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ITS Societal Impacts: Current Knowledge and Research Needs

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EXECUTIVE SUMMARY

The Volpe Center researched and authored this report for the Office of the Secretary of Transportation (OST) as part of Project Plan Agreement OP-50E, entitled "ITS Technical Assistance." This report reviews and critiques the current state of knowledge of the potential social impacts of Intelligent Transportation Systems (ITS) and recommends research actions to fill in gaps in crucial knowledge.

A primary mission of the Department of Transportation (DOT) is to advance societal benefits through the development and reinforcement of the nation's transportation system. Currently, the Department is shifting its focus from building surface infrastructure to making it "work better through adaptation and modernization."' The federal ITS program exemplifies this shift. As stated ***in the*** DOT's ***National ITS Program Plan*** ITS could achieve multiple societal benefits:

> "If ITS technologies are effectively integrated and deployed, there could be a number of benefits including more efficient use of our infrastructure and energy resources, and significant improvements in safety, mobility, accessibility, and productivity."2

To date, a fundamental research question has been whether ITS user services are in society's best interests. This interest has been compelled by the DOT's broader mission and goals to serve society as well as federal legislation, such as the Clean Air Act Amendments of 1990 (CAAA), the Intermodal Surface Transportation and Efficiency Act of 199 1 (ISTEA), and the National Environmental Protection Act of 1969 (NEPA).

Although ITS user services will not likely benefit everyone or everywhere, the DOT aims to design and administer an inclusive ITS program that addresses a wide range of societal needs. This ambition is underscored in the Department's ***1994 Strategic Plan,*** which asserts a fundamental goal to "put people first" by:

> "Ensur[ing] that transportation policies and investments embrace the concerns of the traveling public and neighborhoods, economic development interests, and other societal concerns."3

To date, much of the Department's research has assumed the tone, if not the absolute methods, of traditional cost-benefit analysis. For the most part, this research has focused on broad, tangible impacts potentially affecting large, broadly defined constituents. Drawing on insights provided by cost-benefit research, the DOT, ITS America, and others have begun to explore ITS' potential societal implications. These societal implications are best addressed using social impact assessment, which builds upon traditional cost-benefit analysis. Social impact assessment also expands the base of knowledge by valuing important intangible effects, which often cannot be quantified or monetized. For example, an advanced traffic management system's impact on neighborhood cohesion may greatly concern affected residents.

In addition, social impact assessment addresses not only changes in absolute levels of benefits and costs, but how impacts are distributed among specific, carefully defined groups. It often seeks to resolve how deep and discriminating impacts affect individuals.[4]

Social impact assessment, however, presents a formidable challenge to public policy evaluators. In particular, there are several barriers to credibly evaluating ITS' societal impacts:

Potential Barriers to ITS Societal. Evaluation
• Heterogeneity and complexity of society • Uncertainties about aggregate benefits, disbenefits, and costs • Uncertainties about indirect relationships • Unknowns about ITS markets and deployment time frame • Decentralized deployments driven by local needs and policies • Uncertain assessment methods and criteria

The objective of this report, therefore, is to determine whether and how these barriers can be overcome. For insight, we investigated four research areas: 1) the theoretical literature on social impact assessment; 2) the ITS societal issues literature; 3) social impact studies of conventional transportation services; and 4) long-range demographic and transportation forecasts.

The rest of this executive summary highlights the current knowledge of ITS' potential societal impacts and identifies major research needs. This summary also highlights ongoing, complementary research activities engaged in by DOT administrations, ITS America, and others.

CURRENT KNOWLEDGE OF ITS SOCIETAL IMPACTS

We identified thirty published papers addressing the societal implications of ITS user services. Our review shows that there is insufficient knowledge about ITS' potential social impacts. Most of the literature is highly exploratory, searching for questions rather than arriving at answers. The literature rarely employs rigorous methods to appraise potential impacts. Most significantly, the literature does not stringently examine ITS' distributive potential. Nearly all of the studies stress the need for further social impact research. Below are highlights of our review:

There is no consensus on relevant societal issues and constituent groups. The ITS literature defines "societal" impacts in sweeping terms. It embraces such diverse concepts as institutional issues, legal issues, privacy, user acceptance, travel demand, access, economic utility, and economic externalities. The literature also broadly defines constituents; most of the papers implicitly address generic urban and suburban commuters. Eleven papers explore issues concerning specific groups (rural residents, disadvantaged central city residents, elderly, and bicyclists). The DOT's Draft May 1994 ***National Program Plan** for* IVHS,[5] a precursor to the

March ***1995 National ITS Program Plan,*** and Barbara Richardson's paper, "Socio-economic Issues and Intelligent Transportation Systems," provide the most comprehensive lists of issues and constituents.

Although aggregate benefits, disbenefits, and costs of ITS user services are better understood, little is known about their potential distribution among particular constituent groups. The DOT, ITS America, and other organizations have researched the potential impacts of specific ITS user services on traffic congestion, productivity, efficiency, mobility, safety, air quality, and energy use. However, few papers deeply investigate how these impacts could be distributed among users and non-users of ITS technologies and services.

For the most part, ITS research has not attempted to measure community level impacts. The DOT and ITS America have investigated institutional issues affecting private industry, local governments, and other Federal agencies as well as privacy concerns. This essential research has effectively identified non-technical impediments to ITS deployment. However, to date, research has not deeply appraised impacts at the community or individual level. In particular, both the ***1994 DOT Strategic Plan*** and ***the*** May ***1994*** Draft ***National Program Plan for IVHS assert*** that DOT projects will ensure access to basic needs and opportunities, choice, neighborhood cohesion, and travel convenience.

There is no resolution on whether ITS will have positive, neutral, or negative social impacts. The literature acknowledges the potential for positive impacts if ITS user services are designed and administered as needs-oriented solutions rather than technology-driven showcases. However, several papers express concerns that there will be inevitable unintended, potentially negative, consequences. For the most part, these concerns stem from perceptions that the ITS program is automobile focused and neglects the needs of particular groups, specifically low income, elderly, disabled, and non-motorized travelers.

There is little research identifying alternative futures of ITS deployment. Alternative futures describe how current actions or programs, buffeted by changing social and technological forces, could lead to different future states of social development. Although the DOT and others have projected time horizons for market penetration of individual user services (shown in Appendix B), they have yet to generate most likely and preferred scenarios of integrated ITS user service bundles as they could be deployed in the nation's metropolitan and rural areas. As a first step, in March 1995, FHWA and ITS America held the Alternative Futures Symposium on Transportation, Technology and Society, which brought together participants from community, government, and private sector organizations to develop alternative futures for a ten to fifteen year time horizon. The results from this symposium were not available at the time of writing.

The literature does not offer a framework to assess ITS social impacts. Most of the current papers are exploratory "think pieces," which identify issues, but do not attempt to qualitatively or quantitatively measure impacts. Most significantly, few offer a structured and direct examination of how integrated ITS user services could affect societal welfare. In addition, with three exceptions, the literature does not offer criteria for comparing ITS deployment alternatives and for resolving trade-offs between potentially conflicting impacts (e.g. improved mobility for drivers vis-a-vis reduced safety for pedestrians).

