT records reviewed are indicative of *both* state and local liability, since county roads fall under VDOT's responsibility.

14. See Culkin, *et al.*, *Assessment of Tort Liability Risk Management in the Virginia Department of Transportation*, Virginia Transportation Research Council, September 1988; VDOT Computer Printout "Outstanding Claims Against the Department—April 4, 1983 to March 31, 1992." The study also tabulated claims (over a 6-month period) against VDOT for amounts lower than $1,000. A total of 304 such claims were filed, of which 154 eventually resulted in state compensation for a total payout of over $30,000. Of the successful claims, nearly 50 percent were based on negligent operation of VDOT mowers.

TABLE 1
CLAIMS OVER $1000 PAID BY VDOT
(APRIL OF 1983 THROUGH JUNE OF 1988)

Claim Description	Total Claims	Total Amount Paid ($k)	Largest Claim Paid ($k)
Maintenance Claims			
Fallen Tree	4	7.3	3.5
Loose Gravel	3	24.5	12.0
Uneven Sidewalk	2	10.0	7.0
Obscured Sign	1	17.5	17.5
Open Manhole/Drain Cover	4	26.5	22.5
Object in Road	2	3.2	2.0
Other Improper Road Maintenance	3	64.0	30.0
Bridge Expansion Joint	1	1,569.7	1,569.7
Defective Equipment Claims			
Gate Malfunction	1	1.2	1.2
Malfunctioning Signal	2	15.5	10.0
Draw Span	2	16.0	8.0
Failure to Provide Safety Equipment Claims			
Ice on Bridge	2	0.5	0.3
No Rock Slide Barriers	1	13.0	13.0
No Guardrail	4	41.4	18.5
Hazardous Design Claims			
Flood Damage/Standing Water	3	31.1	15.1
Hazardous Road Design	4	276.2	250.0
Inadequate Warning Claims			
Work Zone Signing	2	38.8	35.0
Improper Signing	2	8.0	5.0
Operational Personnel Negligence Claims			
Dust	1	111.2	100.0
Wet Paint	6	4.6	1.6
Cut Power Line	1	1.2	1.2
Inmate Mistreatment	3	49.0	24.5
Blasting/Grading/Other Property Damage	21	56.3	12.0
Mower/Motorgrader Collisions	12	34.5	12.9
TOTAL	87	2,421.2	

operations: decisions by the state to implement congestion-reducing (or cost-saving) measures that end up decreasing road safety[15] and state decisions to implement additional safety features on existing roadways.[16] Thus, a total of eight areas of operation can be identified that tend to determine the extent of liability currently faced by state highway departments. Subsequent sections of this report will examine the extent to which the various IVHS are likely to fall into one of these eight areas in order to estimate IVHS-induced liability that state and local governments should anticipate.

Implications for IVHS

In addition to identifying which highway department operations represent liability risks, Table 1 also provides several other insights. The first of these is that over 80 percent of the successful claims involved negligence in road construction or maintenance. Since IVHS focus on increasing the information available to the driver and automating vehicle control, these types of claims are not predictive of any additional liability with IVHS. Furthermore, in the areas of state highway department operations that are most analogous to IVHS (traffic signals and railroad crossing barriers), only two claims totalling $15,500 were successful against VDOT during the 5-year period. Thus, the data tend to show that there is a low correlation between technology and state highway department tort liability. Second, the overall VDOT liability exposure was less than $500,000 per year over this period, and over 60 percent of this yearly average was the result of a single accident involving a bridge expansion joint. This further seems to indicate that fears of excessive state government IVHS liability are unfounded. Finally, Table 1 shows that nearly every successful claim involved "active" negligence by VDOT employees (e.g., mower/motorgrader collisions, blasting damage, wet paint, dust, inmate injuries, etc.); only a few (no guardrail, no rockslide barrier) involved a failure by VDOT to provide a service or safety device. This demonstrates that although VDOT is definitely required to use reasonable care once it engages in an activity, it has little, if any, responsibility to provide services it decides not to implement.[17] Consequently, it is unlikely that state highway departments will face significant liability for failing to implement IVHS.

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15. State decisions to implement congestion- and cost-reducing techniques, such as the use of left-lane freeway entrances and exits, narrow lanes in construction zones, and the opening of freeway shoulder lanes to traffic during rush hour all reduce highway safety; thus, they can potentially lead to state liability under hazardous design and negligent operation claims.
16. The implementation of additional safety features can also lead to increased state liability because once they are provided, they must be operated and maintained non-negligently. See John Vance, Supplement to "Liability of State and Local Governments for Negligence Arising Out of the Implementation and Maintenance of Warning Signs, Traffic Lights, and Pavement Markings," in Legal Research Digest, No. 3, p. 3, Dec. 1988. Thus, state liability for traffic accidents typically *increases* when new safety features are installed.
17. The failure to provide guardrails or rock barriers can be viewed as a negligent road design decision (i.e., once VDOT decides to build a road, it has an obligation to provide reasonable motorist safeguards).

However, although the VDOT data seem to indicate that state governments are unlikely to face significant IVHS-related tort liability, such a conclusion is suspect for two reasons. First, although Virginia did not experience significant liability related to high-technology equipment, case law from other states indicates that the cases are occurring. For instance, highway departments in other jurisdictions have been held liable for malfunctioning traffic lights,[18] street lights,[19] drawbridge barriers,[20] and railroad grade crossing signals.[21] Taken together, these cases indicate that at least the potential exists for significant state IVHS liability. Furthermore, although a formal study has not been conducted, VDOT officials believe that the number of accidents involving high-technology roadway safety equipment is increasing and that this trend will likely impact state tort settlement and award figures. For example, over the 5-year period for which VDOT tort claims were analyzed, not a single suit was successfully brought against the state for accidents involving high-technology electronic safety equipment. However, in the last year, at least two such malfunctions have occurred, and both are expected to result in claims against the state.[22]

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18. See, e.g., *Stevenson v. State Department of Transportation*, 619 P.2d 247 (Ore. 1980) (state negligent for failing to shield a traffic light that was clearly visible to drivers rounding a curve on the other of two connecting roads).
19. See, e.g., *Greene v. City of Chicago*, 363 N.E.2d 378 (Ill. 1976) (holding city liable to motorist injured in traffic accident on a road where the street lights were malfunctioning).
20. See, e.g., *Martin v. Louisiana*, 175 So.2d 441 (1965) (nonoperation of positive barrier designed to stop moving vehicles at drawbridge was not negligence on the part of the highway department).
21. See, e.g., *Hebert v. Missouri Pacific Railroad Co.*, 366 So.2d 608 (La. 1979) (holding state highway department liable for the failure to install safety devices at railroad crossing).
22. In the first of these, a VDOT fog safety system consisting of airport runway lights embedded in the pavement of I-64 at Afton Mountain malfunctioned when the mountain was shrouded in fog. VDOT officials were aware of the malfunction, but since only one section of lights had malfunctioned and all the lights would have to be turned off during repairs, they decided to postpone repairs until the fog cleared. Before such repairs could occur, a recklessly driven pickup precipitated chain reaction pileups involving 54 vehicles on both sides of the highway. Although the initial accident occurred on a lighted portion of the highway, the chain reaction resulted in collisions throughout the unlit section. Two people were killed and forty-four were injured, and the state expects tort challenges based on the fog light system failure even though Virginia was under no obligation to provide such a system and is one of only a handful of states to have installed such a sophisticated safety system.

The second incident involved an electronic sign system that VDOT runs in cooperation with the District of Columbia on I-495 in Northern Virginia. This system, which consists of three variable message signs, is used to warn travelers in advance when the I-495 drawspan at the Woodrow Wilson Bridge is raised. When the D.C. bridge operators get a request to raise the bridge, they call the VDOT traffic control center, which then activates the signs. However, despite operational procedures that indicated otherwise, the signs were never used during late-night bridge openings, since the traffic center, shut down at night and the bridge operators typically failed to call in the requests before closing. During one late-night opening (in which the signs were not activated), the driver of a car that was stopped at the bridge was killed when his car was rear-ended by a tractor trailer. The lights and siren at the bridge indicating a drawbridge opening were activated, but the truck driver did not notice them or the stopped traffic in time. As with the Afton Mountain incident, VDOT officials expect to be sued, although VDOT was under no obligation to provide the extra safety feature of electronic variable message signs.

Second, a plausible explanation exists for the relatively low liability figures indicated in the table. Virginia did not pass its Tort Claims Act (under which the state consented to private tort suits against the government) until 1981. Thus, at least for the early part of the 5-year period examined, it is likely that the absence of lawyers specializing in suits against the state and the lack of knowledge by plaintiffs and lawyers alike concerning their capacity to sue worked to reduce the overall number of lawsuits. Consequently, VDOT's liability exposure as measured in the survey was almost certainly artificially low as a result of the survey's timing in relation to the passage of Virginia's Tort Claims Act.

A report analyzing state highway department tort claims bears out this second assertion.[23] Although incomplete reporting by state highway departments precluded the establishment of exact tort claims figures over this time period, the report provided estimates by extrapolating from the data provided. The estimates indicated that the number of tort claims against state highway departments was growing at approximately 20 percent per year—from less than 3,000 claims/year in the early 1970s to an estimated 24,000 to 27,000 claims (for an estimated $8 to $10 billion) in 1987. More importantly, the report estimates that the total settlement and judgment expenses experienced by state highway departments had increased from $6.3 million in 1973 to between $125 and $150 million in 1987 (with an additional $30 million spent in defending against these actions). Given that Virginia's population was approximately 2.4 percent of the national population in 1986, Virginia's expected share of these claims would be $3.6 to $4.3 million per year.[24] Thus, this national data indicates that the tort liability problem is fairly severe, and given the 20 percent growth rate in claims, state highway departments are justified in hesitating to implement systems that may increase their overall liability.

Private Manufacturers

Further insight into the magnitude of the IVHS tort liability problem can be gained by investigating current liability levels in the automotive industry.[25] As with state governments, the past several decades have witnessed a significant increase in automobile manufacturer tort liability. This increase has

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23. Daniel S. Turner, et al., "Status Report: Tort Liability Among State Highway Agencies, in Tort Liability & Risk Management," Transportation Research Circular No. 361, July 1990.
24. This figure is seven to nine times higher than the figure given in Table 1; thus, it confirms that Virginia's liability has been well below the national average.
25. As a result of the wide variety of products and services under consideration, it is conceivable that a number of different industries will be involved in IVHS development, including defense contractors, automobile manufacturers, highway developers, highway equipment manufacturers, and telecommunications firms. Thus, examination of all these industries would potentially be helpful in developing estimates of expected IVHS tort liability. However, to simplify the analysis, this study limits the inquiry to examination of current automaker tort liability.

primarily been fueled by several legal changes, including the switch from negligence to strict liability for product-related injuries, relaxed privity requirements that permit direct consumer suits against manufacturers, and the switch from contributory to comparative negligence in most jurisdictions. The purpose of this section is to sift through the existing automobile manufacturer liability data in order to identify the vehicle characteristics that are likely to raise IVHS liability concerns. These characteristics will then be used in the next section to determine the extent to which each proposed IVHS technology is likely to introduce significant liability concerns.

Liability Data

Blashfield's *Automobile Law and Practice* lists a number of different reasons for which plaintiffs can sue automobile manufacturers, including negligence (in design, inspection, or in failure to warn), warranty (express or implied), and strict products liability (for design defects, manufacturing defects, or failure to warn).[26] Although the variety of specific tort actions is nearly endless, it is possible to identify certain characteristics that are common to most successful lawsuits against manufacturers. These characteristics can then be used in predicting the liability levels for different IVHS. In order to identify these characteristics, a computerized case law search was performed.[27] Table 2 gives the results of this search (and includes other cases uncovered while researching this paper); it lists the types of tort suits that are currently having success against automobile manufacturers.[28]

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26. See *Blashfield's Automobile Law and Practice Sections* 485-88 (3d ed., Frederick D. Lewis, ed., 1969, 1992 pocket part). Blashfield's also identifies four other potential actions against manufacturers relating to deceit (fraudulent misrepresentation, willful concealment, deceit in advertising, and nonfraudulent misrepresentation), but these are tangential to the IVHS tort liability problem; thus, they are not addressed here.

