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OPENING SESSION
October 19, 1989

Dr. John A. Deacon, Professor
Civil Engineering Department
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INTELLIGENT VEHICLE HIGHWAY SYSTEM

Let me begin by expressing appreciation to Calvin for inviting me to be with you today. It's so good to see people I haven't seen for months and, in some cases, since last year's Transportation Forum.

When the invitation was extended to me to speak at the 26th Transportation Forum, I was in Washington, D.C. with the Transportation Research Board, directing its study on advanced vehicle and highway technologies. Although I resigned that position about 10 days ago, I'm still very interested in advanced technology. I remain convinced that it will play an increasingly pivotal role in further reducing the heavy toll of highway accidents and in relieving our choking congestion.

I have a few remarks to make about Bob Campbell. Bob is one of the foremost highway safety researchers in the world today and he has led the most prestigious of our highway safety research centers. When Bob talks it's worthwhile listening to him.

Several years ago, I found myself in northern Virginia rush-hour traffic, cramped in a van with Bob and several others. We were in congested traffic and a couple of bicyclists cruised past us. Of course everyone is a little annoyed when a bicyclist passes cars that are stopped at traffic lights. Bob made a few unpleasant remarks about the bicyclists, their innate intelligence, and how they have no concern for their own safety. (I think he would have been more temperate had he realized I was a bicyclist myself.) I want to reassure Bob that cyclists do sometimes modify their behavior to minimize accident risk. One common adaptation they make is seeking low-volume country roads when they leave the city and want to ride recreationally.

When my wife and I purchased a tandem bicycle several years ago, we encountered a whole new set of problems in transporting a bicycle by car. A tandem bicycle is big and doesn't fit in or on most cars. Last spring we decided to opt for a permanent, though expensive fix—we decided to purchase a minivan. It turns out that not any minivan would do. There is only one minivan into which a tandem will fit without a lot of disassembly, and that's an Astro. If any of you have a tandem and want to transport it, buy an Astro—and make sure you get the model with bucket seats in the middle row. Remove the rear seat and it works very well.

We picked up the new van last spring. On the trip home the brake warning light started flashing, but the brakes seemed fine. Since the auto dealer had closed, we didn't know what to do, except to go home, which we did without mishap. Early the next morning we called the dealer who said he wasn't sure, but thought there was no real problem and promised to get back with us promptly. Just before noon, he phoned and said, "First, raise the hood." Then he said, "Locate a flat black box on the driver's side near the brake cylinder and disconnect the two wires leading to the box." As it turned out, there were about 20 wires, coupled in two harnesses. We figured we'd gotten the right box anyway. Next, he said, "Turn the ignition key and hold it for five seconds; then, reconnect the wires at the wiring harnesses and test to see if the brake light has been extinguished." We did this and, fortunately, it had been. We've experienced no further difficulty. We know the black box is still working because, about once a week, the wiper blades unexpectedly sweep the windshield. Now, wet or dry, visibility is assured and we can be confident the black box is working.

There is a moral to this story that I want to share with you. The moral is simply that our vehicles, cars and trucks alike, continue to make incredible advances in their use of computer chips—for control of the vehicle, for monitoring of its operations, and for diagnostics. This trend is irreversible. You know it and I know it. Computer chips are making major impacts on vehicle reliability, on fuel economy, on emissions, on service and repair practices, and on many, many other aspects of vehicle operations.

Now, many want to take advantage of these smart vehicles by making our highways smarter as well. Communication links between vehicles and the highways on which they move promise to make travel quicker, safer, and less polluting. The proposed systems have been dubbed (and you've seen the names): Smart Cars Smart Highways, Intelligent Vehicle Highway Systems (IVHS), and Advanced Vehicle and Highway Technology. Whatever you wish to call them, they refer to exploitation of technology, specifically that which relates to sensing, communication, and computation. I want to address these specific technologies. I hope you will soon share with me, if you don't already, the conviction that this is very practical stuff, much of which we're capable of doing today if we have the will and if there is a political responsiveness to it.