The macro-scale societal implications of most individual ITS user services can be inferredfrom studies of analogous conventional transportation services. Although ITS user services will likely create new markets for specialized information and products, most share similar functions and goals with conventional transportation services. Appendix A compares individual ITS user services with conventional services. We found numerous studies assessing how individuals respond to and are affected by changes in the transportation system. These changes include: 1) efficiency improvements to traffic and public transit operations; 2) implementation of travel demand management programs, such as carpooling, congestion pricing, and parking restrictions; 3) introduction of information services at public transit stations; 4) augmented public transit security; 5) introduction of demand responsive transit; 6) emissions detection to support vehicle inspection and maintenance programs; and 7) introduction of passive and active safety devices on vehicles.

ITS' capacity to provide societal benefits will improve if constituent groups participate in planning and decision-making. The literature emphasizes that the DOT, ITS America, and suppliers of ITS user services must involve constituents in design and implementation activities. In June 1994, the National Policy Conference on ITS and the Environment brought together constituents from environmental, local government, and community organizations to discuss program priorities. This was also the objective of the March 1995 Alternative Futures Symposium.

RESEARCH NEEDS

Given the current limited state of the knowledge of ITS social impacts, we identified the following research actions:

ITS Societal Research Needs
1. Identify societal goals and evaluation criteria
2. Identify relevant impacts and constituent groups
3. Develop alternative futures of ITS' potential role in supporting transportation and social needs.
4. Identify or develop methods to assess how ITS user services will impact societal welfare.
5. Identify how the DOT can design or administer ITS user services to increase benefits and eliminate or ameliorate disbenefits.

We discuss each of these research actions below:

1. Identify Societal Goals and Evaluation Criteria

The DOT must clearly identify its societal goals. Which constituents are important? How does the department value transportation alternatives?

Identify criteria that can resolve value conflicts created by ITS deployment In particular, criteria should be developed to value trade-offs between potentially conflicting impacts as well as help determine whether an alternative is beneficial or detrimental.

2. Identify Relevant Impacts and Constituents

ITS deployments and their potential societal consequences cover a vast terrain of concepts and constituents. ITS user services could potentially impact, positively or negatively, the economic, political, physical, psychological, environmental, and social circumstances of multitudinous constituents. These constituents include various demographic groups, private sector enterprises, and government agencies. As a first step, therefore, researchers must identify and prioritize impacts and constituents for assessment.

For our study, we began by identifying impacts and constituents by reviewing the priorities affirmed ***in the DOT's 1994 Strategic Plan and the May 1994 Draft National Program Plan*** *for* ***IVHS.*** Ideally, prioritization should reflect input from potentially impacted parties. For the most part, the Department's priorities, which are discussed below, reflects the interests and concerns voiced in the ITS societal issues literature.

Societal research must address the distribution of ITS social impacts among community groups. Effective and equitable service delivery is at the heart of the DOT's mission. As a result, ITS societal research must consider impacts on community constituents. In particular, social assessments should consider the distribution of potential economic, physical, psychological, environmental, and social benefits, disbenefits, and costs among users and non-users of ITS user services. Exhibit ES-1 shows the societal impacts and community demographic groups identified ***in the 1994 Strategic Plan and the May 1994 Draft National Program Plan for IVHS.***

Societal research should address ITS' potential impacts on economic development and US. industry. Based on the two DOT documents, Exhibit ES-2 illustrates ITS societal impacts potentially affecting the public and private sectors. The DOT has addressed most of these impacts through its institutional issues research and activities. To date, the primary goals of these efforts have been to identify and remove non-technical barriers to ITS deployment. However, the research has not looked beyond start-up activities to consider potential impacts of ITS user services on economic development, productivity, and global competitiveness. Although we recognize this research need, we also caution that the results would be highly speculative given the large number of powerful external forces influencing the economy, industrial viability, and global comparative advantage. ITS America's Benefits, Evaluation, and Costs (BEC) Committee is currently soliciting papers to investigate potential ITS impacts on U.S. industry