27. Given that the analysis here is simply trying to *identify* the types of claims that the automobile manufacturers currently face (for purposes of identifying liability-inducing vehicle characteristics), the case law search simply selected a sample of tort suits against the big three automakers in the Westlaw multistate database. Thus, the search was limited to suits against General Motors, Ford, and Chrysler and primarily involved appellate decisions (since most trial court decisions are not published).

28. Table 2 actually includes both successful suits against the manufacturers and cases in which verdicts for the manufacturer were overturned on appeal and remanded for new trials. These cases were included to ensure a truly representative listing of the types of tort suits manufacturers face was compiled, since such a small number of these cases are actually decided at the appellate level (where published opinions are available).

TABLE 2
CLAIMS AGAINST MANUFACTURERS

Design Defect (Both Negligence and Strict Liability) Actions
Roof/Rollbar Design Insufficiently Crashworthy
Design Insufficiently Crashworthy
Defective Seatbelt System Design
Defective Door Lock Design
Defective Roof Design (in rollover accident)
Lack of Seat Belts (in customized van)
Defective Engine Design (sudden stalling)
Defective Tire Rim Design
Defective Sunroof Design (plexiglass not shatterproof)
Faulty Brake Design
Negligent Transmission Design
Inadequate Bumper
Unsafe Fuel Tank Design
Failure to Provide Head Restraints

Manufacturing Defect (Both Negligence and Strict Liability) Actions
Defective Accelerator
Defective Axle
Defective Tire
Defective Hood Latch
Manufacturing Defect (sudden, unintended acceleration)
Defective Seat Belt
Defect Caused Vehicle to Catch Fire
Defective Transmission
Defective Tire Rim
Defective Welding on Roof Support
Particulate in Power Steering System
Defective Electrical System
Defective Steering Mechanism
Defective Tie Rod Assembly
Defective Brakes
Defective Wheel Bearing

Failure to Warn (Both Negligence and Strict Liability) Actions
Failure to Warn Against Overloading
Failure to Warn Against Mixing Radial and Conventional Tires
Failure to Warn of Risks Involved with Inadequate Torque on Wheel Stud Nuts

Express Warranty Actions
Faulty Power Steering Apparatus

Implied Warranty Actions
Defectively Connected Drive Shaft
Defective Push Rod (brakes)

The claims data listed in Table 2[29] provide several helpful insights for our inquiry into IVHS tort liability. First, note that the areas of operation implicated in Table 2 are simply a subset of the liability-inducing areas of operation identified in the section on state highway department liability. Table 2 shows that design defects, manufacturing defects, inadequate warnings, and insufficient provision of safety equipment[30] are the primary areas of concern. Since these are four[31] of the eight areas identified in the state highway department liability section, the application of current tort data to the proposed IVHS need only focus on the eight characteristics identified earlier. Second, Table 2 shows that a very high percentage of the successful actions are based on design and manufacturing defects (most of which are brought under strict liability claims). This implies that the IVHS liability inquiry should focus on whether the incidence of design and manufacturers' defects is likely to increase or decrease with the use of IVHS. Third, the claims identified in Table 2 almost exclusively involve structural defects (that increase the severity of injuries received in a crash) and electrical or mechanical defects that decrease a driver's ability to control the vehicle. This indicates that the inquiry into the impact of IVHS design and manufacturing defects must focus on these areas, since other defects (e.g., a defective radio) do not induce significant tort liability concerns. Finally, although no effort was made to quantify automotive industry tort liability, the

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29. The claims listed in Table 2 are taken from the following cases (in order of appearance).
Design Defects. See *Reed v. Chrysler Corp.*, 1992 WL 380588 (Iowa 1992); *Chrysler Corp. v. Blackmon*, 841 S.W.2d 844 (Tex. 1992); *Martell v. Chrysler Corp.*, 588 N.Y.S.2d 682 (1992); *Hierta v. General Motors Corp.*, 492 N.W.2d 738 (Mich. 1992); *Green v. Ford Motor Co.*, 491 N.W.2d 243 (Mich 1992); *Moore v. Chrysler Corp.*, 596 So.2d 225 (La. 1992); *General Motors Corp. v. Johnston*, 592 So.2d 1054 (Ala 1992); *Brantley v. General Motors Corp.*, 573 So.2d 1288 (La. 1991); *Meyering v. General Motors Corp.*, 232 Cal.App.3d 1163 (1991); *Chase v. General Motors Corp.*, 856 F.2d 17 (4th Cir. 1988); *Ford Motor Co. v. Bartholomew*, 297 S.E.2d 675 (Va 1982); *Hancock v. Paccar, Inc.*, 283 N.W.2d 25 (Neb. 1979); *Anton v. Ford Motor Co.*, 400 F.Supp 1270 (Ohio 1975); *Buccery v. General Motors Corp.*, 60 Cal.App.3d 533 (1976).
Manufacturing Defects. See *Fill v. Matson Motors, Inc.*, 183 A.2d 324 (N.Y. 1992); *Gentry v. General Motors Corp.*, 839 S.W.2d 576 (Ken. 1992); *Haymaker v. General Tire Inc.*, 420 S.E.2d (W.Va. 1992); *Jones v. General Motors Corp.*, 585 N.Y.S.2d 820 (1992); *Consalo v. General Motors Corp.*, 609 A.2d 75 (N.J. 1992); *Spain v. General Motors Corp.*, 829 P.2d 1272 (Az. 1992); *American Manufacturers Mutual Insurance Co. v. General Motors Corp.*, 582 So.2d 934 (La. 1991); *Dearie v. Ford Motor Co.*, 583 So.2d 28 (La. 1991); *Brantley v. General Motors Corp.*, 573 So.2d 1288 (La. 1991); *Doupnik v. General Motors Corp.*, 225 Cal.App.3d 849 (1991); *General Motors Corp. v. Lupica*, 379 S.E.2d 311 (Va. 1989); *Anderson v. Chrysler Corp.*, 403 S.E.2d 189 (W. Va 1991); *Leathers v. General Motors Corp.*, 546 F.2d 1083; *Langford v. Chrysler Motors Corp.*, 513 F.2d 1121 (1975); *Snider v. Bob Thibodeau Ford, Inc.*, 202 N.W.2d 727 (Mich. 1972); *Nelson v. Ford Motor Co.*, 469 F.2d 261 (1972).
Failure to Warn. See *General Motors Corp. v. Saenz*, 829 S.W.2d 230 (Tex. 1992); *Ilosky v. Michelin Tire Co.*, 307 S.E.2d 603 (W. Va. 1983); *Hügel v. General Motors Corp.*, 544 P.2d 983 (Colo. 1975).
Express Warranty. See *Clark v. Bendix Corp.*, 42 A.2d 727 (N.Y. 1973).
Implied Warranty. See *Elmore v. American Motors Corp.*, 451 P.2d 84 (Cal. 1969); *Darryl v. Ford Motor Co.*, 440 S.W.2d 630 (Tex. 1969).
30. Inadequate safety equipment claims are listed in Table 2 under design defects (e.g., lack of seat belts and lack of shatterproof glass).
31. Implicit in Table 2 is a fifth area, decisions to implement additional safety features that increase liability, since many of the design defect claims are based on the failure to implement safety features provided with other vehicles (e.g., safer door latches, shatterproof glass, etc.).

vast number of such suits uncovered in the computerized search indicates that the level of liability is significant.[32]

Are Claims That IVHS Will Shift Liability Accurate?

This section attempts to estimate the extent to which IVHS implementation will transfer accident liability from drivers to manufacturers and/or highway departments. Unfortunately, this task is difficult because available records are almost completely devoid of IVHS-related tort liability data since few IVHS have been implemented, and the ones that are in operation are of limited magnitude and have a very short track record. Consequently, one cannot extrapolate estimates from the current data but must instead try to identify which IVHS characteristics are similar to the characteristics of current systems experiencing tort liability problems. Furthermore, IVHS encompass a wide variety of proposed automated highway applications, each of which possesses different liability implications. Thus, to determine the degree to which IVHS shift accident liability, it is necessary to examine the liability shift that each specific IVHS service is likely to cause.

The VDOT survey and private manufacturer tort data discussed above identified the following eight highway department operations and vehicle design characteristics as integral parts of successful auto accident lawsuits:

- highway department maintenance failures
- defectively manufactured equipment and vehicles
- failure to provide "standard" safety features
- hazardous vehicle or roadway designs
- inadequate warnings
- negligence of operational personnel
- driver convenience and traffic throughput upgrades that decrease safety
- addition of new safety features.

This section reviews the engineering literature to determine the planned operation of each type of IVHS technology and uses this information to deter-

32. For instance, in a computerized search of the Westlaw products liability data base (multistate), a total of 716 suits were found against Ford, General Motors, and Chrysler. This number, while significant in itself, is likely vastly underrepresentative of the number of actual suits, since (1) most suits are not appealed and thus typically are not available on Westlaw (which primarily covers published appellate decisions), (2) federal courts are not included in the multistate database, and (3) many actions are likely settled out of court.

mine which IVHS possess one or more of the above liability-inducing characteristics. Before embarking on this review, however, it is important to note that two of the eight highway design/operational characteristics identified as liability sources are essentially inapplicable in the IVHS context. The first of these is negligence by operational personnel, which should not be implicated with IVHS, since automation tends to decrease both the number of highway department employees and their level of involvement in safety-related activities. Second, inadequate warnings are not a significant concern since most forms of IVHS actually increase the amount of warning information available to drivers. Thus, since these two characteristics can be ignored, the inquiry into each type of IVHS technology need consider only the following questions:

- Are increased maintenance problems likely to develop from the use of high technology equipment?
- Is an increase expected in the overall number of occurrences of defective equipment as a result of increases in the number or complexity of highway or vehicle safety equipment?
- Is liability likely to be imposed for decisions not to install IVHS?
- Are an increased number of claims for design defects likely to develop from the use of IVHS?
- Do IVHS congestion-reduction or traveler-convenience features decrease safety?
- Do IVHS assume responsibility for certain aspects of vehicle control and navigation or provide sufficient aid to the drivers that they might justifiably rely on the system to aid in the driving process?

Real-Time Optimization of Traffic Signals

Real-time traffic signal optimization networks are IVHS that use real-time traffic data to continuously coordinate and optimize traffic light signal timing over entire metropolitan areas. These systems accumulate traffic speed and volume information through the use of roadside sensors and relay these data to a control center. At the control center, the data are entered into a computerized network optimization program that computes signal timing patterns that maximize total traffic throughput. These new signal timing patterns are then relayed back to the traffic signals. This process is repeated every few minutes, thereby providing signal timing patterns that can respond to and alleviate congestion.

Local and state governments already set traffic signal timing patterns to maximize traffic throughput. However, the techniques currently used in this process are not optimum since (1) they rely on traffic data that is months or years old, (2) there are usually only a limited number of traffic signals coordi-

nated in the optimization process, and (3) often only three or four different timing patterns are used. Real-time signal optimization has the potential to provide significant traffic throughput enhancements, since the optimization is based on real-time traffic statistics (and thus the signal timing would be optimized to relieve congestion from accidents, unusual traffic activity, and other incidents) and since real-time traffic data captures the benefits that can be gained by including more signals in the network optimization process.

The implementation of signals that optimize traffic flow based on real-time traffic statistics is unlikely to significantly alter the number of accidents or the liability of the parties involved in them. Traffic signals are currently maintained and operated by state and local governments. In spite of this government control, Table 1 revealed that liability for intersection accidents is only shifted from the driver to the state when maintenance crews fail to repair broken traffic signals or replace missing ones. The shift to IVHS-optimized traffic signal control will not transfer vehicle control or decision-making functions from the driver and thus should not alter the current apportionment of liability between drivers and other institutions. In addition, although the use of IVHS-optimized signal timing will significantly complicate intersection control from the governments' viewpoint,[33] from the driver's perspective, the system will operate exactly as it does today. Thus, unless these systems actually increase the number of accidents, they should not result in an increase in tort liability for intersection controllers. An increase in accidents is unlikely to occur because the technology required to optimize intersections is mature today:[34] sensors are already used at many intersections; phone lines, cellular radio, or other mature technology can be used to implement the communications function; routing algorithms have already been developed; and the electronic circuitry required at the intersection is relatively simple. In sum, this form of IVHS technology is unlikely to be affected by tort liability concerns.