With that introduction, I now want to classify (to some degree) the technologies that we're talking about, to clarify why we're concerned about them, and to note current actions that are underway in this country and elsewhere to implement them. I'll have some parting thoughts about things we might do in Kentucky, at both local and state levels, to be prepared to take advantage of these technologies.

Basically, there are four different systems with which we're dealing and I'll go through them in some detail (Table 1.) (*Tables and Figures are listed at the end of this speech*). They include (1) **traffic management systems**, (2) **driver information systems**, (3) **commercial operations and fleet management** (thus far this is primarily heavy vehicles), and (4) **automated systems**. We're not talking about clean power, alternate fuels, alternate engines, or exotic materials. We're not talking about robotics in maintenance and construction and we're not talking about track roadbeds. We're not talking about trains. We're talking about conventional, pneumatic-tired vehicles operating on our highway systems, with (eventually) some degree of automated control.

Traffic Management Systems

First, we'll look at traffic management systems, with which we are familiar (Table 2). Traffic signal control systems link together our signals at surface street intersections. Freeway management systems include ramp metering, changeable message signs, high-occupancy vehicle lanes and other similar features. Incident and event management includes accidents, maintenance activity, reconstruction activity, sporting events, and, though I hate to mention it, disasters such as recent the San Francisco earthquake.

Demand management is not normally considered in the advanced technologies sense, but advanced technologies do offer some options we haven't had before, such as road pricing. I know this is an unpopular concept, but we may eventually end up with road pricing and advanced technology will help us a great deal there.

What I really want to focus on in traffic management systems are the attributes necessary to take advantage of available technology. First, the system has to be traffic responsive, and it has to be traffic responsive in real time. It has to sense the traffic that's out there now and take appropriate actions. It needs to be predictive as well (as in what's going to happen in the next 15 minutes or the next hour) and make the appropriate adjustments. We need an integrated system, a system that integrates surface street control with vehicle control, with freeway control, and with incident management. The whole thing needs to be linked across jurisdictional boundaries, so that we have a truly collaborative and interjurisdictional system. Finally, we need to make sure that the algorithms that drive these kinds of systems are optimized.

Driver Information Systems

The next technology I want to talk about is driver information systems (Table 3). Located inside the vehicle is a cathode ray tube that displays a map showing, as a minimum, the road network and the position and direction in which the vehicle is traveling. In-vehicle displays go much beyond this, but this is the type of feature we see.

There are other aspects, though, of driver information systems. Some types of information that can be provided to drivers are: road, weather, and traffic conditions, and the availability of services, rest areas, parking, and attractions (e.g., Disney World). They can provide navigational or locational information (where am I relative to everything else?). They have the ability to plan routes in advance or in real time and to provide guidance to drivers through a comprehensive street and highway network. Almost inevitably coupled with this is advanced vehicle and driver self-diagnostics. Self-diagnostics will determine if the vehicle is safe and proper to operate and whether the driver is (because of alcohol, for example) and should not operate the vehicle. There also will be information about how fast a driver should go, given prevailing conditions.

Again, what is the purpose of this information? There are a host of reasons for driver information systems. They can assist a driver in scheduling a trip, for instance. If a driver learns that congestion is bad, he may delay a trip to the grocery store until later. Or, he may travel through a less congested area to a different store. He also can get trip status information and estimated time of arrival to use in selecting the routes while a trip is in progress. This is particularly important information, perhaps not so much for people driving cars, but certainly for commercial trucking operations and fleet management.

This system is going to provide the capability for requesting emergency services when a vehicle is disabled on the roadway and, almost undoubtedly, is going to have personal communications through cellular telephone or similar technology.