Exhibit ES-1

Community Constituents and Potential ITS Societal Impacts

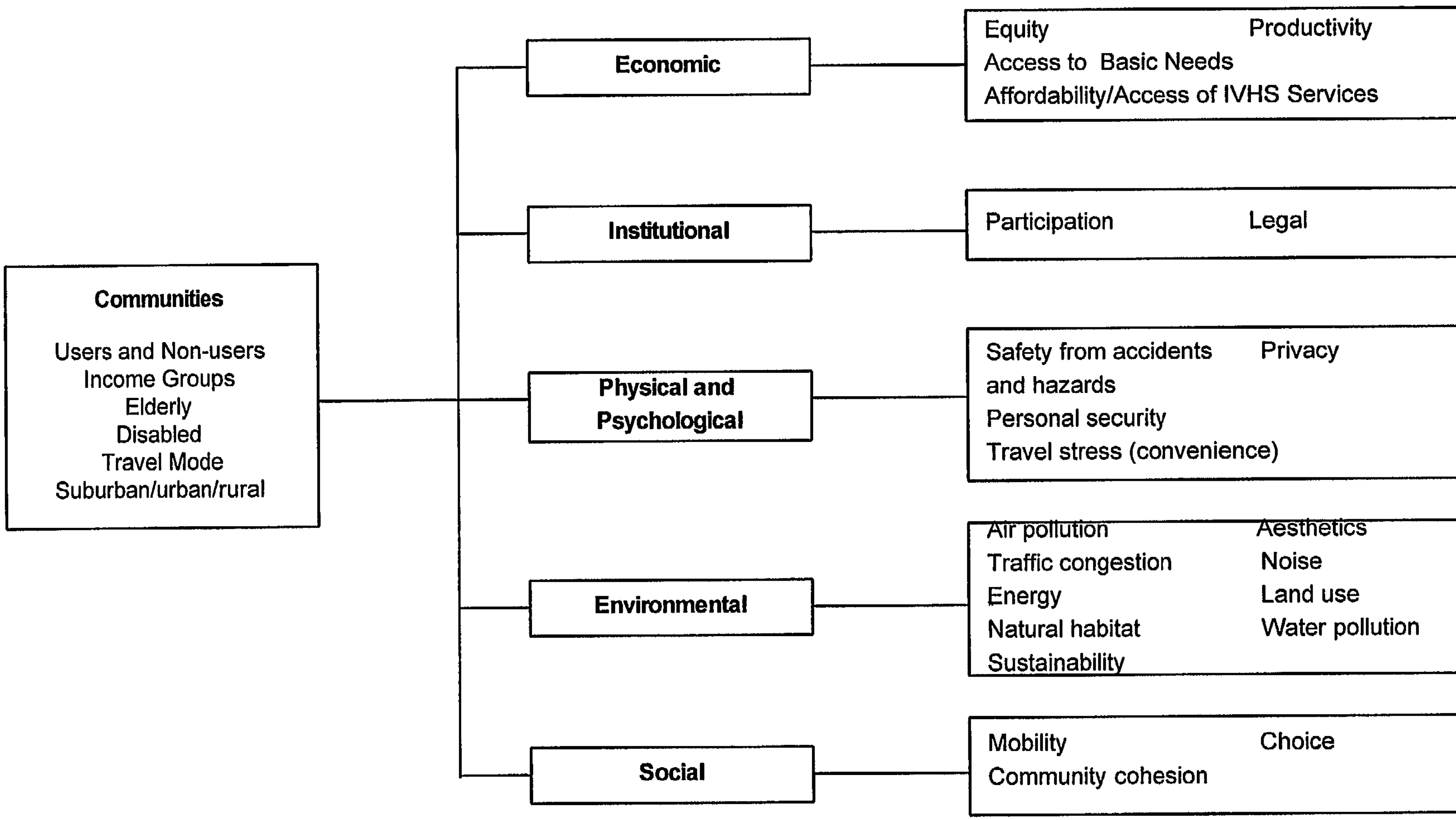
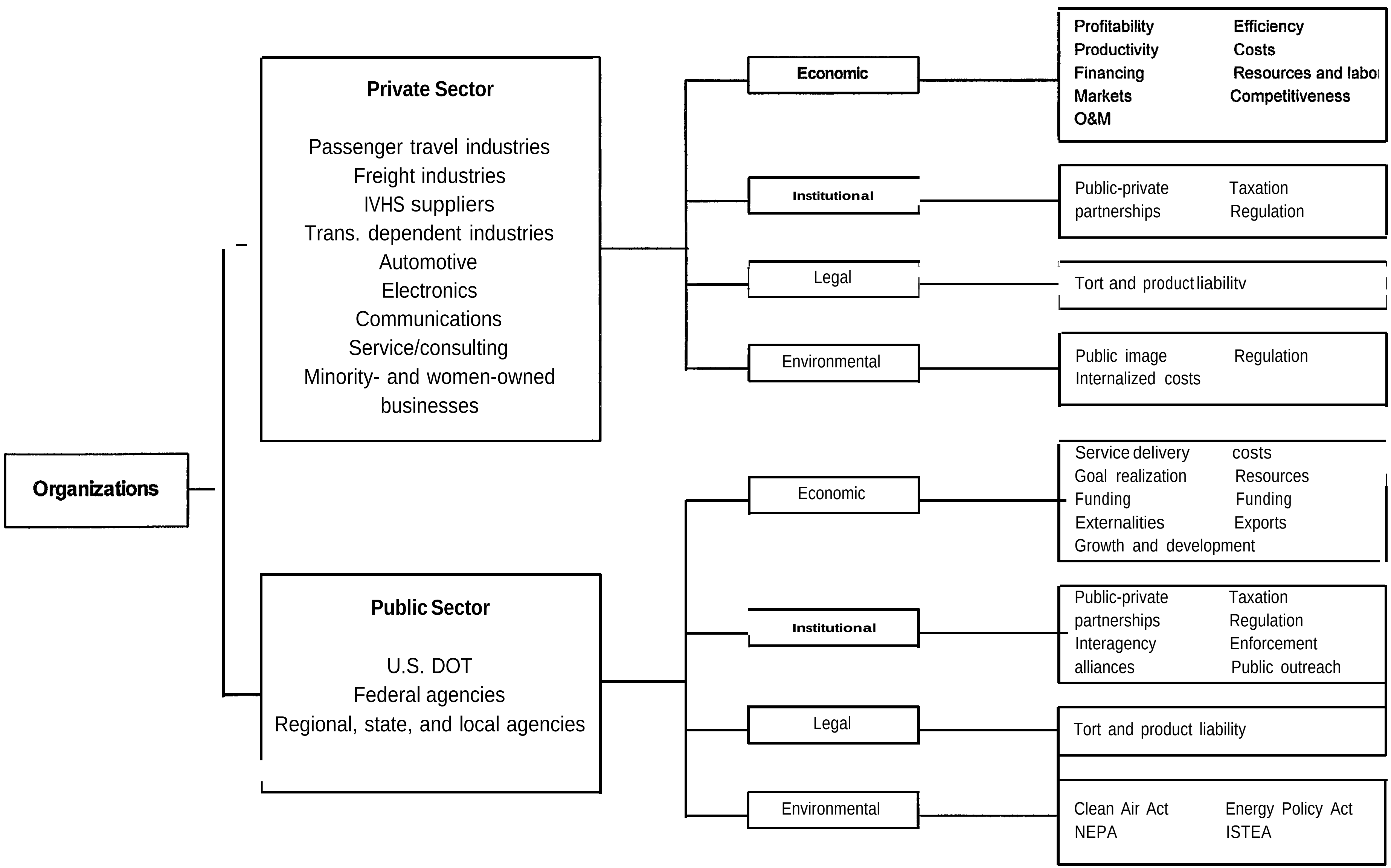


Exhibit ES-2

Organizations and Potential ITS Societal Impacts



and global competitiveness. In addition, the Volpe Center is preparing a report for the ITS Joint Program Office, documenting the potential impact of ITS markets on U.S. industry.

Evaluators should collect and review the most recent results of ITS cost-benefit analyses in order to strengthen the foundation of societal research. It is difficult to investigate ITS' distributive potential without first understanding aggregate impacts. In 1990, the U.S. General Accounting Office reviewed ITS cost-benefit studies ***in its Smart Highways*** report. In 1992, at OST's request, the Volpe Center inventoried ITS cost-benefit studies and critiqued their estimates of congestion, air quality, energy use, safety, user satisfaction, and economic impacts. Most of these earlier studies lacked empirical data to validate results and employed tentative methodologies. We also found very little information on expected costs and financing mechanisms for ITS implementation, operations, and maintenance. During the past two years, however, the quantity and quality of cost-benefit research has increased notably, some of it based on operational tests and other field trials. As a result, the DOT should review this most recent cost-benefit research in order to improve confidence in the potential magnitude of ITS aggregate impacts and costs. ITS America's BEC Committee is presently soliciting a paper to address ITS benefits, disbenefits, and costs. In addition, the Volpe Center is preparing a fact book for the ITS Joint Program Office, documenting studies of potential ITS impacts and costs.

3. Generate Alternative Futures

The DOT's Intelligent Transportation Systems Joint Program Office predicted that many ITS user services will be widely available in ten to fifteen years.6 Since ITS user services have not been widely deployed in the U.S., social impact assessment cannot move forward until future states of ITS deployment are defined. As a result, the following research activities are required:

The DOT should identify most likely deployment scenarios for diverse metropolitan areas. An essential question of social impact assessment is if, how, and when ITS user services will be adopted by local areas. The DOT has projected expected time frames for the availability of individual ITS user services (shown in Appendix B), but has yet to forecast future ITS deployment scenarios expected in metropolitan areas. The Department's ITS Early Deployment Program could provide useful insights into how these areas may apply ITS user services to meet local needs. By 1998, this program will have funded the short- and long-term strategic plans of 75 metropolitan areas and 30 major intercity corridors. Additional information will be forthcoming from the Alternative Futures Symposium.

4. Identify Assessment Methods

Our review of the theoretical literature and conventional transportation studies failed to disclose an "off-the-shelf' or agreed upon methodology, which could be adopted for ITS societal research. Instead, ITS social assessment methods will have to be tailored for particular investigations.

In addition, the impacts and constituents identified in the two exhibits can be evaluated at any scale: national, regional, city, neighborhood, or individual. The size of the unit selected for assessment distinguishes "macro" and "micro" analysis.7 Macro-scale analysis examines highly aggregated data and is perched sufficiently high to observe an action's general impacts. Micro-scale analysis is concerned with disaggregated data and operates at the ground level, scrutinizing smaller-scale phenomena and interactions. With respect to ITS social impact assessment, both macro-scale and micro-scale approaches have particular implications for an assessment's credibility.