Highway Information Systems

Highway information systems provide roadside displays and radio broadcasts to disseminate data on traffic flow (congestion and accident locations), highway or environmental conditions (work zones, ice, or fog), and alternate routes for drivers. Roadside displays are typically implemented as permanent variable electronic message boards spaced along a highway, and the radio broadcasts usually consist of taped messages broadcast over an AM radio station. The information disseminated over these systems is collected by a number

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33. Specifically, with this system (1) sensors will be required to gauge traffic flow, (2) communication circuits will be needed to relay the sensor data to a traffic control center and the optimized signal pattern back to the intersection, (3) a sophisticated computer model will be required to optimize signal timing based on the sensor data, and (4) more complex signal circuitry will be required at each intersection since the traffic lights must be capable of operating in both radio-controlled and autonomous modes.

34. In fact, by replacing aging signal circuitry, the probability of signal failures will likely be reduced.

of highway monitoring techniques including roadside sensors, cameras, and on-site reporting by police and emergency services.

Highway information systems can significantly improve highway throughput and safety. The safety enhancements primarily result from the ability to warn drivers of potential hazards, and congestion can be reduced by routing traffic around accidents and by providing drivers with information about traffic levels on alternate routes. Highway information systems will typically be implemented by private contractors and operated by local or state highway departments. These displays and broadcasts are already being implemented in many areas but may be phased out if use of in-vehicle motorist information systems becomes widespread.

Highway information systems are likely to have some impact on the allocation of liability for traffic accidents. State and local governments already are held liable for negligently failing to replace broken or missing street signs.[35] Although the state may have no duty to provide a particular sign, once it does, it comes under a duty to maintain the sign with due care. In addition, there is at least some precedent that states can be held liable for failing to implement warning signs in certain hazard areas.[36] Both claims will likely be leveled against highway departments with regard to highway information systems.[37] Consequently, it is reasonable to expect that widespread use of highway information systems will shift at least some liability to state and local governments.

In estimating the extent of this liability shift, at least two factors tend to indicate that highway information systems could result in increased liability as compared to current state liability for missing signs. First, by providing information that is both current and highly visible, they are more likely to generate driver reliance,[38] which can be a persuasive factor at negligence trials. Second, electronic signs can be both defective as well as missing; thus, they are likely to be inoperable more often than the conventional signs they replace. Consequently, state liability should increase to the extent that additional accidents occur during periods in which highway information systems are malfunctioning.

However, a number of other factors indicate that highway information systems are unlikely to significantly transfer liability to the state. First, highway information systems should help decrease the overall number of accidents

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35. *See supra* Table 1.
36. See generally *Peavler v. Board of Commissioners of Monroe County*, 492 N.E.2d 1086 (Ind.App. 1986). (The trial court finding of state highway department negligence for failing to provide a warning sign before a dangerous curve was reversed on the ground that whether or not sovereign immunity applied was a question for the jury.)
37. See *supra* note 22 and accompanying text.
38. For example, a variable message board flashing "ICE ON BRIDGE" is likely to receive increased attention (and hence generate more reliance) than a roadside sign stating "Bridge May Freeze Before Highway."

by warning drivers of hazards and by reducing the overall time that drivers are on the road. This reduction in accidents should result in fewer lawsuits against the state for other perceived problems (e.g., negligent road design), thereby reducing state legal fees and settlement costs. Second, highway information systems are likely to be used somewhat sparingly given the effectiveness of conventional signs for most applications. Thus, although these systems will generate increased driver reliance, overall government liability is unlikely to be significant as a result of the limited number of highway information systems implemented. Finally, to the extent that current liability for roadside signs is predictive of the liability with highway information systems, it appears unlikely these systems will cause much of a problem given that the total liability for defective or missing signs and signals has been under $18,000 per year in Virginia. Taken together, these factors seem to indicate that highway information systems will shift some accident liability to state highway departments, but the magnitude of this shift will not be significant enough to justify legislative intervention.

Automatic Tolls and Congestion Pricing

This category of IVHS includes systems that fully automate the toll collection process by mounting electronic scanners above each lane of traffic. Automatic toll systems will (1) electronically identify passing vehicles by reading vehicle-mounted identification tags, (2) assess a toll, and (3) bill drivers for their toll fees through the mail. These systems would replace conventional toll booths, thereby providing significant decreases in both congestion (since cars could pass through the toll area at full speed) and toll collection costs. In addition, IVHS toll collection can also be used to implement "congestion pricing," which is the assessment of higher tolls on highways during peak congestion periods to reflect the higher cost to society that rush hour driving represents. These systems will almost exclusively be run by state and/or local governments.[39]

The use of automatic tolls and/or congestion pricing is unlikely to expand the liability of the system operators or developers for two reasons. First, malfunctions in the system should not cause additional accidents (and their associated liability). In fact, by eventually eliminating the need for toll plazas, they may be able to reduce state liability by eliminating accidents that currently occur as a result of speed changes and narrow lanes in toll collection areas. Second, the systems do not involve state control of the vehicle or state provision of traffic and/or environmental information on which a driver could reasonably rely. Thus, the primary legal concerns with these systems are suits arising from

39. The potential does exist for local governments to give right-of-way licenses to private developers for the establishment of toll roads that could use automatic toll collection such as currently is under consideration for the extension of the Dulles Toll Road (Rt. 267) to Leesburg in Northern Virginia.

mistakes in scanning and/or billing and privacy challenges to a system that records driver's movements, both of which are beyond the scope of this report.

Automatic Vehicle Location and Navigation Systems

Automatic vehicle location (AVL) and navigation (AVN) systems are used to locate, track, and in the case of AVN, direct vehicles in traffic. The location and tracking functions can be implemented through a variety of techniques including dead reckoning, triangulation (using global positioning satellites), or proximity beacons. With AVL, the vehicle location information is typically transmitted to a central control station where fleet managers use the data to dispatch the nearest available vehicle in response to calls. This technology is primarily of interest to police, rescue organizations, and businesses such as taxicab companies that dispatch a dispersed fleet of vehicles. AVN, on the other hand, computes the vehicle's location in order to help instruct the driver on the best route to a known destination. AVN systems currently under consideration vary widely in sophistication. The simplest systems merely show drivers their location on a digital street map display, but there are systems that actually provide computer voice instructions about when and where to turn and base their route selection on real-time traffic conditions.

Both systems should provide significant enhancements over current vehicle location and navigation techniques. AVL systems will either supplement or replace shortwave radio systems that are currently used by police, rescue, and private dispatchers. These systems will reduce errors caused by garbled radio transmissions[40] and will optimize the dispatch process since computer algorithms can more quickly determine the optimum dispatch solution.[41] AVN systems could even have a broader impact; they may eventually become a standard feature in most vehicles. It has been estimated that these systems will decrease the total number of vehicle miles traveled by as much as 40 percent on trips to new destinations and by 7 percent on daily work trips.[42]

AVL and AVN could be implemented as purely private ventures or through public-private partnership arrangements. Private industry will likely produce the initial systems for use with commercial vehicle fleets and rental cars, but

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40. The envisioned location systems either use satellite communication links or line-of-sight communication links to nearby beacons or detectors (which are connected to the control center via telephone lines). These systems should eliminate message clarity problems that current systems frequently face when using line-of-sight radio broadcasts to communicate over large metropolitan areas.

41. Furthermore, computerized systems will also be capable of considering more variables in the dispatch optimization process, including vehicle locations, likely response times (based on both distances and speed limits), and the impact of the new vehicle distribution on response time to future calls.

42. Albert J. Sobey, "Business View of Smart-Vehicle Highway Control Systems," in the *Journal of Transportation Engineering*, Vol. 116, No. 4, 1990, 461, 468.

the potential for AVL and AVN to improve local police and rescue service may well lead to extensive government involvement. In addition, local and state governments may eventually install roadside sensors and transmitters (in connection with other IVHS services) that could be used in implementing the AVL/AVN vehicle location function. Adaptation of these sensors for use with AVL/AVN could also lead to government investment in this area of IVHS.

AVL systems are unlikely to significantly alter the current allocation of liability in automobile accidents. These systems do not transfer vehicle control from the driver, they should not cause an increase in accidents (even if they function poorly), and they do not encourage driver reliance (since they are primarily used by fleet dispatchers rather than drivers). It is at least arguable that local municipalities could face increased liability when using AVL systems, since errors in dispatching police and emergency vehicles (e.g., delays and dispatches to incorrect locations) can have catastrophic results for which the IVHS operator (and designer) may be liable. However, since local governments already dispatch vehicles using a less sophisticated process, they currently face the same liability; thus, they should not face an increase in liability unless AVL turns out to be less effective in eliminating dispatch errors than the system currently in use (which is unlikely, since the old system can simply be supplemented by AVL). Thus, AVL systems will likely have a positive impact on governments' and manufacturers' liability to the extent that they help eliminate transmission errors that currently create liability problems.

AVN systems, however, are already under development, and reports indicate that tort liability concerns are discouraging the implementation of systems that provide route guidance rather than simply indicate the vehicle's location on a map display.[43] The concern is that AVN systems providing incorrect route information[44] may contribute to some accidents, thereby shifting liability for those accidents to the AVN system manufacturer. State governments face significant liability in the routing of certain types of vehicles over state roadways (e.g., oversized loads) since accidents may occur if the vehicle is incompatible with certain features of the specified route.[45] This problem would be greatly magnified with AVN as a result of the large number of vehicles relying on routing information, and it would be difficult to avoid mistakes given that road con-

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43. Robert A. Johnston, *et al.*, "Automating Urban Freeways: Policy Research Agenda," in the *Journal of Transportation Engineering*, Vol. 116, No. 4, 1990, 442, 450.

44. For example, if the route displayed on a map directs a vehicle down a one-way street the wrong way or over a bridge undergoing repairs.

45. For example, the Virginia Department of Transportation misrouted a tractor-trailer carrying a $1,000,000 nuclear reactor pump motor under an overpass with insufficient clearance. The pump clipped the overpass and was dislodged, spilling approximately 10 gallons of nuclear waste onto the highway. VDOT accepted responsibility for the accident and financed the removal and replacement of 250 feet of highway and the replacement of the motor pump. See generally, McKelway, Bill, "Inconsistencies Litter the Trail of Hazardous Spill," Richmond Times Dispatch, 31 August 1991.

struction results in daily changes in the highway system. Thus, tort liability resulting from accidents in which driver reliance on AVN information was conceivably a contributor to the crash poses a significant barrier to the development of the more sophisticated forms of AVN.

Motorist Information

Motorist information (MI) services encompass a variety of systems that communicate travel, traffic, roadway, weather, and vehicle information to drivers. These systems operate over dedicated radio channels and provide either an audio or a visual output for vehicle occupants. Early MI systems will likely differ from AM and FM radio (which currently perform many of the functions mentioned above) only in the use of channels dedicated to information services. More advanced MI systems, however, will allow a driver to choose the type of update desired (e.g., traffic or weather) and will likely combine the MI and AVL/AVN services so that information could be individually tailored to the driver's needs (hence to provide only the information immediately pertinent to the driver given his location, route, and destination). MI systems could most readily be provided by the private sector. Automakers or other manufacturers could provide the receivers and state/local governments could license regional operators to provide the service. However, since the initial investment is significant (road sensors, transmitters, etc.) and consumer interest is questionable, government involvement may be necessary to initiate these services.

Motorist information systems are unlikely to cause significant tort liability problems. They are very similar to existing AM/FM radio motorist information techniques, which cause few (if any) tort claims. They do not exert any vehicle control, and it will likely be difficult for drivers to postulate a believable reliance argument that justifies holding the IVHS developers or operators liable for any accidents. Furthermore, since these systems are primarily concerned with driver convenience (not safety), it is unlikely that even the manufacturers of defective MI units will be held liable for auto accidents.

Cooperative Route Guidance

Cooperative route guidance (CRG) systems are enhanced MI systems that implement two-way communications between vehicles and the traffic control center. This upgrade permits speed and location monitoring at the individual vehicle level, thereby providing improved traffic flow information at the control center.[46] CRG systems will likely be implemented by government agencies or in public-private partnerships, since the traffic monitoring function they serve is likely to be of use to regional traffic control centers.

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46. If CRG use becomes widespread, CRG-based monitoring may eliminate the need for roadside sensors.

Like MI, CRG systems are unlikely to significantly increase the tort liability of governments and/or manufacturers. The only difference between MI and CRG is that the communication link is two-way, thereby providing the traffic control centers with speed and location information from vehicles rather than from roadside sensors. This additional radio link has no impact on driving and thus should not result in increased liability.