What are some of the options? Much progress has already been made. You can turn on your radio in most larger areas and the "eye in the sky" will provide details on the location of traffic congestion and accidents. Metropolitan television stations use maps to show where accidents have occurred; they may even announce the average speed on certain routes. This is advanced driver information; it's technology that is being used today and it's technology that can literally expand without bounds.

Being tested in Southern California is another kind of system where, from home or office, through teletext or videotext, one can access information about congestion and travel conditions. The information is displayed on a TV screen or through printed output, on an individualized basis. Ultimately, of course, we see in-vehicle systems that automatically locate the vehicle; there are on-board computers, there are computerized displays of various sorts. There are even going to be voice synthesizers which say "as you approach the next intersection prepare to turn, ... move to the left lane, ... now turn left." These are examples of driver information systems.

Commercial Operations and Fleet Management

Let's talk now about commercial operations and fleet management (Table 4). Much of the necessary technology is already in place. Automatic vehicle identification (AVI) or electronic license plates is not new technology. It's here, it's available; although we don't yet know exactly what technology is best, we certainly have that capability.

We also have the capability for weigh-in-motion and automatic vehicle classification. Automatic vehicle location has not developed quite so far, but there are a number of ways we can locate a vehicle automatically on the network. There will be on-board computers and two-way communications (both data and voice), and there will be a host of other technologies such as bar code readers and printers.

We will concern ourselves with two basic uses of commercial operations and fleet management technology. The first is for truck monitoring and enforcement, which primarily is an activity involving public agencies. We collect planning data, seek to enforce size and weight regulations, track hazardous materials, and try to properly document and clear commercial vehicles. There are also some auditing purposes that we're concerned with.

Now, the fleets also are pursuing this technology. At this point, the big fleets (particularly the trucking fleets) have done more to advance the technology than any other segment of the transportation industry, including taxi, police, ambulance, and emergency services. There are many reasons for their interest in these technologies. A business can employ real-time dispatching and control, and automatic reporting and manifest preparation (the secretary doesn't have to key in all the information at the end of each day). A trucker can send a quick status report to any customer regarding the location and arrival time of a shipment, or can identify in advance approved truck routes. Truckers will benefit from automatic clearance and pre-clearance in crossing state boundaries and in the automatic monitoring of vehicles and cargos.

In addition to truck monitoring and fleet management, there are other functions for which this technology can be used. For instance, the collection of toll and parking payments (we're doing some of this) and tracking of stolen or improperly documented vehicles. We have even contemplated using this kind of information (by feeding information back to a traffic control system) to measure how well traffic is moving. Knowing the times at which a transponder-equipped vehicle passes two known points, we can estimate the travel speed and get some indication as to the quality of traffic flow. This application is scheduled for testing in the New York City area in January, 1990.

Automated Vehicle/Highway Systems

With automated systems, we can again build from a fairly low level of sophistication to a fairly high level (Table 5). Independent vehicle operation and blind-spot surveillance is high on the list. It ought to be priority for school bus operators who have trouble seeing kids walking in front of buses. As you are well aware, most of our school fatalities are children who have been struck by a bus because the driver was unable to see them. We also need blind-spot surveillance in our cars as we change lanes, and particularly in trucks whose drivers can't see what's behind them. In more advanced systems, we have collision warning. With collision avoidance capability, a driver receives a warning upon approaching an object too quickly, and if he doesn't respond appropriately, automatic braking occurs. This is something we can do now, and although insurance companies may not embrace it, it is good technology that's available now.

Our current vehicle cruise controls are limited in what they can do. But, we are looking toward adaptive speed control or smart cruise control that can accelerate, brake automatically, and will attempt to maintain a constant, desired speed.

If we can develop vehicle-to-vehicle communications (two or more vehicles), we can reduce headways and have a terrific effect on capacities and likely increase speeds as well. We can control entry and exit on freeways, and control passing maneuvers. The next stage is a link between highway and vehicle, such as steering control (i.e., lateral control) as the vehicle moves down the roadway. Through hazard warning, we can provide information to approaching drivers about congestion, construction, crashes, etc. All these things build up and become fully automated systems which are basically hands-off.