As a result, we have identified the following research needs:

A framework is required to assess equity impacts among community constituents. Successful and useful assessments depend on a well-defined research design. A framework examines the processes by which impacts originate and are transmitted through society.* It also defines a logical taxonomy of variables, particularly measures of effectiveness (MOEs) for assessing tangible as well as intangible impacts.

A framework may help identify how ITS could impact economic development and industrial competitiveness. As noted earlier, many external forces will overshadow ITS' impact on economic development and industrial competitiveness. It will also be difficult to predict future economic, political, and global trends for the time horizons of interest (ten to fifteen years).

Methods need to be identified or developed to measure ITS'social impacts. Social impact assessments should employ effective, yet economical, data collection and analysis methods. Our review of the theoretical literature and conventional transportation studies suggests that most social impact assessment methods are ambiguous and employed with varying degrees of confidence. In particular, there are uncertainties about how to consider intangible impacts, such as changes in community cohesion and travel stress. At the request of ITS America's Societal Implications Task Force, Walter Albers inventoried methods that could be employed to assess ITS' societal impacts, which are summarized in Appendix D. In May 1995, the University of Michigan will conduct a workshop entitled, "Methodologies for Analysis of Societal Issues in Transportation," in Michigan. The workshop, which is funded, in part, by FHWA and ITS America, will identify and describe tools and methods that can be used to analyze the social impacts of transportation projects.

Analysis at too high a level will return superficial results and mask real issues. Typically, if impacts are assessed too macroscopically, important local factors and impacts are missed. Our review of the theoretical literature and conventional transportation studies suggests that the same transportation project behaves differently in different environments.[9] For example, a study of Chicago urban freeways found that new freeways tended to spur growth in a developing area and accelerate decline in a declining area.”

ITS social impact assessment should acknowledge that deployment characteristics will vary from region to region. In his study of urban transportation programs, Alan Altshuler observed that the ability of transportation services to promote societal objectives depended on “service area boundaries, patterns of operation, eligibility and fare policies, system scale, and the predominant sources of financing.“” This will also be true of ITS deployment. As noted in the May *1994* Draft *National Program Plan for IVHS* ITS is a “family of enabling technologies, which can be selected and used by public and private deploying entities to satisfy locally defined needs."[12] Different types of regions will likely emphasize different ITS user services. Given the diversity of the economic, demographic, and transportation characteristics of the nation’s metropolitan areas, research at the metropolitan area level will likely provide more useful insights about ITS’ societal impacts than a broad national study.

Large community constituent groups should be stratified into relevant subgroups. It becomes easy to overlook detrimental impacts on individuals or small groups if their large disbenefits and costs are averaged with the small gains of the majority, particularly if the overall net benefit is positive.[13] In addition, large demographic groups are rarely homogeneous. Our review of the demographic data shows variations within elderly, disabled, and income groups that will affect how individuals respond to changes in the transportation system. For example, several studies showed that higher income elderly were more mobile and possessed more driver’s licenses than their low-income counterparts. Another study concluded that “the same person may be elderly, poor, disabled, and a member of a minority group. However, to the extent that an individual shares more than one of these characteristics, the mobility problems he or she faces may also be magnified--probably by a factor that is larger than the sum of its parts."[14] ITS social impact assessments, therefore, should resist the temptation to create homogeneous demographic groups when reality reflects a more complex heterogeneity.

The DOT and ITS America has commissioned white papers for the Alternative Futures Symposium to examine national (macro-scale) societal issues. The March 1995 symposium developed most likely and preferred futures based on issues provoked by white papers concerning: 1) demographic and economic trends; 2) special needs (education, gerontology, disability); 3) social and economic equity and access; 4) land use, environment, and sustainability; and 5) industry and employment. These papers were not available at the time of writing.

5. Identify Program Design and Administration Opportunities

ITS societal research should attempt to explicitly identify how the DOT could use the ITS program to achieve equity in the distribution of benefits and costs. In other words, assessments should not be exclusively preoccupied with impacts, but attempt to recommend specific Departmental actions. Given this, we identified the following research needs:

Societal research should identify opportunities and variables that can be controlled to achieve desired outcomes. Societal equity and other impacts are often outside the control of transportation planners. However, current DOT priorities and actions could affect the future social distribution of ITS impacts.

Find opportunities and forums for public participation and interaction. The DOT as well as ITS America have already begun outreach efforts to potentially impacted parties through national workshops and local informational briefings. However, the DOT should identify more opportunities to actively engage grassroots community organizations in design and planning activities.

OTHER ITS SOCIETAL RESEARCH ACTIVITIES

Currently, other organizations are researching ITS societal impacts. In 1993, ITS America formed a Societal Implications Task Force to explore societal issues. In addition, George Mason University may develop research needs to resolve ITS societal issues, although the scope and status of this work was unclear as of March 14, 1995.15 Also, in September 1994, the University of Leeds (Institute for Transport Studies) began evaluating how IVHS socioeconomic impact assessments could be integrated with conventional highway infrastucture evaluation.

Specifically, four major conferences will be held in 1995:

Conference	Date	Objective
Alternative Futures Symposium	March 13,1995 Washington, D.C.	Generate most likely and preferred futures for ITS deployment (10 to 15 year time frame)
ITS America Annual Meeting	March 15-16, 1995 Washington, D.C.	General presentations of potential ITS social impacts and issues
Methodologies for Analysis of Societal Issues in Transportation	May 8-9, 1995 Ypsilanti, Michigan	Identify and apply methods to assess societal impacts of transportation projects
Unnamed (GMU?)	Fall 1995?	Scope undefined

In addition, the Federal Transit Administration (FTA) and the Surface Transportation Policy Project (STPP) sponsored a conference, entitled "Transportation, Environmental Justice and Social Equity," from November l6-18, 1994, in Chicago. The conference addressed the impacts of transportation facilities and services in low-income and minority neighborhoods as well as social equity in transportation investments. The conference served as a focus for providing input for the DOT's response to the 1994 Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." A follow-up conference entitled, "Environmental Justice and Transportation: Building Model Partnerships," will be held in Atlanta from May 1 l-13,1995. The purpose of this workshop is to identify, promote and strengthen plans to include community stakeholders in transportation decision-making.

ENDNOTES

1. U.S. Department of Transportation, *Strategic Plan* January 1994, unnumbered.

2. U.S. Department of Transportation, *National ITS Program Plan* Synopsis, March 1995, p. 1.

3. U.S. Department of Transportation, *Strategic Plan,* January 1994, unnumbered.

4. Peter G. Sassone, "Social Impact Assessment and Cost-Benefit Analysis," in *Methodology of Social Impact Assessment,* eds. Kurt Finsterbusch and C. P. Wolf, Stroudsburg, PA: Dowden, Hutchinson & Ross, Inc., 1977, p. 74-82.

5. *The* analysis performed for most of this report, *ITS Societal Impacts: Current Knowledge and Research Needs,* was completed in October 1994, and, therefore, frequently references the May *1994* Draft *National Program Plan for IVHS.* This report has not been updated to address the content of *the* March *1995 National ITS Program Plan.*

6. Handout of the DOT's ITS Joint Program Office, undated.

7. Raghu Singh, "Macro and Micro Levels of Analysis in the Social Impact Assessment of a Reservoir Development, *in Methodology of Social Impact Assessment,* eds. Kurt Finsterbusch and C. P. Wolf, Stroudsburg, PA: Dowden, Hutchinson & Ross, Inc., 1977, p. 91-101.