Collision Warning

Collision warning systems are vehicle-mounted detection devices that continuously scan the front, rear, and blind spots of an automobile for other vehicles. These systems issue an audible warning to the driver when they determine that a collision is imminent. The scanning function is performed by vehicle-mounted transmitters and receivers that bounce radio waves off nearby objects to compute the separation distance. This information is then correlated with the vehicle's speed and direction to determine whether the separation is adequate.

Collision warning systems should provide significant highway safety improvements. Many of the most serious accidents involve head-on collisions that are caused by sleeping or impaired drivers. Audible warnings should significantly reduce these types of accidents. In addition, many accidents occur during lane changes, and collision warning systems mounted in vehicle blind spots should help to avoid these accidents. These systems will almost certainly be produced and installed by the automobile manufacturers or their subcontractors.[47]

Although collision warning systems leave full control of the vehicle in the driver's hands, they are likely to induce some degree of driver reliance as motorists come to expect warnings when their vehicles get dangerously close to other vehicles. This reliance may provide a basis for shifting liability to manufacturers of these systems for accidents that occur when the systems malfunction or fail to provide warnings as a result of design limitations (e.g., the system may be unable to detect impending collisions with motorcycles, or its performance may degrade under certain weather and/or road conditions). The brunt of this liability will be faced by the manufacturers who produce and distribute the collision warning devices. Estimates of the likely extent of this liability can best be developed from the analogous manufacturer-supplied safety devices that exist today: seatbelts and airbags. As shown in Table 2, suits claiming negligent design or manufacture of both seatbelts and airbags are common. Both types of suits can be expected with collision warning systems, and the liability will likely be much higher given the technical challenge of designing a system that lives up to driver expectations.

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47. However, government regulations may eventually *require* the installation of these devices and/or specify performance criteria they must meet.

In addition to negligent design and defective product claims, negligence suits alleging the failure to provide collision warning devices in all cars can be expected. A tremendous number of such suits have been brought (with limited success) against automakers for failing to provide airbags in all cars[48] despite the fact that government regulations simply mandate that either seatbelts or airbags be provided.[49] Consequently, even if regulatory actions appear to immunize manufacturers who decide not to provide collision warning systems, some level of liability may still be possible.

In summary, collision warning systems are likely to generate a host of negligence suits against auto manufacturers. This may well delay or even prevent the deployment of collision warning systems that are cost-effective in terms of accident reduction. As with airbags, consumers are likely to initially be uncertain as to the value of these systems and consequently will be unwilling to pay a price that covers their cost. Thus, state regulations requiring collision detectors may be appropriate if the systems are efficient from an accident cost viewpoint.

Collision Avoidance

Collision avoidance systems are vehicle-mounted, electro-mechanical devices that detect imminent collisions and then use automatic braking to alert the driver and decrease the probability of an actual collision. Advanced collision avoidance systems may also use throttle and steering control to avoid collisions during lane changes.

Collision avoidance systems, like collision warning devices, have the potential to reduce accident rates substantially. Collision avoidance systems, however, should outperform collision warning devices, since the avoidance maneuver may fully prevent the accident without any response by the driver; if not, at least the driver has additional time to evade the accident. As with collision warning systems, collision avoidance equipment would almost certainly be developed and sold by the auto manufacturers, although governmental regulation of their performance characteristics is possible.

The tort liability concerns with collision avoidance systems are very similar to those of the collision warning systems. When accidents occur after a collision avoidance system fails to warn the driver or take corrective action, manufacturers could be held (1) strictly liable under a defective design liability claim, (2) strictly liable for a manufacturing defect, or (3) negligent for inducing driver reliance in a system that fails to avoid all accidents. In addition, manufacturers may also be sued for failing to install collision avoidance systems in all vehicles. These are exactly the same strategies that will be used against manu-

48. See *infra* note 70.
49. See The National Traffic Motor Vehicle Safety Act of 1966, 15 U.S.C. 1381 *et seq.* (1988).

facturers of collision warning systems, and they are likely to transfer significant liability. Furthermore, manufacturers of collision avoidance systems will face additional liability since these systems can potentially *cause* accidents. Collision warning systems do not actively take control of the car; they are simply an aid to the driver in detecting dangerous situations. Collision avoidance systems, however, take control of braking and possibly steering. This may *increase* the chance of accidents in some situations. Collision avoidance systems obviously have the potential to avoid a large number of accidents when perfected; however, in the developmental stage, they may actually increase the number of accidents. The liability for almost all accidents in cars equipped with collision avoidance systems would conceivably fall on the manufacturer.[50] Thus, manufacturers will also likely be hesitant to develop these kinds of IVHS.

Speed and Headway Keeping

Speed and headway keeping systems (S&HK) are vehicle control systems that use automatic radar detection, throttle control, and braking to maintain safe and efficient spacings between vehicles on the roadway. Technically, these systems are nearly identical to collision avoidance systems, but S&HK systems continuously control the throttle and brakes to maintain optimal separations between vehicles (instead of only intervening when collisions appear imminent). When implemented, these systems should both increase highway safety and throughput (by encouraging overly cautious drivers to maintain posted speeds and by decreasing vehicle clustering, which results when both slow and fast drivers share the same highway). These systems would again be completely self-contained within the vehicle and thus would almost certainly be developed by the automakers. Cruise control is an example of a primitive form of S&HK.

Manufacturers' liability for S&HK systems should be nearly identical to that experienced with collision avoidance systems. The primary difference between these systems is the continuous control aspect. The earlier review of case law against private manufacturers revealed that cruise control systems have been nearly liability free; thus, only the collision avoidance aspect of S&HK systems are likely to cause liability transferring accidents. Therefore, the tort liability for S&HK systems should be essentially identical to the collision avoidance liability discussed above. Another potential problem with S&HK systems is that they are likely to lower driver attention levels, since they essentially perform all of the driver's functions except steering within the lane boundaries. This lower attention level could actually cause an increase in accidents, many of which may be (falsely) attributed to S&HK system failures.

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50. This is likely to occur in accident situations in which the collision avoidance system was not at fault, since negligent drivers may falsely blame the collision avoidance system for accidents, and juries that are both wary of high technology and sympathetic to injured plaintiffs may hold manufacturers liable in many accidents that were caused solely by driver error.

Automated Highways and Guideways

Automated highways are extremely advanced S&HK systems that provide complete control of vehicles. In the most advanced of these systems, the motorist only provides destination information; the system would perform all other driving functions. Thus, the tasks of navigation, steering, throttle control, braking, collision avoidance, and intersection control would all be performed automatically by the vehicle.

Automated guideways are high speed pallet or conveyor belt systems that would provide automated transportation on major arteries. These systems differ from automated highways in that automated guideways use ordinary automobiles on a physical guideway as opposed to intelligent vehicles guided by electronic signals and detectors. Automated guideway systems would provide for conventional vehicle operation on secondary roads; switching stations would transfer the vehicles onto the automated guideways.

Automated highways and guideways could eventually provide enormous improvements in highway safety, throughput, and convenience. The vast majority of today's automobile accidents are caused by driver failures: misjudgments, inattention, alcohol impairment, etc.[51] Automated systems would provide for significantly lower accident rates.[52] In addition, these systems should provide significant highway capacity increases, since the quicker reaction times and improved vehicle control would permit drastic reductions in both lane widths and vehicle headways. They will also optimize intersection throughput, enhance merging and exiting, and reduce the overall number of accidents, all of which would help relieve congestion.

Significant involvement by state and local governments will be required to provide interactive roadways, automatic lanes, and optimized intersections with automated highways or to implement the high-speed pallet systems with automated guideways. Automated highways will also require installing automation systems in new vehicles and older ones. Consequently, both automated highway and guideway development will almost certainly require some sort of public-private partnership.

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51. See, e.g., Johnston, *supra* note 34 (indicating that 71 to 93 percent of all accidents are caused by human error); *1991 Virginia Traffic Crash Facts*, Virginia Department of Transportation, 1991, p. 27 (indicating that in approximately 56 percent of the automobile accidents in Virginia in 1991, the driver was cited for a moving violation).

52. Automated highway systems will by no means eliminate all accidents. System shortcomings and malfunctions will still cause crashes, and the accidents that do occur will potentially involve more vehicles (since vehicle headways are smaller). However, driving is essentially a mechanical task, and experience with computers, robotics, and other technology has shown that refined electromechanical systems can perform such tasks far more quickly, safely, and efficiently than humans, although environmental factors such as rain, ice, snow (which decrease roadway frictional resistance), and fog (which decreases visibility) are significant obstacles to the development of safe systems. See Johnston, *supra* note 43, at 449.

Automated highway and guideway systems will likely significantly increase government highway departments' and private manufacturers' accident liability. Several aspects of these systems contribute to this increase in liability, including the transfer of vehicle control to the IVHS technology, the increase in vehicle and roadway complexity, the increased component reliability that will be required with automated systems, and the negative impact that several highway capacity enhancements (which are part of these systems) will have on roadway safety.

The most significant of these aspects is the complete transfer of vehicle navigation and control that occurs with these systems. Since motorists are no longer involved in the driving process, they will lose all responsibility for accidents that occur. They essentially become the equivalent of airline or subway passengers, and the IVHS developers, operators, and insurers assume legal responsibility for all accidents. The result of this shift in responsibility is that even if these systems provide phenomenal safety improvements, they are still unlikely to keep the auto accident liability of manufacturers and governments at or below current levels.

The second aspect of automated highway and guideway systems that is likely to increase system developer and operator tort liability is the increased vehicle and roadway complexity required. The preceding sections revealed that both maintenance failures and defective equipment were the primary causes of much of the tort liability faced by vehicle manufacturers and highway departments today. Since increases in both the number and complexity of the systems controlling the vehicle should correspondingly increase the number of maintenance failures and defective equipment claims, these systems are likely to significantly increase the liability of states and manufacturers.

A closely related and equally significant liability problem involves the reliability of both the IVHS and non-IVHS equipment employed with these systems. Development of automated highway and guideway systems that perform adequately (even assuming a complete absence of vehicle breakdowns) is in itself a tremendous technical challenge. As with commercial airlines, defects or failures in a single part of the system can lead to accidents; thus, frequent maintenance and testing of all aspects of the system will be required. Although achieving high levels of reliability may be relatively easy with the highway aspects of these systems (since state maintenance crews can keep them in good working order), it is much harder to achieve sufficient reliability levels with the vehicles. Cars have hundreds of electronic and mechanical parts, and the current reliability levels for these parts fall far short of that required with automated highways.[53] Furthermore, individuals own their own vehicles; thus, it

53. See Johnston, *supra*, note 43 (stating that studies have estimated "that automated vehicles will need to be about 10 times as reliable as current autos to be as safe, and that a 'very expensive' maintenance program will be needed").

will be far more difficult for manufacturers to protect themselves through rigid maintenance and testing requirements, since consumers will naturally resist such measures (whereas, airlines do not). Consequently, both significant investment by the automobile manufacturers (to decrease vehicle breakdown levels) and stiffer state-mandated maintenance levels will likely be required to minimize states' and manufacturers' liability caused by accidents resulting from breakdowns.

The final aspects of automated highway and guideway systems that are likely to impact the developers' liability are the decreased lane widths and vehicle headways and the high travel speeds that are envisioned with these systems. These features are not included to reduce the number of accidents but to provide increased highway capacity and shorter travel times for commuters. However, these improvements come at a cost in safety: higher speeds and closer vehicle spacings mean that when accidents occur, the damage will be more serious, and the accidents will involve a larger number of cars. With automated highway systems, this problem could be significant. Even if such systems had relatively quick reaction times, cars can only be slowed down or redirected so quickly. Consequently, freeway accidents will likely involve a large number of cars; thus, significant liability may still be incurred even with systems with incredibly low accident rates.

The above discussion demonstrates that tort liability represents a significant hurdle that must be crossed prior to the development of automatic highway and guideway systems. This will at least delay or maybe even prevent the deployment of automated roadway systems that are cost-effective in terms of accident reduction. As with many other auto safety systems, consumers are likely to be uncertain as to the value of these systems at first and will be unwilling to pay a price that even covers their cost. Significant state involvement in the form of research and development seed money, insurance coverage, regulatory protection, and indemnification promises and/or liability limits will likely be required to spur investment in these systems.