The Current Threat

To address why we are interested in these new technologies, I want to start at the bottom and go up (Table 6). Most of you know that our current highway legislation, which for years has been driven by the Interstate system, is nearing completion and will expire in 1991. There's a major thrust for new legislation beginning after 1991 and, in my opinion, advanced technology is going to be the new vision for the highway future. Advanced technology will probably drive, in part, the post-1991 highway legislation. There is no other jewel, no other promise, that we have to offer for major gain.

We're also concerned with the research and development in other countries, particularly in Europe and Japan. We're afraid we're going to lose the edge in our technical competence and international competitiveness.

With advances in technology generally, we can do things now we couldn't even contemplate 10 years ago. Now that our technology is so much improved, we can do a much better job in applying it to the highway environment than we've ever before attempted.

Because of obstacles to road construction, it's getting tough to build roads. We're not spending a lot of our money on road construction; more of our highway dollars are going to maintenance and operation. The construction dollar is not going as far and instead of buying capacity, we're buying safety, aesthetics, noise barriers, and the like. What that means is that we can't buy as much capacity as we used to with the highway dollar.

Traffic growth, of course, causes increased congestion and affects highway safety (Table 7). There has been a two-percent increase per year in congested peak-hour travel over the last 10 years. Bob Campbell mentioned 85,000 fatalities a year—this may become a reality; it very well may happen if bold steps are not taken.

The way total disbursements for highways progressed from 1950 to 1985 looks pretty good (Figure 1). We've spent a lot more money in constant-year dollars recently than we did in the past, though not much has changed since 1970. We get a slightly different picture when we express this on a per-vehicle-mile basis (Figure 2). You'll note that on a per-vehicle-mile basis, we're spending less in 1985 than we did in 1950. The peak came during the Interstate era, but we're now going down, not up. If you look at the annual capital outlay of construction dollars, on a per-vehicle-mile basis, we are again below where we were in 1950, and half of where we were in the Interstate era (Figure 3). So, once again, we're not spending as much money for new road building as we used to and the money that we do spend is being increasingly used to purchase things other than capacity.

R & D in Other Countries

There are several interesting research and development demonstrations being conducted abroad (Table 8). Prometheus and Drive are European efforts. Prometheus, sponsored primarily by the vehicle industry, spends $100 million a year in research and development on in-vehicle electronics and controls. Drive is funded at about $50 million a year; it's a three-year program sponsored primarily by government and focuses on roadway infrastructure technology. RACS, AMTICS, and IVS are Japanese. RACS and AMTICS, primarily navigation efforts, are being demonstrated in Tokyo and elsewhere. IVS is a more advanced technology and a future kind of thing.

There are other interesting demonstrations in Berlin and London. In Berlin the nickname is LISB, and in London it's Autoguide. Both are in-vehicular navigation systems. It is interesting to note that the London experience is purely private—a profit-making endeavor. They haven't made a profit yet, but that's the intent.

Potential Impacts

There is a wide range of potential impacts from advanced technology—safety, mobility, economy, and convenience (Table 9). Another is our national defense. Many of you old-timers know that we sold the Interstate system, in significant part, because of national defense. Although we're not presently trying to sell advanced technology for defense purposes, it is going to have to be sold that way and it's going to have a major impact.

America's R & D

There are already numerous illustrations of the implementation of advanced technology in the United States (Table 10). We have third generation traffic signal control systems. We have freeway management systems and, in several states, we have automatic toll collection, where you don't have to stop to pay tolls. These efforts are continuing. In truck monitoring enforcement, most of the states are now collecting weigh-in-motion and automatic vehicle classification data. The trucking folks are pushing fleet management.