8. Kurt Finsterbusch, *Understanding Social Impacts: Assessing the Effects of Public Projects,* Beverly Hills, California: Sage Publications, 1980.

9. George L. Peterson and Robert S. Gemmell, "Social Impact Assessment: Comments on the State of the Art," Finsterbusch, *in Methodology of Social Impact Assessment,* eds. Kurt Finsterbusch and C. P. Wolf, Stroudsburg, PA: Dowden, Hutchinson & Ross, Inc., 1977, p. 374-387.

10. Peterson and Gemmell, *op. cit.,* p. 380.

11. Alan Altshuler, The *Urban Transportation System: Politics and Policy Innovation,* Cambridge, MA: MIT Press, 1979.

12. U.S. DOT, *op. cit.,* May 1994 Draft *National Program Plan for IVHS.*

13. John H. McKoy et *al, Transportation and Equity: Towards a Frameworkfor Distributive* Analysis, prepared for the Association of Bay Area Governments, Berkeley, California, September 1973.

14. *Ibid.,* p. 7.

15. Draft Minutes, ITS America Societal Implications Task Force Meeting, Sharaton Washington Hotel, March 14, 1995.

TABLE OF CONTENTS

1. INTRODUCTION

PURPOSE

At the request of the Office of the Secretary of Transportation (OST), the Volpe Center reviewed and critiqued the state-of-the-knowledge concerning the potential societal impacts of Intelligent Transportation Systems (ITS) user services. As a result of this assessment, the Volpe Center identified DOT research actions to fill in gaps in crucial knowledge. It is hoped that the contents of this report will ultimately provide a foundation and structure for achieving three primary goals:

- Affirm that the priorities of the federal ITS program support and advance the goals of the DOT's overall mission and goals. In particular, the Department's 1994 *Strategic Plan* emphasizes societal objectives as well as delivery of services to a broad spectrum of diverse constituents.
- Clarify the full extent of societal benefits, disbenefits, and costs of ITS user services as well as their social distribution.
- Identify ways in which deployers and supporters of ITS user services, especially within the public sector (and the federal DOT, in particular), could increase societal benefits and avoid or reduce disbenefits for particular constituents.

OBJECTIVES

This report investigates ITS social impact considerations by asking the following questions:

- What do we mean by ITS societal impacts?
- Why is it important to estimate ITS societal impacts?
- How should the term "societal" be defined in the context of ITS? Which types of societal impacts and constituent groups are most relevant to assess, given the characteristics and functions of ITS user services as well as the DOT's mission and goals?
- How could deployment characteristics affect the ability of broad, diverse constituents to access and use ITS services?
- When are ITS impacts beneficial or detrimental for society and particular groups? How can the DOT and local planners choose the "best" option among transportation alternatives? How can ITS societal impacts be measured?

- What is known about ITS societal impacts? Can evaluators infer knowledge of potential ITS societal impacts from social impact assessments of analogous conventional transportation systems and services?

- What information is needed to enable the DOT and ITS deployers to design, fund, and administer socially beneficial ITS programs and projects?

RESEARCH APPROACH

Research Areas

In order to answer the above questions, we investigated four broad research areas:

1. ***Social Impact Assessment Theoretical Literature:*** We researched the theoretical literature concerning the role of social impact assessment in public policy decision-making. In particular, this literature addressed five specific activities: 1) employing criteria to evaluate alternative policy actions; 2) identifying relevant impacts and constituent groups; 3) developing alternative futures; 4) measuring societal impacts; and 5) developing strategies to increase benefits or mitigate disbenefits.

2. ***ITS Societal Issues Literature:*** We summarized and critiqued published papers addressing the societal implications of ITS user services in order to gauge the current state of knowledge.

3. ***Societal Impact Studies of Analogous Conventional Transportation Services:*** Because the ITS-specific literature was limited, we reviewed social impact studies of closely related conventional transportation services. Examples of these services include traffic management systems, traffic information, on-board vehicle systems, travel demand management strategies, emissions mitigation and detection systems, and public transportation systems.

4. ***Demographic and Transportation Trends:*** We reviewed literature, which summarizes and/or analyzes demographic and transportation trends.

Most of information was acquired from the following sources:

- Volpe Center Technical Reference Center library
- Transportation Research Information System (TRIS)
- Select university transportation libraries
- FHWA, FTA, and Army Corp of Engineers libraries
- National Technical Information Service (NTIS)
- Society of Automotive Engineers (SAE)
- Oak Ridge National Laboratory’s ITS database

- Proceedings of ITS America annual meetings
- Proceedings for the June 1994 National Policy Workshop on Intelligent
- Transportation System and the Environment
- Discussions with experts

The bibliography, found at the end of this report, organizes selected literature by the four research areas discussed above.

WHAT DO WE MEAN BY "SOCIETAL IMPLICATIONS"?

Throughout this report, we use the terms "societal impact" and "societal implications," although the latter term is somewhat softer and more ambiguous. Because the terrain of "societal implications" is expansive, we felt it was necessary to launch our investigation from some reasonable point of departure. Where to begin? Since OST wishes to ensure that the ITS program fulfills the Department's overall mission and goals (as well as time and resource constraints), we began by "mapping" the constituents and impacts identified in the DOT's 1994 *Strategic Plan* and *the* May *1994* Draft *National Program Plan for IVHS*.[1]

The results are shown in Exhibits 1 and 2, respectively. For the *DOT Strategic Plan* Exhibit 1 notes only those constituents and impacts directly related to surface transportation (e.g., we excluded air, marine, and other unrelated issues). Constituents are defined as those organizations or groups of individuals to whom the DOT intends to deliver services, as well as those groups potentially impacted by DOT policies. In addition, impacts are categorized into five areas: economic, institutional, physical and psychological well-being, environmental, and social.

The two societal impact maps identify two broad categories of constituents: communities and organizations. First, the DOT's 1994 *Strategic Plan* and the May 1994 Draft *National Program Plan for IVHS* identify six community groups: 1) users and non-users of transportation services; 2) income groups; 3) elderly; 4) disabled; 5) users of different transportation modes (motorized and non-motorized); and 6) geographic areas (e.g., urban, suburban, and rural). Secondly, the documents address two categories of organizations: 1) private sector enterprises and quasi-public organizations (such as national laboratories) involved in or affected by transportation services; and 2) the public sector, including Federal, state, and local agencies.

Exhibits 1 and 2 identify societal issues in the context of stated DOT goals; they do not relate potential impacts to affected constituents. The "impact relevance trees," displayed in Exhibits 3 and 4, respectively, relate specific impacts to community groups and organizations.[2] These diagrams consolidate the impacts and constituents identified by both *the 1994 Strategic Plan* and *the* May 1994 Draft *National Program Plan for IVHS.* For example, although "equity" is not explicitly mentioned *in the* DOT's *Strategic Plan* we include it since it is cited in the May 1994 Draft *National Program Plan for IVHS.* In a few instances, we added issues (such as aesthetics and natural habitat) that are inherent to an explicitly identified category (such as environment).