Summary

The preceding sections show that both highway departments and manufacturers currently face significant tort liability and that the recent trend is toward substantial liability increases each year. At least some forms of IVHS are likely to aggravate this trend. AVN, collision warning, collision avoidance, S&HK systems, and automated highways and guideways are likely to increase the manufacturers' liability. Highway information systems, AVN, and auto-

mated highways and guideways are likely to have a similar impact on state highway departments' liability. For these forms of IVHS, government intervention to limit liability may be appropriate. However, optimized traffic signals, automatic toll booths, motorist information systems, and cooperative route guidance systems are all unlikely to cause much, if any, liability transfer; consequently, tort immunity is inappropriate for these types of IVHS.

PART 2: CONSUMER RISK DISCOUNTING

Part I demonstrated that it is plausible that at least some of the proposed IVHS are capable of transferring tort liability from consumers to manufacturers and/or government highway departments. The transportation community has suggested that government intervention is necessary to mitigate the liability risk and ensure timely implementation of IVHS. Despite the intuitive appeal of this suggestion, a shift in liability for automobile accidents from consumers to IVHS developers is by itself insufficient to justify government intervention. The losses caused by highway accidents are a true cost of driving, and these costs should be internalized into the price of driving to ensure that consumers consider them when deciding how beneficial IVHS-provided driving improvements are.[54] Such cost internalization is achieved with our existing transportation system, since the legal responsibility for most accidents is borne by drivers. Similarly, these costs should also be internalized with "smart" highway systems, since to the extent liability is shifted to IVHS manufacturers, it will simply be shifted back to drivers through higher prices for IVHS products and services. However, liability limits, indemnification, and other forms of government intervention partially externalize accident costs by shifting them to taxpayers or accident victims. Consequently, government intervention is inappropriate, since the cost externalization would distort consumption decisions, thereby leading to overinvestment in IVHS.

Even though cost internalization goals suggest that IVHS-induced liability transfers are harmless, a second phenomenon, the tendency of many consumers to act irrationally and "discount" the true costs involved with serious injuries, may provide an alternative justification for government subsidization of IVHS. Numerous studies have shown that consumers discount accident costs.[55] This discounting occurs for several reasons. First, most individuals

54. If these costs are externalized, then driving appears to be cheaper than it really is. The result of this "discount" will be an overinvestment by consumers in automobile travel (including an overinvestment in IVHS) and a corresponding underinvestment in other modes of transportation.

55. See Calabresi, *supra* note 6 at 55-57, 206.

assume that accidents will not happen to them,[56] and many people do not fully appreciate the true costs associated with a debilitating injury.[57] Consequently, both the probability and expected costs of automobile accidents are typically underestimated. Second, although drivers are aware that there are often a number of intangible costs associated with automobile injuries, they also realize that many of these costs will be borne by third parties such as friends and relatives (e.g., emotional losses).[58] Thus, drivers will rationally discount the costs of these losses. Finally, the direct accident costs (e.g., medical expenses, lost wages, and vehicle damage) are also typically borne by third parties (insurance companies); consequently, rational drivers will similarly discount these costs as well.[59] Thus, risk discounting may cause many consumers to forgo cost-effective IVHS, since they will appear overpriced when priced to cover the manufacturer's expected liability costs. This could potentially slow or even stop the development of cost-effective IVHS technologies; consequently, some sort of tort immunity for IVHS manufacturers may be appropriate to offset the economic inefficiencies caused by risk discounting.

As discussed earlier, this paper does not attempt to determine the *amount* of tort liability protection that is justified by consumer risk discounting.[60] Instead, it focuses on the preliminary problem of *identifying* which IVHS are

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56. Even with mandatory seat belt laws, seat belt use in the United States is less than 60 percent. See, e.g., Virginia Department of Motor Vehicles News Release, Nov. 7, 1991, (stating that survey results indicate that seatbelt use in Virginia was at 57.6 percent). Thus, despite the significant reductions in injury that seatbelts can provide, many motorists are unwilling to take the few seconds required to buckle-up each time they enter an automobile.

57. This is especially true regarding intangible costs such as pain and suffering by both the injured party and his or her family, post-accident care, etc. See Ellen Smith Pryor, "The Tort Law Debate, Efficiency, and The Kingdom of the Ill: A Critique of the Insurance Theory of Compensation," 79 Va. L. Rev. 140, 140-41 (1993).

58. See Richard V. Burkhauser and Robert H. Haveman, "Disability and Work: The Economics of American Policy 19" (1982).

59. Of course, as IVHS are widely adopted, the increased safety they provide should work to reduce insurance premiums, thereby providing drivers with some incentive to invest in IVHS. However, this is a classic "freerider" situation. Drivers will forego investing in IVHS since the marginal benefit to them (in lower insurance rates) is fairly small, but will hope that others invest (so that they receive the rate decrease without paying for it). The net result in such situations is usually that no one invests and thus the anticipated rate decreases are never realized.

60. Determining the appropriate level of intervention is difficult for several reasons. First, the level of response is dependent on the degree to which IVHS actually shift liability away from drivers. Forecasting this prior to IVHS implementation is very difficult. In addition, tort law standards are not constant and are influenced by technology changes themselves; thus, automobile accident liability will likely evolve with the introduction of IVHS, further compounding the difficulties involved with estimating the liability for systems such as fully automated highways, which are not likely to be developed for some time. Finally, the extent of state and federal governments' responses necessarily depends on the degree to which consumers discount risk, which is very difficult to quantify.

likely to be underdeveloped as a result of the risk discounting problem.[61] In this regard, consumer risk discounting should not be a problem when the government is involved in providing the IVHS service, since the government can select and implement the "efficient" level of IVHS use (underinvestment only occurs when the market sets the level of investment). *Thus, neither government highway departments nor private manufacturers who sell IVHS to government agencies should receive liability protection.* Consequently, IVHS services such as optimized traffic signals, highway information systems, and automatic toll collection systems do not seem to qualify for tort liability protection.[62]

Second, consumer risk discounting should only cause underinvestment in IVHS that improve highway *safety*; it should not affect consumer investment in IVHS aimed at increasing highway throughput or simplifying driving.[63] *Consequently, only the forms of IVHS that provide significant safety improvements should be considered as part of any IVHS liability reform effort.* Optimized traffic signals, automatic toll booths, highway information systems, AVL, motorist information, and cooperative route guidance provide limited highway safety enhancement. Consequently, it is unlikely that consumer risk discounting can be used to justify liability reduction efforts on behalf of the developers of these systems. Further, the tort liability problem associated with each of these forms of IVHS is limited. Thus, our investigations into the likely magnitude of the liability problem and the implications of the justification of consumer risk discounting indicate that only AVN, collision warning, collision avoidance, and S&HK systems, and automated highways and guideways should be considered in any IVHS tort liability protection program.

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61. Besides consumer risk discounting, one other phenomenon that might justify government intervention is investor risk aversion. Although normally it is not a problem to promote investment in high-risk/high-payoff ventures (since the risk can be spread over multiple investors or the project can be undertaken by a large firm), with large-scale risky projects, underinvestment may occur because many firms won't consider them since materialization of the risk implies bankruptcy. This argument for government intervention, however, only potentially applies to the most ambitious forms of IVHS such as automated highways and guideways and could potentially be solved through government research and development money (as opposed to liability protection). This justification for government intervention is considered further, *infra* note 77.

62. The logic of this argument seems to imply that automated highways and guideways (both of which are likely to be developed by private manufacturers but purchased by state highway departments) should also be excluded from liability protection. However, the enormous magnitude of the potential liability associated with these systems and the unpredictability of the risk will likely make manufacturers hesitant to invest significantly in these technologies without more concrete guarantees that their liability costs will be compensated.

63. It is possible to argue that increased throughput results in decreased driving time, which in turn leads to fewer accidents, since the average trip is shortened. However, convenience is a variable that affects consumers' decisions about whether or not to make trips; thus, much of the safety gain from reduced travel time will likely be lost by the choice of consumers to make more trips.

PART 3: POTENTIAL SOLUTIONS TO IVHS LIABILITY

Parts 1 and 2 revealed that significant liability is unlikely to arise with many forms of IVHS, but if such increases were to occur, they would not be the type that should be addressed through government intervention. However, for AVN, collision warning, collision avoidance, S&HK, and automated highway/guideway systems, there are arguably good reasons for government intervention. Thus, for these forms of IVHS, it is necessary to investigate what form of intervention is appropriate. This section examines the intervention methods that have been proposed in the IVHS literature[64] and attempts to determine which methods are best suited for the IVHS listed above. The methods examined in this section include government regulation, legislative liability limits, government indemnification, liability disclaimers, liability insurance, and mandatory risk pooling.

State and/or Federal Regulation

One potential method of intervention is through the establishment of regulatory guidelines that specify IVHS design parameters. With this approach, compliance with the specified guidelines would serve as a defense in lawsuits claiming negligence on the part of IVHS developers or operators. The regulatory guidelines could be promulgated by either state or federal agencies, and the scope of protection provided would vary depending on the state or federal distinction.

If regulatory guidelines specifying system design and/or operational parameters are promulgated by a state agency, compliance with them establishes a presumption of reasonable care in the design of the system. Thus, the establishment of such state regulations would preclude negligence lawsuits against IVHS developers unless the regulations specifically provide that they are not intended to shield developers from common law liability.[65]

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64. See, e.g., K. Syverud, "Liability and Insurance Implications of IVHS Technology," in SAE Technical Paper Series 901507, 1990, p. 83.

65. Note, however, that regulatory compliance would not shield IVHS developers from common law strict liability (see, e.g., *Shipp v. General Motors Corp.*, 750 F.2d 418, 421 (5th Cir. 1985)). Thus, regulatory compliance will not protect IVHS manufacturers who develop and sell products to consumers, since consumer product manufacturers are currently held strictly liable in tort.

Federal government regulations can also be used to limit IVHS tort liability.[66] The best example of how federal regulations have been used as a liability shield is provided by a series of negligence actions against automobile manufacturers for the failure to provide airbags in vehicles that were subsequently involved in serious accidents.[67] In these cases, the preemption claims were based on the following section of the National Traffic Motor Vehicle Safety Act (NTMVSA) of 1966, which states:[68]

> [N]o state or political subdivision of a state [has] any authority . . . to establish, or to continue in effect, with respect to any motor vehicle or item of motor vehicle equipment, any safety standard applicable to the same aspect or performance of such vehicle or item of equipment which is not identical to the federal standard.[69]

This section appears to expressly preempt state negligence actions for the failure to provide airbags. Consequently, most courts that have addressed this issue, including at least 10 federal district courts and 3 federal appellate courts, have found that preemption applies.[70] However, 4 district courts have interpreted the NTMVSA differently. They concluded that the wording does not clearly express an intent by Congress to occupy the whole field of regulation so that preemption does not apply. Thus, the airbag cases clearly show that federal regulations can preempt state law, but they also indicate that to be an effective defensive tool for IVHS developers, the regulations must clearly express their intent to preempt state statutes, regulations, and common law court decisions.

Compliance with federal or state regulations, therefore, is potentially an effective method of reducing IVHS tort liability. Existing case law indicates that both federal regulations (through preemption) and state regulations (through

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66. Under the Supremacy Clause of the United States Constitution, art. VI, cl. 2, Congress has the authority to preempt state law. For preemption to apply, the federal law must either expressly indicate its intent to preempt state law (and the extent to which it will be preempted) or "indicate an intent to occupy an entire field of regulation, in which case the states must leave all regulatory activity in that area to the Federal Government." See *Michigan Canners & Freezers Ass'n v. Agricultural Mktg. & Bargaining Bd.*, 467 U.S. 461, 469 (1984). Congress's authority to preempt state law extends to federal regulatory agencies, and preemption will shield negligent or even strictly liable private manufacturers from liability despite conflicting state regulations or common law. Furthermore, compliance with federal regulations could even shield state governments (through preemption) from liability under their own state laws.

67. See Theroff, E., "Preemption of Airbag Litigation: Just a Lot of Hot Air?," 76 Va. L. Rev. 577 (1990), for a complete discussion of these cases.

68. Codified at 15 U.S.C. Sections 1381-1431 (1988).

69. 15 U.S.C. 1392(d) (1988).

70. For an extensive listing of court decisions that have (or have not) applied federal preemption in the airbag context, see Theroff, *supra* note 67, at footnotes 4, 5, 8, 15, 22, 31, 32, 34, and 58.

preclusion) can successfully shield defendants in negligence actions based on state law. Furthermore, a regulatory approach is likely superior to other alternatives such as statutory liability limits or federal government indemnification, since the requirement that manufacturers comply with the regulations at least ensures that minimum safety standards will be employed.