We also have on-going research and development in the United States (Table 11). The Smart Corridor is centered on the Santa Monica freeway in Los Angeles. Being examined is the diversion of freeway traffic to surface arterials. The Pathfinder project, also in Southern California, is using 25 vehicles to demonstrate vehicle navigation and route guidance. PATH, at the University of California, deals with more advanced technology, including lateral and longitudinal control of vehicles and new propulsion technology. HELP (Heavy Vehicle Electronic License Plate) is a demonstration project that has been underway for three or four years. Manufacturers, specifically smaller ones, also are doing a lot of things, and we have four or five universities getting into research and development in a major way.

We've had a number of agencies and organizations studying advanced technology recently, and their bottom-line conclusion is that we need to greatly escalate our research and development efforts (Table 12). From these efforts (as I see it), it appears there will be a large-scale federal program (Table 13). The federal folks are emphasizing early deployment and a partnership that joins public and private sectors. The lead agency, at the moment is the Federal Highway Administration. The projected $200 million annual cost (half public and half private) excludes construction and hardware costs for implementation and early deployment projects. The federal plan has a very broad technical scope and emphasizes early deployment of mature technologies that will set the stage for major technological breakthrough in the more distant future.

Hopefully, we will get an update on the federal view of advanced technology in tomorrow's report by Dave Phillips, FHWA's Association Administrator for Research, Development, and Technology.

Local Opportunities

A large number of influential national organizations, including the Transportation Research Board, are supporting large-scale federal initiatives. TRB, for example, is constituting a high-level panel to explore the various high-tech options and the institutional means to advance and implement them (Table 14). Although opportunities for most of us here today to participate in the advanced-technology movement may seem to be limited, each of us must not only stay well-informed about advancements being achieved elsewhere but we also must push to implement in our localities and throughout the state, the most advanced available technologies appropriate to our needs (Table 15). Indeed, Kentuckians can assume a critical leadership role in demonstrating how advanced technologies can be introduced into a mature highway infrastructure by existing public and private agencies to meet real challenges to our mobility, productivity, and personal safety. The challenges are truly enormous though, and traditional techniques for preserving and enhancing the nation's mobility must not be abandoned in the rush to embrace exciting new prospects (Table 16).

Let me conclude by observing that it is truly an exciting time for transportation folks in Washington. A new national transportation policy—currently being developed by Transportation Secretary Skinner—will be unveiled on the 8th of January. An exposition—displaying a variety of advanced transportation concepts—is being developed in conjunction with the annual Transportation Research Board meeting. If you haven't attended a TRB meeting in a while, this year promises to be a particularly interesting one. If possible, make plans soon to attend. The real fun in Washington will start soon after the first of the year as Congress begins to tackle the enormous task of drafting post-1991 highway legislation. However it comes out, advanced technology will almost certainly be a centerpiece of that legislation.

Thanks for your attention.

TABLE 1. TAXONOMY OF ADVANCED TECHNOLOGIES

- ❑ Traffic Management Systems
- ❑ Driver Information Systems
- ❑ Commercial Operations and Fleet Management
- ❑ Automated Vehicle/Highway Systems
- ❑ Non-AVHT
  - – Clean Power
  - – "Exotic" Materials
  - – Robotics in Maintenance and Construction
  - – Tracked Roadbeds and Trains
  - – Etc.

TABLE 2. TRAFFIC MANAGEMENT SYSTEMS

- ❑ Traffic Signal Control Systems
  - – Optimal Timing (Improved Algorithms)
- ❑ Freeway Management Systems
  - – Ramp Metering
  - – Changeable Message Signs
  - – HOV Lanes
- ❑ Incident and Event Management
- ❑ Demand Management
- ❑ Attributes
  - – Traffic Responsive
  - – Real-Time Control
  - – Integrated System (Freeways and Surface Arterials)
  - – Enhanced Detection and Surveillance
  - – Enhanced Management
  - – Future Link with Driver Information Systems
  - – Collaborative (Inter-Jurisdictional)
  - – Optimized
  - – Predictive