Exhibit 1

Societal Impact Mapping: DOT 1994 Strategic Plan

GOAL	CONSTITUENTS	IMPACT CATEGORY				
		Economic	**Institutional**	**Physical and Psychological**	**Environment**	**Social**
Tie America Together	• Passenger industries: rail, Amtrak • Freight industries: trucking, aviation, maritime, rail • State and regional agencies	• Productivity • Efficiency • Global competitiveness • Growth • Stability	• Regulation • Taxes and revenue • Institutional alliances			• Choice
Invest Strategically in Transportation Infrastructure	• Nation and regions • U.S. companies • Minority- and women-owned businesses • New transportation industries	• Efficiency • Economic growth • Financing and investment • Market opportunities • O&M	• Public-private • partnerships • Interagency alliances	• Public safety	• Traffic congestion	
Create a New Alliance	• IVHS program • GPS companies • High-speed rail • Automotive • Space technology	• Efficiency • Global competitiveness • Exports • Defense conversion	• Public-private partnerships • Interagency alliances	• Public safety	• Environmental integrity	
Promote Safe and Secure Transportation	• Communities • Industries	• Health care costs	• Public outreach and education • Enforcement • Collaboration with States and locals	• Prevent deaths and injuries • Safety from HAZMAT • Personal security • National security	• Keep air, water, and soil safe from hazardous materials	
Actively Enhance Our Environment	• General public • National interests • Global interests • Intermodal transport • MPOs • Transit/rail	• Environmental externalities	• Regulation • Public participation and outreach • Enforcement • Interagency alliances	• Public health	• Air pollution • Marine pollution • Greenhouse gases • Traffic congestion • Land use • Energy use	
Put People First	• Consumers • Traveling public • Neighborhoods • Economic development interests • Americans with disabilities	• Economic development • Investments (costs) • Viability	• Public participation and involvement			• Mobility • Choice • Neighborhood cohesion
Transform DOT	• Internal and external customers	• Service delivery • Resources • Goal realization	• Effective and productive internal organization			

Exhibit 2

Societal Impact Mapping: May 1994 Draft National Program Plan for IVHS

ITS GOALS AND OBJECTIVES	CONSTITUENTS	IMPACT CATEGOR!				
		Economic	**Institutional**	**Physical and Psychological**	**Environment**	**Social**
1. Improve Safety • Reduce the number of motor vehicle collisions, and associated injuries and fatalities • Improve the ability to handle HAZMAT incidents • Enhance traveler security and roadway service responsiveness **2. Increase Efficiency** • Increase efficiency by smoothing flows • Increase average vehicle occupancy • Increase capacity of existing facilities • Reduce vehicle miles traveled • Reduce time lost in intermodal interchange • Reduce time delay associated with congestion **3. Reduce Energy & Environmental Impact** • Reduce harmful emissions per unit of travel • Reduce energy consumption per unit of travel • Reduce new right-of-way requirements and community disruption • Reduce fuel wasted • Enhance efforts to attain air quality goals **4. Enhance Productivity** • Reduce costs incurred by fleet operators • Reduce cost and improve equity of fee collection • Reduce delays and costs of regulating vehicles • Reduce cost and improve quality of data collection • Reduce travel time • Reduce cost to transportation-dependent industries **5. Enhance Mobility** • Improve accessibility to intermodal transportation • Improve quality of travel options information • Improve mode choice options • Improve travel time predictability • Improve transportation affordability • Reduce travel stress	• Users and non-users • Freight industries: trucking, aviation, maritime, rail • State and regional agencies • Nation and regions • Companies • Transportation dependent industries • IVHS industries • Automotive • Communications companies • Communities • Neighborhoods • Americans with disabilities • Elderly • Income groups • Cyclists and pedestrians • Geographic areas (urban/rural)	• Productivity • Efficiency • Global competitiveness • Equity • Financing and investment • Market opportunities • Externalities • costs • Human resources • Profitability	• Institutional alliances • Public-private partnerships • Interagency alliances • Regulation • Enforcement • Public outreach and education • Collaboration with States and locals • Public participation and outreach • Tort and product liability	• Public safety • Deaths and injuries • Safety from HAZMAT • Personal security • Travel stress • Privacy	• Air pollution • Marine pollution • Greenhouse gases • Traffic congestion • Land use • Energy use • Sustainability	• Mobility . Choice • Access • Neighborhood cohesion • Community preservation