The use of federal regulations is probably the best approach for providing tort liability protection for the manufacturers of IVHS installed in individual vehicles, such as AVN, collision warning, collision avoidance, and S&HK systems.[71] The primary liability concern with such systems is that they transfer responsibility for part of the driving process (e.g., navigation and vehicle control) to IVHS, thereby resulting in increased manufacturer liability despite the ability of these systems to decrease the overall number of accidents. A regulatory approach is a sensible solution in this situation, since the regulations can both mandate reasonable safety criteria and shield manufacturers from liability.

Regulatory approaches, however, are probably inappropriate for more ambitious IVHS such as automated highways and guideways. The complexity of such systems is so high that it is essentially impossible to specify regulatory guidelines prior to substantial development work on the systems. However, private investment into this research is likely dependent on the liability protection provided by the regulations. Thus, in this situation, a regulatory scheme is unlikely to be effective; instead, blanket protection through other forms of government intervention may be necessary to promote the development of these systems.

Statutory Liability Limits

IVHS tort liability could also be reduced through federal or state statutory limits on the liability exposure of IVHS manufacturers and operators. Federal liability limits could be implemented as part of the NTMVSA, thereby preempting state tort law.[72] State liability limits could similarly be implemented by expressly limiting the liability exposure of the manufacturers of specific IVHS products.

IVHS manufacturers have expressed interest in statutory liability limits, since they decrease the overall liability exposure while increasing the predictability of expected liability costs. Furthermore, these manufacturers can point to several successful experiments by the federal government in the use of statutory liability limits to promote important high-risk private ventures, including

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71. Federal regulations are preferable, since the automobile manufacturers sell nationwide (and thus desire a uniform standard) and since the state courts are hesitant to extend regulatory protection into the (strict liability) product area.
72. The Constitutionality of federal liability limits was upheld in *Duke Power Co. v. Carolina Environmental Study*, 438 U.S. 59 (1978).

the Warsaw Convention (an international agreement establishing liability limits for the commercial air industry for any crash), the Price-Anderson Act (which established liability limits for the nuclear power industry), and the 1988 Amendments to the Commercial Space Launch Act (establishing liability limits for the space booster industry).[73] State legislatures have also recently enacted a number of statutes limiting the liability of certain groups, most often as part of tort reform efforts.[74]

However, statutory liability limits are troublesome because they externalize tort costs without providing any guarantee of safety. This effectively *decreases* the manufacturers' incentives for investing in safety enhancements. Consequently, it seems perverse to argue for IVHS statutory liability limits as a means of *increasing* highway safety. Of course, statutes that limit liability often include severe civil and/or criminal penalties for safety abuses, but it is still doubtful that these penalties are sufficient to produce the highest level of investment in safety.[75]

Despite these concerns, liability limits may well be the best approach for promoting private investment in automated highway and guideway technologies. Regulatory approaches are not well suited for encouraging investment in these two forms of IVHS, and both are technologies that carry large initial safety risks, although they promise enormous safety gains as the technologies mature.[76] Consequently, at least for early ventures into automated highways and guideways, liability limits (or federal indemnification) are the recommended approach for promoting private development efforts.

Federal Government Indemnification

Federal government indemnification is another potential method of addressing IVHS tort liability problems. An indemnification program could conceivably come in either of two forms. Under the first approach, the federal government would simply indemnify the developers of IVHS for either a proportion

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73. See Syverud, *supra* note 64, at 90-92.
74. See, e.g., W. John Thomas, "The Medical Malpractice 'Crisis': A Critical Examination of a Public Debate," 65 Temp. L. Rev. 459 at note 16 (1992) (stating that every state except West Virginia has reformed state laws governing medical malpractice lawsuits since 1970).
75. Technically, these costs are not really externalized, since most accident victims are also motorists. However, since the key assumption in this report is that motorists are discounting these accident costs, manufacturers can ignore them when making investment decisions; thus, they are effectively externalized.
76. These risks are likely sufficient to deter large-scale investment in these technologies by many or even all private companies, since the risk of bankruptcy often outweighs the prospect of potentially significant—but uncertain—long-term rewards. Cf. Albert J. Sobey, "Business View of Smart Vehicle Highway Control Systems," in Journal of Transportation Engineering, Vol. 116, No. 4, 1990, 461, 462, 475. Similar concerns were behind federal intervention with the commercial air, nuclear power, and commercial rocket industries.

of their liability costs or all such costs exceeding some specified threshold. Ideally, this government subsidy would be set at a level that would encourage an "economically efficient" amount of IVHS development. A second approach would require that IVHS developers purchase liability insurance to the extent it is available on the private market, and the federal government would provide indemnification for judgments that exceed the available insurance coverage. This approach has been used by the federal government with the nuclear power and commercial rocket industries.[77]

In a sense, federal indemnification is essentially equivalent to statutory liability limits except that with indemnification, all taxpayers share in covering accident costs. Consequently, indemnification is a potential approach for use with automated highways and guideways and may be superior to statutory liability limits in that spreading the accident costs across all taxpayers seems to be fairer than letting these costs fall exclusively on the accident victims. However, although such an approach appears to be a plausible solution to the IVHS tort liability problem, it will likely be very difficult to implement from a political perspective. When indemnification programs were implemented in the nuclear power and commercial rocket industries, there were neither existing interest groups (such as the trial lawyers bar) with strong vested interests against indemnification nor deeply felt societal notions about the way to redress automobile accidents.[78] Combined with the additional problem of large budget deficits (and a corresponding reluctance to enact new spending programs), federal indemnification may prove to be difficult to implement even for IVHS that require subsidies to reach the most efficient level of implementation.

Liability Disclaimers

IVHS equipment manufacturers could also attempt to limit or avoid tort liability through the use of liability disclaimers in the signed sales agreements. These disclaimers would purport to either limit what causes of action could be brought against the manufacturer, the manufacturer's liability exposure, or both. Similarly, government agencies providing IVHS services could attempt to disclaim IVHS liability by prominently declaring (through roadside signs) that those opting to use IVHS-enhanced highways agree to forfeit any causes of

77. See Syverud, *supra* note 64, at 83. Note that the second approach is primarily concerned with addressing manufacturers' inability to obtain adequate insurance. However, if this is the only concern, then mandatory risk pooling (discussed *infra*) is a better approach, since it solves the liability problem without requiring a federal subsidy. Thus, in cases where a government subsidy is also required to ensure efficient resource allocation, it makes sense to simply compute exactly what subsidy is required to achieve the most efficient result. Therefore, the first approach, which allows setting the subsidy at any level, seems the better indemnification approach.

78. *Id.* at 93.

action against the highway department relating to the design, construction, operation, or maintenance of the system.

The validity of liability disclaimers has long been recognized by American courts and upheld under principles of "freedom of contract." However, many courts have been hesitant to enforce such disclaimers in cases involving consumers purchasing retail products, since manufacturers could use disclaimers to avoid product liability.[79] Based on similar logic, the Uniform Commercial Code (UCC) has arrived at the same result.[80] The UCC explicitly or implicitly recognizes freedom of contract principles in Sections 1-102, 2-316, and 2-719 and essentially holds disclaimers to be completely effective with commercial buyers. However, the UCC imposes restrictions on a party's ability to contract out of certain rights and/or remedies. In particular, UCC Section 2-719(3) states that certain damage limitations may be unconscionable and that "a presumption of unconscionability exists for consequential damages arising from personal injuries occasioned by consumer goods."[81] Although this is not an absolute limitation on the use of disclaimers with consumer goods,[82] it does indicate that without special considerations, disclaimers will likely be ineffective in the consumer *product* context.

With regard to IVHS *services*, however, the use of disclaimers may be somewhat more effective. The strict liability rules that apply with consumer products have only been sparingly adopted by courts in the services context.[83] In most service contexts, the rationale that disallowing disclaimers thwarts strict product liability does not exist. If the courts find that IVHS services are not the types of services to which strict liability applies, then they may be willing to enforce liability disclaimers.

The primary reason that courts have experienced problems with determining whether strict liability should be extended to services is that many transactions encompass both products and services. For example, hospitals and medical doctors have generally only been held to a negligence standard even though they provide products (drugs, artificial joints, etc.) along with their professional services.[84] However, other courts have held service providers strictly liable in hybrid product/service applications.[85] According to Prosser, the primary factors that courts consider in determining whether or not to impose strict liability in these contexts are:

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79. Prosser and Keeton, *Prosser and Keeton on Torts*, 5th Edition (1984) at 691- 692.
80. The UCC is a model commercial law code that has been adopted (in some form) by all 50 states.
81. See also UCC Sections 1-102(3) and 2-302(1).
82. See *Collins v. Uniroyal*, 315 A.2d 16 (1974).
83. See Prosser, *supra* note 80, at 720.
84. See *Id.* at 720 (in particular, footnote 43, which provides a list of cites to relevant cases).
85. See, e.g., *Edward M. Chadbourne Inc. v. Vaughn*, 491 So.2d 551 (Fla 1986) (highway contractor held strictly liable).

- the nature of the activity
- whether the defective product was transmitted in the course of rendering a service or only used
- whether it was the service or the product that was the principal thing bargained for.

In addition, Prosser notes that the most important factor may well be "whether or not the service provider is the kind of enterpriser who ought in the public interest be held strictly accountable for harm resulting from the defects in things transmitted in the course of rendering services."[86]

Applying this to IVHS, it is clear that the service distinction is unlikely to provide developers with a great deal of protection. The IVHS services currently under contemplation—such as highway information systems, motorist information, cooperative route guidance, and automated highway/guideways—all typically involve hybrid product/service transactions. In addition, with most of these services, a product will be transferred to the consumer (such as a motorist information receiver in the vehicle). Finally, the operators of these services will either be state governments or large corporations, which are exactly the kind of enterprises that are most likely to be held strictly accountable.[87]

Furthermore, even if strict liability is not applied to certain IVHS services, this provides no guarantee that courts will give effect to negligence disclaimers. Courts have often applied UCC principles in the services context, so the provisions of UCC 2-719(3) will likely be applied in at least some service-related disclaimer cases. In addition, outside of contexts in which the dangers are somewhat obvious, courts are likely to hesitate before recognizing a disclaimer clause, since the consumer may well discount the risk or misunderstand the bargain. Consequently, even with regard to IVHS services, it is unlikely that disclaimers will prove to be an effective solution to the tort liability problem.

Liability Insurance

Privately obtained liability insurance is another method that state and local governments and automobile manufacturers can use to limit their liability exposure. Most firms already carry liability insurance policies,[88] which would cover the liability they would be exposed to with IVHS product development. Thus, insurance seems to be the natural solution to the IVHS liability problem.

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86. *Id.* at 720.
87. This will be especially true in the case of state highway departments in jurisdictions that have enacted tort claims acts, since these acts are specifically designed to ensure state agencies are held liable for their torts.
88. Unless they deliberately choose to self-insure, thereby eliminating middleman costs at the price of higher risk.

Unfortunately, the use of insurance as a method of controlling IVHS tort liability is unlikely to prove satisfactory. Insurance is a very effective method for spreading risk (i.e., eliminating the risk of judgments far greater than the expected liability level), but it does not provide protection against increases in the expected liability level, since insurers quickly raise policy premiums to reflect higher risk. Since the IVHS tort liability problem is primarily associated with increased liability exposure (caused by the expected shift in tort liability from drivers to manufacturers and government highway departments), liability insurance will fail to address the primary component of the IVHS tort liability problem. This is not to say that insurance will not be helpful or necessary. As the expected manufacturers' liability levels increase, the dangers associated with liability judgments that far exceed the expected liability level become far greater, since they could potentially force manufacturers into bankruptcy. Thus, when the potential liability associated with a new project is excessive, many manufacturers will refrain from developing the project in order to avoid the risk. However, if liability insurance is available, the risk can be spread across numerous policy holders, which allows the insurance company to set the policy premiums to reflect the expected liability level. Thus, the availability of liability insurance will be very important to the development of IVHS, even if it is not the solution to every IVHS tort liability problem.