TABLE 3. DRIVER INFORMATION SYSTEMS

- ❑ Types of Information Provided
  - – Road, Weather, and Traffic Conditions
  - – Services, Rest Areas, Parking, and Attractions
  - – Navigation (Location)
  - – Route Planning and Guidance
  - – Vehicle and Driver Self-Diagnostics
  - – Appropriate Speeds
- ❑ Purpose of Information
  - – Trip Scheduling
  - – Destination and Route Selection
  - – Trip Monitoring and Status (Estimated Time of Arrival)
  - – Request for Emergency Assistance
  - – Personal Communication
- ❑ Some Options
  - – Radio
    - • Commercial
    - • Highway Advisory (Automatic Option)
  - – Home or Office Systems
    - • Commercial Television
    - • Teletext and Videotext
  - – Vehicle Systems
    - • Automatic Vehicle Location
    - • Computerized Displays
    - • On-Board Database
    - • Voice Synthesizer

TABLE 4. COMMERCIAL OPERATIONS AND FLEET MANAGEMENT

- ❑ Necessary Technology
  - – Automatic Vehicle Identification
  - – In-Motion Weighing
  - – Automatic Vehicle Classification
  - – Automatic Vehicle Location
  - – On-Board Computers
  - – Two-Way Communications (Data and/or Voice)
  - – Other (Bar Code Reader, Printer, Etc.)
- ❑ Truck Monitoring and Enforcement
  - – Collection of Planning Data
  - – Size and Weight Enforcement
  - – Tracking Hazardous Materials Movements
  - – Documentation and Clearances
  - – Auditing
- ❑ Fleet Management (Truck, Taxi, Police, Etc.)
  - – Automatic Clearance/Pre-Clearance
  - – Automatic Monitoring of Vehicles and Cargo
  - – Real-Time Dispatching and Control
  - – Automatic Reporting and Manifests
  - – Quick Response to "Emergencies"
  - – Current Status Reports for Customers
  - – Approved Truck Routes and Access Provisions
- ❑ Toll and Parking Payments
- ❑ Stolen or Improperly Documented Vehicles
- ❑ Measurement of Flow Quality/Congestion

TABLE 5. AUTOMATED VEHICLE/HIGHWAY SYSTEMS

- ❑ Independent Vehicle Operation
  - – Blind-Spot Surveillance
  - – Collision Warning
  - – Collision Avoidance
  - – Adaptive Speed Control (Smart Cruise Control)
- ❑ Continuous Vehicle-to-Vehicle Communication
  - – Platoon Management
  - – Entry/Exit/Passing Control
  - – High Speeds/Capacities
- ❑ Continuous Highway-Vehicle Communication
  - – Steering Control
  - – Hazard Warning (For Example, Crashes, Construction, and Congestion)
- ❑ Full Automation

TABLE 6. THRUST BEHIND CURRENT INITIATIVES

- ❑ Travel Growth
  - Congestion
  - Safety
  - Environment
  - Conservation
- ❑ Obstacles to Road Construction
- ❑ Advances in Technology
  - Communication
  - Computation
  - Sensing
- ❑ Technological Competence and International Competitiveness
  - PROMETHEUS
  - DRIVE
  - RACS
  - AMTICS
  - IVS
  - Other
- ❑ Post-1991 Highway Program
  - AVHT: New Vision for the Highway Future
  - Opportunity for Expanded R&D

TABLE 7. HIGHWAY TRENDS

	Annual Change: 35 Years to 1985	Annual Change: 10 Years to 1985
❑ User Impacts		
– Travel (Vehicle-Miles per Capita)	+2.6%	+1.9%
– Congestion (Congested Peak-Hour Travel)	- - -	+2.0%
– Safety (Fatalities per Capita)	-0.5%	-1.0%
❑ Societal Impacts		
– Conservation (Fuel per Capita)	+2.2%	0.0%
❑ Infrastructure Impacts		
– Travel (Vehicle Miles)	+4.0%	+2.9%
– Disbursements (1985 Dollars)	+3.7%	+1.1%
– Public Roads (Miles)	+0.5%	+0.2%