Exhibit 3

Community Constituents and Potential ITS Societal Impacts

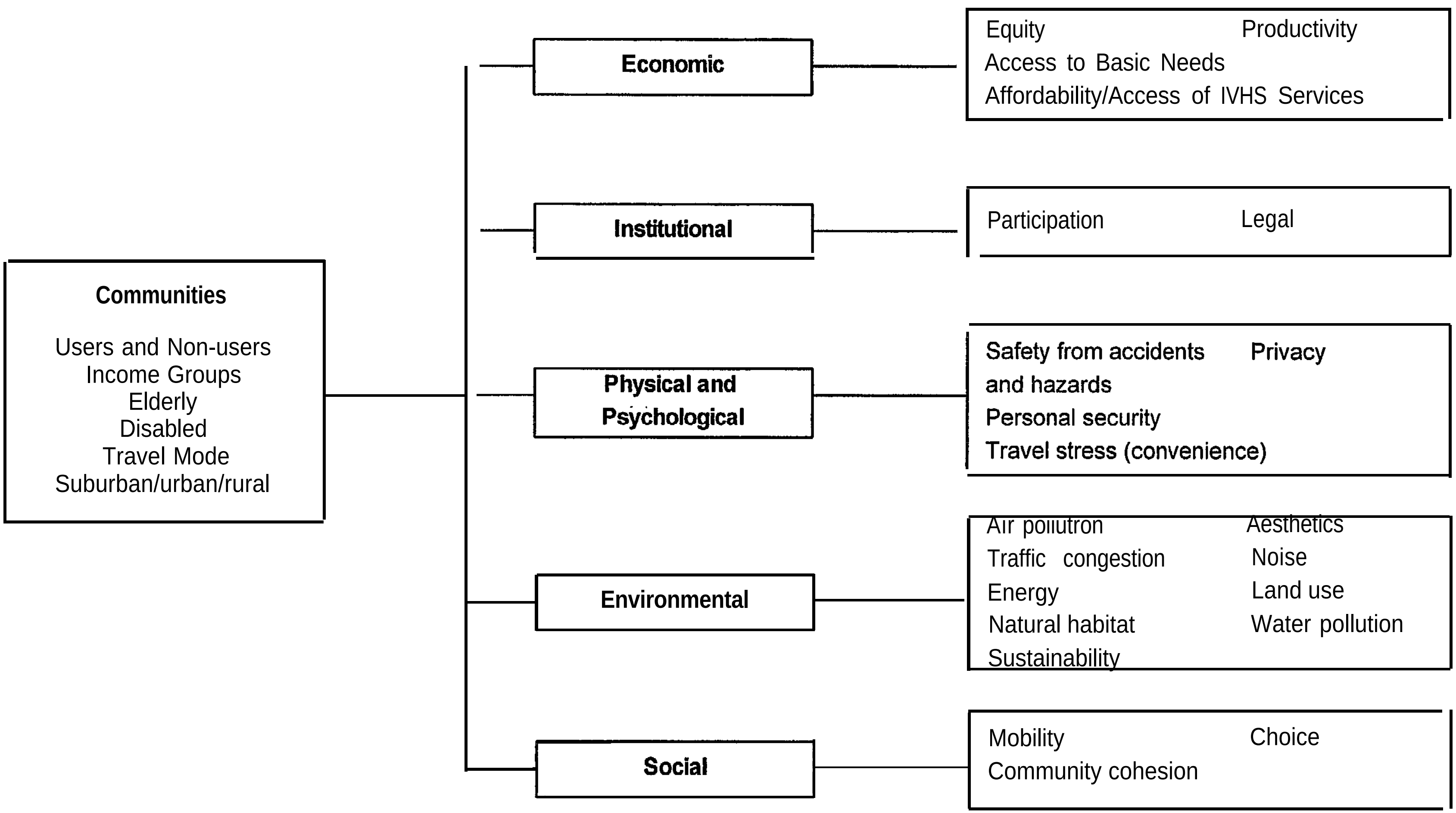
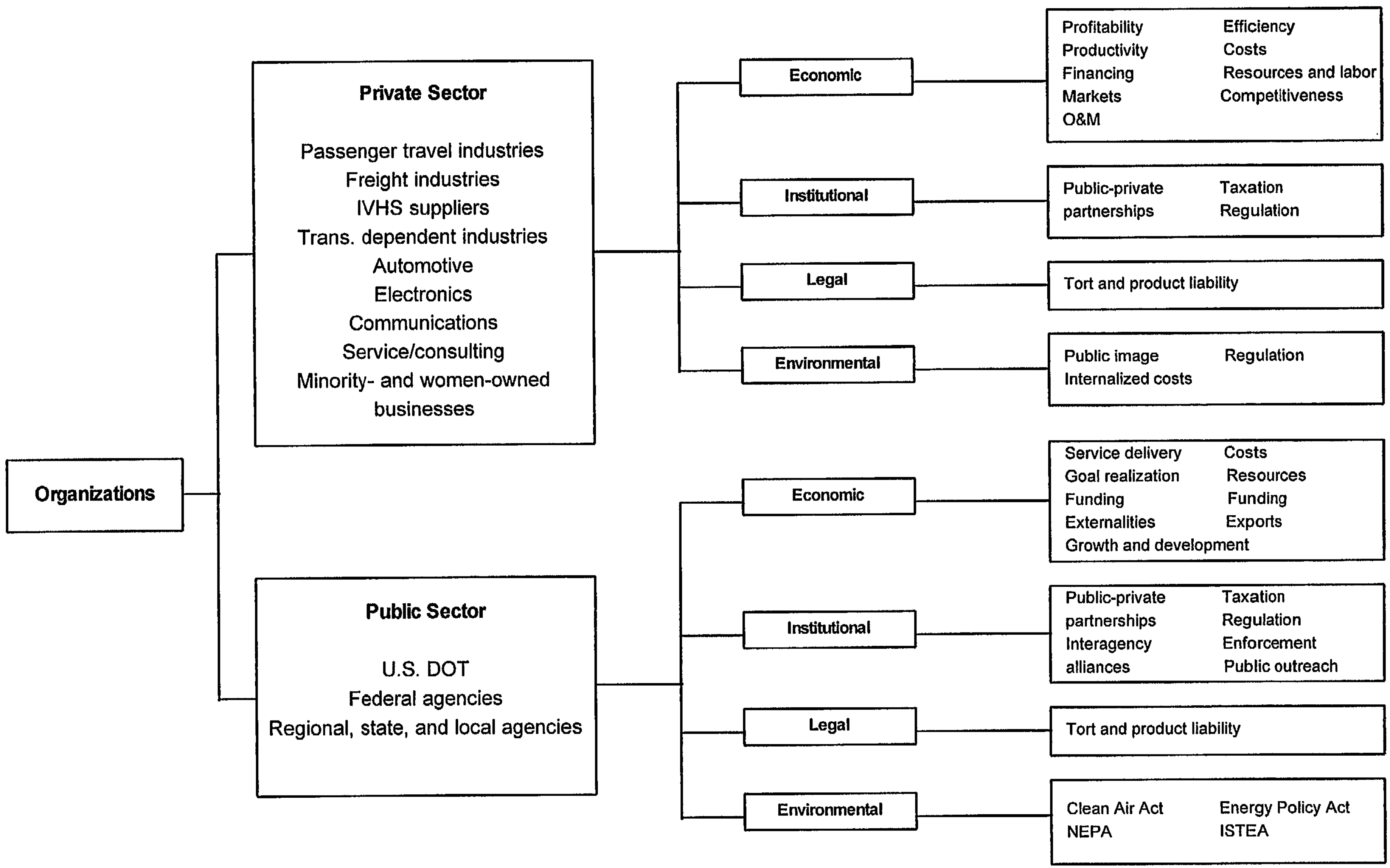


Exhibit 4

Organizations and Potential ITS Societal Impacts



Again, the exhibits are meant to orient the investigation of ITS societal impacts. They represent a point of departure, but not the final destination. Instead, it is hoped that this report can provide a map by which ITS evaluators can navigate and comprehend the ample topography of potential ITS "societal" impacts.

REPORT CONTENTS

Given the purpose and objectives, this report is organized by the following chapters:

- ***Introduction*** provides the report objectives and research approach.
- ***why Evaluate ITS Societal Implications?*** provides the imperatives for clarifying the societal implications of ITS deployments.
- ***Background*** describes the objectives of ITS user services and the federal ITS program.
- ***ITS Deployment Traits: Potential Impacts on Access and*** Use describes the potential attributes of ITS deployment in the U.S. that could impact access and use by the public.
- ***What is a "Societal" Evaluation?*** outlines the social impact assessment process and describes five key evaluation objectives.
- ***State of the Knowledge: ITS Literature Review*** summarizes and critiques the current knowledge of ITS' potential social impacts based on a review of ITS-specific literature.
- ***A Comparative Analysis of ITS and Conventional Transportation*** infers knowledge of potential impacts of ITS deployments based on a review of social impact assessments of analogous conventional transportation studies.
- ***Conclusion and Recommendations*** critiques the current state-of-the-knowledge of ITS societal implications, identifies unresolved issues, and recommends essential research activities.

WHY EVALUATE ITS SOCIETAL IMPLICATIONS?

In recent years, public and private sponsors of Intelligent Transportation Systems (ITS) have recognized the need to assess the private and societal impacts of ITS user services. To date, ITS planning has focused on important concerns of technical feasibility and deployment. However, there are compelling reasons to better appraise the societal implications of deploying these new transportation technologies and services.

This section identifies and discusses three fundamental imperatives for evaluating ITS' broader impacts on communities and organizations:

Imperatives for Evaluating ITS Societal Impacts
• DOT mission and goals • Federal legislation and executive orders • Potential community opposition and litigation

THE DOT MISSION AND GOALS

Although ITS user services will not likely benefit everyone or everywhere, the DOT aims to design and administer an inclusive ITS program that addresses a wide range of societal needs. This ambition is underscored in its published documents and mission statements.