Mandatory Risk Pooling

Mandatory risk pooling is an approach that can be used to facilitate the development of new technologies for which the potential liability exceeds the insurance coverage available on the private market. Although such a scheme does nothing to address the problems associated with the magnitude of IVHS liability, it is an effective method of guaranteeing fairly constant liability costs despite the unavailability of sufficient liability insurance. With risk pooling, the federal government would require that all IVHS manufacturers[89] obtain liability insurance to the extent it is available and then pay additional liability premiums into a common pool. This pool would be used to satisfy judgments against the manufacturers that exceed the coverage of the available private insurance policies. The federal government would provide coverage (in the form of loans) for judgments that exceed the pool's resources.

An example of mandatory risk pooling is the Price-Anderson Act, under which the federal government requires risk pooling within the nuclear power industry.[90] In this context, such an approach is highly effective, because the overall liability exposure (measured as the probability of an accident multiplied

89. It is unlikely that state or local governments would participate in such a scheme, since they probably have sufficient resources available (through taxation powers) to accept the risk of one or more large liability judgments.
90. 42 U.S.C. 2210.

by the cost of the accident) is relatively low. The problem is that the potential liability costs are likely to be too great for a single power company (the one unlucky enough to have an accident) to bear. The problem with using risk pooling in the IVHS arena is that to a large extent, it is the liability exposure that causes problems (because of the liability transfer), and risk pooling does nothing to reduce them. However, for IVHS products or services that remain unsubsidized, it may be a sensible way of avoiding any problems raised by the unavailability of liability insurance.[91]

CONCLUSIONS

This paper set out to determine the extent to which tort liability is causing underinvestment in IVHS technology and to identify appropriate methods of responding to any underinvestment identified. This inquiry led to a number of conclusions:

- Current tort claims data indicate that
  - — significant liability may be transferred to private manufacturers developing collision warning, collision avoidance, S&HK, AVN, and automated highway systems
  - — highway departments may face limited liability with highway information systems and significant liability with automated highway/guideways.
- The liability-transferring characteristics of IVHS and consumer risk discounting may justify enactment of liability protection measures for IVHS developers.
- Liability protection is inappropriate for many IVHS, including
  - — government-developed (or government-purchased) systems (since the absence of a consumer purchaser eliminates the risk-discounting problem)
  - — highway information systems, AVL, motorist information systems, cooperative route guidance, optimized traffic signals, or automated toll collections (since current tort liability data indicate that

91. Note that insurance companies already shoulder nearly all of the liability costs for traffic accidents through individual policies. Thus, unless IVHS actually increase the overall number of accidents (which they are *not* supposed to do), the insurance companies should be able to easily accommodate the risks associated with IVHS liability, and mandatory risk pooling will not be necessary.

the liability problem is unlikely to be significant with these forms of IVHS)

— AVL, motorist information, cooperative route guidance, optimized traffic signals, or automatic toll collection systems (since these forms of IVHS do not provide sufficient safety enhancements to justify an assertion that consumers are likely to discount their accident prevention capabilities).

- Tort liability protection is only potentially appropriate for AVN, collision warning, collision avoidance, S&HK, and automated highway/guideway systems.

  — For AVN, collision warning, collision avoidance, and S&HK systems, the suggested approach to dealing with any tort liability problems is the combined use of liability disclaimers and federal regulations (similar to seatbelt regulations) that shield complying manufacturers from product liability.

  — For automated highways and guideways, statutory liability limits or federal indemnification are probably the preferred alternative, although these forms of IVHS are so far from development that the optimum solution is not clear.

When deciding whether or not to adopt any of the solutions mentioned here, it is important to consider the efficiency of the current transportation resource allocations. Where it can be shown that consumer behavior (such as risk discounting) has significantly reduced demand for IVHS services below the "optimum" level, then intervention is appropriate. Of course, the problem is determining when, and to what extent, such inefficiencies actually exist. The primary justifications for government intervention cited with regard to IVHS tort liability are that consumers discount accident risks or fail to fully appreciate the value of IVHS services and thus will refuse to pay extra for these services. However, the only indication of such inefficiencies (outside the risk-discounting studies that are not specific to IVHS) is consumer ambivalence, which could just as easily be the result of an accurate and rational cost/benefit analysis of the value of reduced accident rates and travel times. Furthermore, since most forms of IVHS are still very immature, this evaluation becomes even harder to make because a great deal of uncertainty exists as to the actual gains that IVHS will provide. In addition, even if inefficiencies can be demonstrated, it is still necessary to show that enough of a problem exists to justify government intervention. Consumer biases probably exist to a degree with all products, but government does not intervene to achieve more efficient results. A related problem involves gauging the magnitude of any inefficiencies that exist to determine the appropriate amount of corrective action.

Taken together, these uncertainties may be sufficient justification for withholding any type of corrective action at present. Relatively small-scale IVHS experiments are currently being initiated by both public and private organizations across the nation. These will educate consumers and provide better indications of the extent to which IVHS will improve transportation.

Two other justifications can also be given for delaying action on the IVHS tort liability problem. The first is that IVHS have yet to be convincingly demonstrated to be the answer to America's transportation problems. The proposed systems are for the most part very expensive, and it is questionable whether the benefits will match the costs. In addition, given the phenomenon of roadway travel increasing to fill all available capacity, there is a question whether many of the claimed benefits will ever be achieved. The second justification only relates to some forms of IVHS. For many of the less advanced forms of IVHS (such as optimized traffic signals, highway information systems, automatic tolls, AVL, motorist information systems, and cooperative route guidance), the tort liability problems appear to be relatively minor and thus unworthy of special protection. Similarly, the highly advanced IVHS applications such as automated highways and guideways, which create the most significant liability problems, are several decades away from development, and it may be too early to fashion solutions for their liability problems. Consequently, it may be sensible to delay any action with regard to these forms of IVHS and to concentrate the tort liability efforts on collision warning, collision avoidance, and automatic navigation systems, which are closer to development and which may have significant liability transfer problems.

Appendix

Application of Sovereign Immunity and the Public Duty Defense to IVHS

In predicting the impact of tort liability on state and local highway departments, it is necessary to consider the impact that sovereign immunity and the public duty defense will have in liability suits against the state. The following sections examine the extent to which these defenses are still capable of deflecting highway department tort liability and predict the extent to which they will apply in future lawsuits involving IVHS.

Sovereign Immunity

Sovereign immunity is a common law concept that protects government entities from tort liability. Historically, sovereign immunity shielded local, state, and federal governments from responsibility for virtually all torts, but statutory enactments during the last 50 years have worked to greatly reduce the scope of the immunity. The following paragraphs briefly trace the history of sovereign immunity and evaluate its capability for shielding local and state highway departments from IVHS tort liability.

The concept of sovereign immunity was first introduced in the famous English case of *Russell v. Men of Devon.*[92] The doctrine quickly took hold in America, although as early as 1855 Congress waived the immunity with respect to contract claims and claims involving federal laws and regulations. Over the years, Congress enacted several additional laws that further limited the scope of the immunity and in 1946 passed the Federal Tort Claims Act (FTCA),[93] under which the United States government consented to suits in tort. By exposing the federal government to tort liability, the FTCA appeared to complete the statutory abolition of sovereign immunity at the federal level. However, the act contains several important exceptions; thus, vestiges of federal government sovereign immunity still survive today.

The first exception in the FTCA is that the U.S. government is only made liable "in the same manner and to the same extent as a private individual under like circumstances."[94] This means that state law doctrines such as comparative negligence can work to reduce the federal government's liability. A second restriction (implied by the language of the FTCA and so interpreted by federal courts) is that the plaintiff must prove governmental negligence even in cases where a private individual would be strictly liable (such as product liability suits).[95] The most important exception is the "discretionary function" exception, which exempts activities that are purely governmental in nature from coverage under the FTCA regardless of whether or not the agency or employee abused this discretion in carrying out the activity. The exact language in the FTCA reads:

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92. 2 Term Rep. 667, 100 Eng. Rep. 359 (1798).
93. 60 Stat. 842, currently 28 U.S.C 2674 *et seq.*
94. 28 U.S.C. 2674.
95. See Prosser, *supra* note 79, at 1036.

> The provisions of this chapter . . . shall not apply to (a) any claim based upon . . . the exercise or performance of or the failure to exercise or perform a discretionary function or duty on the part of a federal agency or an employee of the government, whether or not the discretion involved be abused.[96]

Since 1946, at least 39 states have followed the federal government's lead and have statutorily consented to tort liability.[97] Of these states, 19 provide for the discretionary function exception in language nearly identical to that given in the FTCA, 6 more use similar language, and courts in 3 other states (Florida, New York, and Washington) have read the discretionary function exception into state tort claims acts that did not specifically provide for it.[98] This widespread recognition of the discretionary function exception has provided state and local governments with at least some protection in certain types of liability actions. The remainder of this section examines case law decisions that demonstrate which state highway activities are protected by discretionary function immunity and extrapolates these decisions to examine the degree of protection this immunity is likely to provide state and local governments engaged in IVHS development.[99]

In determining the extent of protection the discretionary exception is likely to provide IVHS developers, it is first necessary to identify the types of activities that fall under the exception. A series of Supreme Court decisions has provided a set of guidelines that help answer this inquiry at the federal level, and state courts have tended to follow these guidelines closely in interpreting their own tort claims acts.[100] The guidelines that have been established are as follows:

1. Planning decisions are considered discretionary, whereas operational ones are ministerial (and hence expose the state to liability).

2. Decisions involving "policy judgments" are discretionary.[101]

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96. 28 U.S.C. 2680.

97. "Survey of the Status of Sovereign Immunity in the States, 1988," American Association of State Highway and Transportation Officials, p. 1-5, 1989. Although many of these states legislatively cap the liability exposure (e.g., Virginia's Tort Claims Act provides for a $75,000 liability limit), the practice by many states of providing liability insurance for their employees essentially exposes the state to unlimited liability.

98. John Vance, "Impact of the Discretionary Function Exception on Tort Liability of State Highway Departments" in *National Cooperative Highway Research Program Legal Research Digest*, Volume Number 6, June, 1989, p. 4-5.

99. The discussion of sovereign immunity case law provided below is based on the article by John Vance cited in the preceding footnote.

100. See Vance, *supra*, note 99, at 5.

101. *Dalehite v. United States*, 346 U.S. 15 (1953) (holding that a Cabinet level decision to manufacture a fertilizer that contained an explosive chemical was discretionary, and thus the government was immune from responsibility for damages arising from the explosion of a ship containing this fertilizer).

3. Administrative decisions grounded in "social, economic, and political policy" are discretionary.[102]

4. It is "the nature of the conduct rather than the status of the actor that governs whether the discretionary function applies."[103]

5. "The discretionary function will not apply when a federal statute, regulation, or policy specifically prescribes a course of action."[104]

These guidelines show that the key is whether or not basic policy decisions are involved.

Current Case Law

Highway Design, Construction, and Maintenance. The general rule that has emerged in highway design, construction, and maintenance cases is that governmental negligence is not protected by discretionary function immunity.[105] The one exception to this rule involves design, construction, or maintenance influenced by broad policy factors that are considered discretionary.[106] However, courts have tended to interpret this exception narrowly, thereby limiting it to decisions such as which highways are built and their general routes.[107] Thus, the general rule is that although the decision to construct roads or provide traffic aids is often discretionary, once such a determination is made and acted upon, the state is liable in tort for all subsequent decisions except those driven by broad policy concerns.

Guardrails, Signs, and Traffic Lights. Two classes of decisions involving the installation and upkeep of guardrails, signs, and traffic lights are potentially discretionary. Guardrail, sign, and signal upkeep involves maintenance decisions; thus, it falls under the general rule (see above) that improper maintenance is not protected by discretionary function immunity. With the second class of decisions, which involve judgments on whether or not guardrails or warning signs should be installed, the authorities are split as to whether or not

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102. *United States v. Varig Airlines*, 467 U.S. 797 (1984) (holding that the Federal Aviation Administration's certification of the airworthiness of private aircraft was an activity immunized by the discretionary exception).
103. *Id.*
104. *Kerkovitz v. United States*, 56 U.S.L.W. 4549 (1988).
105. See, e.g., *Breed v. Shaner*, 562 P.2d 436 (Haw. 1977) (state liable for negligent design of highway curve that had contributed to a number of traffic accidents).
106. See *Stewart v. State*, 597 P.2d 101 (Wash. 1979).
107. See *District of Columbia v. Pace*, 498 A.2d 226 (D.C. App. 1985) (holding that a decision on whether or not to upgrade a highway was discretionary).

discretionary exception immunity applies.[108] Discretion is clearly involved in deciding what types of traffic control are installed at specific intersections and where limited guardrail resources are used, but it is questionable whether the discretion required involves "broad policy decisions." Thus, the majority of jurisdictions have held that signing and signaling decisions are operational and hence nondiscretionary.