TABLE 8. R&D ABROAD

- PROMETHEUS
  - Europe
  - Industry Program with University Participation
  - In-Vehicle Electronics and Communication
  - 8-Year, $800 Million
- DRIVE
  - Europe
  - Government Program with University and Industry Participation
  - Road Infrastructure Technology
  - 3-year, $140 Million
- RACS and AMTICS
  - Japan
  - Navigation and Communication Systems
  - Demonstrations in Tokyo and Elsewhere
- IVS
  - Japan
  - Automatic Chauffeuring
- Other Navigation and Route Guidance Demonstrations
  - LISB (Berlin)
  - Autoguide (London)

TABLE 9. POTENTIAL IMPACTS OF ADVANCED TECHNOLOGY

- Users
  - Mobility
  - Safety
  - Economy
  - Convenience
- Society
  - Pollution
  - Conservation
  - Efficient Commerce
- Government
  - Infrastructure Costs
  - Enforcement Costs
- Nation
  - Domestic Technology Base
  - National Defense
  - Industrial Competitiveness
  - International Independence
  - International Standards and Specifications

TABLE 10. U.S. IMPLEMENTATION EXAMPLES

- ❑ Traffic Signal Control Systems
- ❑ Freeway Management Systems
- ❑ Incident and Event Management
- ❑ Radio and TV Driver Information Systems
- ❑ Automatic Toll Collection (CA, LA, NY, TX, VA)
- ❑ Truck Monitoring and Enforcement (For Example, WIM, AVC)
- ❑ Fleet Management (For Example, Trucking, Police, Taxis, Emergency Services)

TABLE 11. SELECTED U.S. R&D[3] PROGRAMS

- ❑ SMART Corridor (CA)
- ❑ PATHFINDER (CA)
- ❑ PATH (CA)
- ❑ HELP and CRESCENT (Western States)
- ❑ Manufacturer Activity
  - Navigation
  - Mobile Communication
  - Digital Mapping
  - Automatic Vehicle Identification
  - Collision Avoidance
  - Headway Control
- ❑ University Activity
  - Massachusetts Institute of Technology
  - Texas A&M
  - University of California
  - University of Iowa
  - University of Michigan
  - University of Minnesota
  - University of Texas

TABLE 12. "POLICY" PAPERS

- Mobility 2000
  - Proceedings of a Workshop on Intelligent Vehicle/Highway Systems
- American Association of State Highway and Transportation Officials
  - Policy Resolution: Intelligent Vehicle/Highway Systems
  - Innovation—A Strategy for Research, Development, and Technology Transfer
- Federal Highway Administration
  - A Program for the Advancement of Intelligent Vehicle/Highway Systems
- Office of the Secretary of Transportation
  - Discussion Paper on Intelligent Vehicle/Highway Systems
- Office of Technology Assessment
  - Intelligent Vehicle/Highway Systems and Urban Traffic Congestion

TABLE 13. PROPOSED FEDERAL R&D[3] PROGRAM

- Partnership
  - Public/Private
  - Local/State/Federal
  - International (Canada, Mexico, Others?)
- Lead Agency—Federal Highway Administration
- Large Scale (Up to $200 Million Annually, Excluding Construction and Hardware Costs)
- Broad Technological Scope
- Early Deployment of Mature Technologies (Immediate Impact)
- Basic Research for Evolving Technologies (Future Impact)

TABLE 14. TRANSPORTATION RESEARCH BOARD STUDY

- ❑ Funding
  - Motor-Vehicle Industry
  - Electronics Industry
  - U.S. Department of Transportation
  - AASHTO/NCHRP
- ❑ National Committee
  - Chaired by Daniel Roos, MIT
  - Approximately 20 Members Representing Industry, Government, and Highway Users and Including Experts in Technology, Management of Innovation, Planning, Public Policy, and Finance
- ❑ Original Schedule
  - July 1, 1989 to December 31, 1990
- ❑ Objectives
  - Evaluate Potential Benefits of Advanced Technology
  - Assess Likely Impacts of an Expanded R&D[3] Program
  - Identify Methods for Effective Program Management

TABLE 15. STATE AND LOCAL ROLE

- ❑ Stay Well Informed
  - Assign Responsibility
  - Support Professional Development
  - Participate in External Forums
- ❑ Support National and Regional Initiatives
  - Research, Development, Demonstrations, and Deployment
  - Development of Standards and Specifications
- ❑ Seek Opportunities for Local Demonstrations
- ❑ Support Private-Sector Initiatives
- ❑ Implement Current Technology
- ❑ Demand Optimal Operation of That Technology
- ❑ Enhance Everyday Operations by Exploiting New Information (Such as WIM)
- ❑ More(?)

TABLE 16. PRESERVING AND ENHANCING MOBILITY

- ❑ New Construction and Improvements
- ❑ Public Transportation
- ❑ Management of Maintenance, Construction, and Public Utilities
- ❑ Travel Demand Management
- ❑ Travel Substitutes
- ❑ Other Transportation Systems Management (For Example, HOV and Reversible Lanes, Ridesharing)
- ❑ Clean Energy
- ❑ Advanced Technology

FIGURE 1. ANNUAL DISBURSEMENTS
(1985 Dollars)

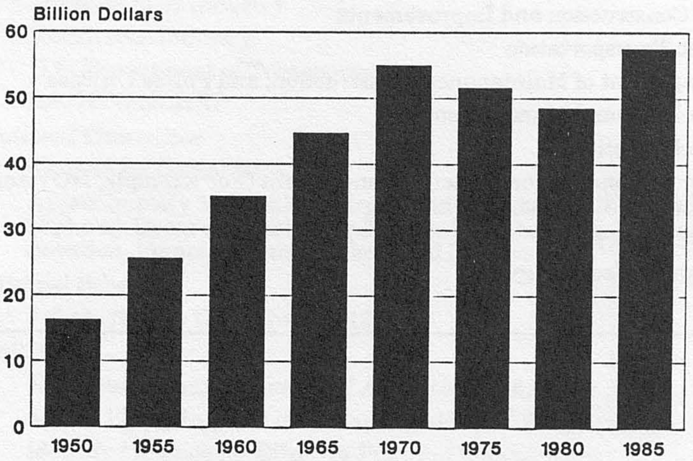

FIGURE 2. ANNUAL DISBURSEMENTS PER VEHICLE MILE
(1985 Dollars)

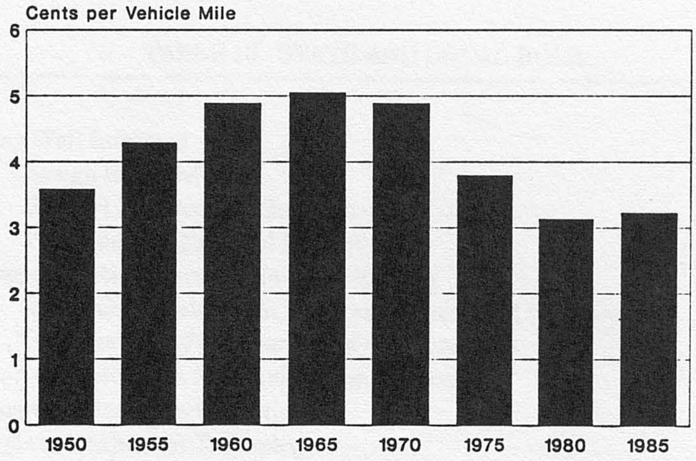

FIGURE 3. ANNUAL CAPITAL OUTLAY PER VEHICLE MILE (1985 Dollars)