Speed Limits. The establishment of speed limits by state and local governments is another area in which government highway designers have claimed sovereign immunity as a defense to tort suits by accident victims. Given the state policy of establishing speed limits on all roadways, it would seem that the establishment of the speed limit on any given road is an operational matter unrelated to any broad policy concerns and hence unprotected by discretionary function immunity. However, the case law has come to the opposite conclusion: setting speed limits has been judged to be a discretionary activity.[109] Even more surprising is that these decisions have been reached in relatively recent cases and in situations where it is likely that the state negligently set speed limits in excess of the maximum safe speed. These decisions show that a certain amount of inconsistency exists in the actual application of discretionary function immunity, which complicates the process of predicting its application with regard to IVHS.

Implications for IVHS

The next task is to use current case law to predict sovereign immunity's impact on IVHS. The discussion above demonstrates that the scope of discretionary function immunity as applied to state and local highway departments is fairly narrow. Basically, the immunity covers:

- decisions on whether or not to implement major upgrades
- operational decisions influenced by broad policy concerns
- decisions involving the establishment of speed limits
- in some jurisdictions, narrower policy decisions (e.g., decisions on where to install traffic lights and guardrails).

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108. Compare *Department of Transportation v. Neilson*, 419 So.2d 1071 (Fla., 1982) (holding that governmental decisions concerning the type of traffic control devices used at specific intersections are discretionary) and *Industrial Indemnity Company v. State*, 660 P.2d 561 (Alaska, 1983) (holding that decisions on where to install guardrails are discretionary) with *Rogers v. State*, 459 P.2d 378 (Haw. 1969) (holding that signing decisions are operational in nature and thus not protected) and *Johnson v. County of Nicollet*, 387 N.W.2d 209 (Minn. App., 1986) (decisions on whether or not to install guardrails not discretionary).
109. See *Kolitch v. Lindedahl*, 100 N.J. 485, 497 A.2d 183 (1985); *State v. Abbott*, 498 P.2d 712 (Alaska 1972).

The IVHS tort liability problems identified in Part 1 are almost exclusively concerned with design, construction, or maintenance issues. Thus, with the exception of government decisions about whether or not to implement an IVHS service, state and local governments will be unable to rely on sovereign immunity for tort liability protection. The cases holding that decisions concerning traffic light, sign, and guardrail installation are discretionary indicate that some limited amount of protection will likely be available on government decisions concerning where to install roadside displays, automatic toll booths, and other safety-promoting IVHS. However, the conflicting authority concerning these installation decisions seems to indicate that, after use of the IVHS equipment becomes widespread, many jurisdictions will drop discretionary immunity and use basic negligence principles in evaluating government liability for failure to install such a system.

Although the conclusions listed above probably represent the full extent to which discretionary function immunity will be able to shield governments from IVHS tort liability, the current speed limit cases indicate that application of the immunity is somewhat inconsistent. A number of factors could have influenced these speed limit decisions, such as (1) the fact that speed limits represent a maximum (not a required) speed, (2) the difficulty of determining optimum speed limits, and (3) the difficulty the highway designer may have in *proving* reasonable care without providing detailed speed/safety tradeoff studies. Without understanding the rationale that led to holdings finding this activity discretionary, it is difficult to pinpoint their exact IVHS tort liability implications. However, these decisions indicate that there is at least the potential for somewhat greater IVHS sovereign immunity protection than is actually predicted here.

Public Duty Defense

Another defense potentially available to government entities and employees facing IVHS-related tort suits is the "public duty" defense.[110] Under this defense, individuals suing public employees must demonstrate that the employee breached a duty specifically owed to the injured party; showing the breach of a duty owed only to the general public is insufficient. This defense was first recognized in *South v. Maryland*,[111] which held that a sheriff was not liable for failing to attempt to release an individual who had been seized by a mob, since the sheriff's duty to act was only owed to the public in general and not specifically to the plaintiff.

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110. The case law involving the application of the public duty defense in highway litigation is primarily based on the extensive survey of such case law provided by Kenneth Nellis in "The Public Duty Defense to Tort Liability," *National Cooperative Highway Research Program Legal Research Digest*, Volume Number 17, December 1990.
111. 59 U.S. 396 (1856).

The rationale for the public duty defense is that exposing public officials such as police officers to personal liability every time they fail to perform their duties with reasonable care is the equivalent of imposing a duty to rescue on them. Such a duty would directly contradict the well established common-law rule which holds that outside of a special relationship, there is no duty to rescue[112] and would also expose the public treasury to almost unlimited liability. Historically, the public duty defense has been used sparingly, since sovereign immunity precluded suits in most cases in which the defense would be applicable. However, with the statutory abdication of sovereign immunity by nearly every state, the public duty defense takes on increased importance as a potential method of limiting the liability exposure of state and local governments.

Increased use of the public duty defense by state and local highway departments, however, may be difficult. The current trend has been for state courts to reject the public duty defense, with at least 10 states abandoning it outright since 1976 because such a defense is inconsistent with state tort claims acts that abdicate sovereign immunity.[113] Furthermore, the defense has almost always been raised in cases involving the failure to provide police or fire protection and for the failure to enforce safety ordinances for buildings.[114] Nevertheless, as shown below, the public duty defense has the potential of limiting IVHS tort liability in at least some states. Recent cases in a number of states have clearly reaffirmed the principle. In these cases, it has been noted that the defense is really just the common-law "no-duty" rule as applied to public officials: the abolition of sovereign immunity does not mean strict liability for public officials. Moreover, there is nothing inherent in the public duty defense that precludes its use in highway litigation cases. Several states have actively applied the defense in highway litigation, and these cases demonstrate that a limited potential exists for using the defense in the future to mitigate IVHS tort liability.

Despite the historical focus on police, fire, and building inspection cases, the public duty defense has been used successfully by state highway departments and officials as well. For example, Illinois, Michigan, and Ohio courts have all used the public duty defense to absolve state highway department

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112. See, e.g., *Farwell v. Keeton*, 240 N.W.2d 217 (1976).
113. See Nellis, *supra* note 110, at 3.
114. *Id.* at 9 and 11-12. As an example, see *Crider v. United States*, 885 F.2d 294 (5th Cir. 1989) holding that a law enforcement officer was not liable under the Federal Tort Claims Act for the negligent failure to detain a drunken driver who later collided with the plaintiff since the officer's duty was only owed to the public in general.

officials from liability in negligent highway design and maintenance suits.[115] In addition, several jurisdictions that recently rejected the public duty defense had recognized it in earlier highway cases.[116] Rhode Island courts have been the most active in applying the public duty defense to protect state highway departments from liability suits; they have applied the doctrine in negligent design, construction, and maintenance actions.[117] Thus, at least in these states (and possibly in others that still recognize the defense), highway departments can focus on the absence of a duty of care to specific individuals to potentially avoid IVHS tort liability.

Although the public duty defense should at least provide some protection to highway departments against IVHS tort liability, the degree of protection provided will likely be insufficient in several respects. First, as mentioned above, the defense is not recognized in at least 10 states, and only a handful of the states that recognize the defense have applied it in highway litigation. Second, the trend is toward rejecting the defense, which is consistent with the similar trend (followed in nearly every state) to reduce sovereign immunity protection. Finally, the public duty defense will not apply in many situations in which the state is a highway litigation defendant. The public duty defense applies only

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115. See, e.g., *Keene v. Bierman*, 540 N.E.2d 16 (Ill. 1989) (state highway engineer not liable to plaintiff injured when car struck tree three feet from roadway), *Lusietto v. Kinsan*, 246 N.E.2d 24 (Ill. 1969) (state maintenance supervisor not liable in wrongful death action involving a large, dangerous hole in the roadway), *Rose v. Mackie*, 177 N.W.2d 633 (Mich. 1970) (state highway commissioner not liable to plaintiff involved in head-on collision along a highway that suddenly, without warning, narrowed from three lanes to two), *Williamson v. Paulovich*, 543 N.E.2d 1242 (Ohio 1989) (city not liable to child struck by automobile [allegedly due to congestion] since the duty to enforce traffic laws by towing illegally parked cars was a public duty), and *Zebransky v. Ohio Dept. of Transportation*, 477 N.E.2d 218 (Ohio 1984) (state highway department under no duty to provide a higher barrier to hinder people from dropping objects off bridge into traffic).

116. See, e.g., *Gerkinger v. Jefferson County*, 93 N.W.2d 130 (Iowa 1958) (holding that the public duty defense absolved the county engineer from any liability regarding a fatal accident at a "T" intersection that did not have signs warning of the "T" or the road termination and that did not have a guardrail to protect against a steep dropoff), rev'd in *Wilson v. Nepstad*, 282 N.W.2d 664 (Iowa 1979); *Richardson v. Belknap*, 213 P. 335 (Colo. 1923) (county commissioners not liable to plaintiffs in wrongful death action alleging failure to uphold their statutory duty to maintain the roads in safe condition [failure to provide guardrails at bridge approach] since statutory duty owed only to the public as a whole), rev'd in *Leakes v. Cain*, 720 P.2d 152 (Colo. 1986); *Clifton v. City of Ft. Pierce*, 319 So.2d 195 (Fla. 1975) (reversing judgment against city for malfunctioning traffic signal on public duty defense grounds), rev'd in *Commercial Carrier Corp. v. Indian River*, 371 S.2d 1010 (Fla. 1979).

117. See, e.g., *Knudsen v. Hall*, 490 A.2d 976 (R.I. 1985) (state's duty to the general public to properly maintain intersection [missing stop sign, brush obscuring visibility] does not provide for individual claims). For later cases obtaining the same result see *Kowalski v. Campbell*, 520 A.2d 973 (R.I. 1987) (negligent maintenance of safety lines on highway); *Carroccio v. Morgan*, 553 A.2d 1076 (R.I. 1989) (failure to maintain highway); *Polaski v. O'Reilly*, 559 A.2d 646 (R.I. 1989) (stop sign mutilated beyond recognition and obscured by shrubs).

when the duties owed are totally public in nature; if they are also owed to specific individuals, the defense is inapplicable. The inquiry concerning which type of duty is involved is ill-defined. In some states, the courts focus on the extent to which the state agency or official deals directly with the injured party; in others, the inquiry is concerned with whether the services or facilities were for direct public use as opposed to those meant to protect the public from general hazards.[118] Thus, it is possible that many courts will define the duties of designing and maintaining safe highway systems as ones owed to specific individuals, thereby precluding use of the public duty defense. Taken together, these limitations severely restrict the usefulness of the public duty defense with regard to IVHS tort liability.[119]

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118. See 18 McQuillin, Municipal Corporations Sec. 53.04b (3d ed. 1984) at 165-66.

119. A theoretical justification for using the public duty defense in IVHS tort liability cases could also be raised in certain cases. As discussed earlier, the common-law rule is that there is no duty to protect or rescue individuals from their own negligence or from the negligent or criminal acts of third parties. However, an exception to this rule is that once a party acts to provide aid, they come under a duty to both provide the aid and to do so non-negligently. It is this exception that causes a significant portion of state liability with IVHS development: by providing new safety systems, the state exposes itself to more liability, since it will be held responsible for many of the accidents that occur when the new system malfunctions. The rationale behind this exception is that by providing aid, an individual might either (1) discourage others from coming to the rescue or (2) cause reliance by the party in danger; thus, the party might well be worse off if a party that started to provide aid and then stopped was not held duty-bound. In situations in which the state is providing increased safety measures on the highway, the first of these rationales is inapplicable, and in many cases, the second rationale will be inapplicable as well (for example, when fog lights are not working on a fog shrouded mountain, reliance by drivers on the lights would not be reasonable). One of the rationales sometimes advanced for the public duty defense is that it prevents liability concerns from discouraging the state to apply additional safety measures. Thus, in cases in which high technology safety equipment malfunctions, the negligence inquiry should arguably only focus on the safety of the highway in the absence of the IVHS equipment. This argument is unlikely to work in many cases: juries are deciding between an injured plaintiff and a state government with nearly unlimited resources, but the rationale has been followed before (see *Goodman v. Raposa*, 312 P.2d 65 (Cal. 1957) (no state liability for malfunctioning traffic signal: the intersection simply reverted to an uncontrolled intersection, and the state was under no duty to direct traffic).