The 1994 DOT Strategic Plan

The Department's 1994 Strategic *Plan*, which defines its fundamental mission, goals, and objectives, asserts a fundamental goal to "put people first" by:

> "Ensur[ing] that transportation policies and investments embrace the concerns of the traveling public and neighborhoods, economic development interests, and other societal concerns."[3]

The National ITS Program Plan

The March *1995 National* ITS *Program Plan,* which provides a "planning reference" for the deployment of ITS user services, identifies the following ITS opportunities and societal goals:

- "Improving travel without harming the environment"
- "Providing convenient travel for all Americans"
- "Increasing transportation system efficiency"

- "Boosting productivity"
- "Improving safety on the Nation's surface transportation system"

IWIS Strategic Plan: Report to Congress

In December 1992, the DOT presented a strategic plan to Congress, describing the Departmental mission and goals for its ITS program. The document states that:

> "The [IVHS] technologies and systems deployed must support the attainment of a wide range of societal goals pertaining to congestion, safety, air quality, and energy. In developing transportation solutions, we must also be aware of privacy and other sensitive social concerns. These systems should be developed, deployed, and used in a way that enhances access to the transportation system by all segments of the population and by all communities wishing to participate. These technologies may have different impacts on different economic, demographic, and social groups; these impacts will be evaluated and actions will be taken to promote equity in the distribution of benefits versus the sharing of costs. IVHS must not impair anyone's safety or mobility."[4]

As evident from these statements, an essential objective of the Department of Transportation and its ITS Joint Program Office is to identify, evaluate, and measure the societal impacts of transportation alternatives.

FEDERAL LEGISLATION AND EXECUTIVE ORDERS

In the United States, a number of federal regulations and executive orders stress the transportation sector's obligations to support environmental and societal objectives. The goals and mandates of these mandates are summarized below:

The Intermodal Surface Transportation and Efficiency Act (ISTEA) of 1991

ISTEA contains several provisions designed to promote transportation efficiency and advance "national goals relating to mobility for elderly persons, persons with disabilities and economically disadvantaged persons." It also states that "social benefits must be considered with particular attention to the external benefits of reduced air pollution, reduced traffic congestion and other aspects of the quality of life of the United States."[5] In particular, ISTEA:

- Contains rules requiring proactive public participation in the transportation planning process.

- Offers a variety of flexible funding sources, including the Congestion Mitigation and Air Quality funds (CMAQ) and Enhancement funds, to promote community development, air quality, and alternative transportation modes (such as bicycling and walking.

- Requires that transportation plans comply with Title VI of the Civil Rights Act of 1964, which bans the use of federal funding to support discriminatory projects, programs, and policies.

- Necessitates the use of Major Investment Studies, which "evaluate the effectiveness and cost-effectiveness of alternative investments or strategies in attaining local, State and national goals and objectives." These studies "consider the direct and indirect costs of reasonable alternatives and such factors as mobility improvements, social, economic and environmental effects; safety; operating efficiencies; land use and economic development; financing; and energy consumption."

Clean Air Act Amendments (CAAA) of 1990

The CAAA established national ambient air quality standards for ozone, carbon monoxide, nitrogen dioxide, particulate matter, lead, and sulfur oxides to safeguard human health and welfare. The U.S. Environmental Protection Agency (EPA) classifies cities and regions as "nonattainment areas" when the measured concentrations of these pollutants exceed their designated standards. To ensure that air quality objectives are met, the CAAA requires nonattainment areas to develop State Implementation Plans (SIPs), which inventory emission sources and identify control measures to ensure progressive attainment of the air quality standards.

Many nonattaimnent areas may turn to transportation control services, including ITS user services, to meet air quality objectives. Although the CAAA emphasizes transportation control measures as proactive solutions, it also insists that transportation plans conform to the intent and objectives of the SIPS and not aggravate the frequency and severity of air quality violations. As a result, transportation planners must prove that their proposed projects, including ITS projects, will, at a minimum, "do no harm." For some environmental advocates, even the implementation of environmentally neutral projects may not be satisfactory.

National Environmental Protection Act (NEPA) of 1969

NEPA of 1969 requires "the use of a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and decisionmaking which may have an impact on man's environment."

As reviewed by one study, the Corp of Engineers estimated that as a result of NEPA, between 1970 and 1978, 41 projects and studies were stopped, dropped or abandoned, 347 were modified, and 102 were temporarily or indefinitely postponed.[6]

Civil Rights Act of 1964, Title VI

Title VI of the Civil Rights Act of 1964 prohibits the use of federal expenditures to support discriminatory programs. It also requires that federal programs show that their benefits or investments are shared equitably across the population. The Civil Rights Office within the U.S. Department of Transportation periodically investigates DOT programs to monitor compliance. Public complaints can also compel these investigations.

American Disabilities Act (ADA) of 1990

The Americans with Disabilities Act of 1990 prohibits discrimination on the basis of disability in private sector employment, services provided by state and local governments, private businesses open to the public, transportation, and telecommunications relay services. The ADA extends civil rights to people with disabilities concurrent with those mandated in the Civil Rights Act of 1964. As defined by the ADA, the term "disability" refers to "any physical or mental impairment that substantially limits one or more major life activities, a record of such an impairment, or being regarded as having such an impairment. Major life activities include caring of one's self, performing manual tasks, walking, seeing, hearing, speaking, breathing, learning and working."7

Older Americans Act of 1965

Title III of the Older Americans Act (OAA) supports the transportation needs of the elderly. As reported by *the Community Transportation Reporter,* in 1989, Title III funded 63 million one-way trips for seniors at a cost of $68 million.'

As a side note, the Urban Mass Transit Act of 1964 requires public transit services to provide reduced fares to the elderly.

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

The Executive Order on Environmental Justice, dated February 11, 1994, requires agencies "to the greatest extent practicable and permitted by law," incorporate environmental justice principles in their missions by "identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects on minority populations and low-income populations."8 The primary objectives of the executive order are to ensure stronger public participation in the design and implementation of federal projects and programs, promote fair enforcement of federal statutes, and improve research and analysis as it relates to minority and low-income concerns.

COMMUNITY OPPOSITION AND LITIGATION

In addition to the previously discussed imperatives, ITS deployment could be hindered by organized community groups opposed to perceived detrimental or inequitable impacts. As highlighted below, these organizations have been effective in halting or compelling public planners to address environmental or community concerns. A few of these examples are highlighted below:

Community Opposition

Citizens have developed grass-roots organizations and coalitions as well as citizen initiatives (proposals approved by popular vote) and referendums (submission to the electorate of an already approved government measure) to impact governmental decision-making and actions:

- In Southern Los Angeles, the Labor/Community Strategies Center, a social justice and community development grassroots organization, introduced and fought for the passage of the Social Equity Clause of Employee Trip Reduction legislation. The clause requires employers to offer transit riders, walkers, bikers, and carpoolers a cash benefit that is equivalent to the after-tax value of a parking space.“”

- As reported *in an American Planning Journal* article, “many freeway projects in cities around the country engendered “freeway revolts,” intense community opposition to specific freeways that resulted, ultimately, in the “opening up” of the transportation planning process.” As an example, the author notes that the cost for the Century Freeway in California increased by 131 percent in 1990 dollars as a result of increased scrutiny by environmental and community groups unhappy with its potential societal impacts.”

Litigation

Armed with federal legislation, environmental and community development groups have sued public agencies to ensure strict adherence to both letter and spirit. A few of these lawsuits are summarized below:

- The Citizens to Preserve the Ojai, Coalition for Clean Air, the Environmental Council of Sacramento, and the Sierra Club brought lawsuits against the U.S. EPA when state and local agencies in California did not develop adequate plans to meet the federal clean air standards by 1987 as required by the 1977 Clean Air Act.[12]

- In 1994, in Los Angeles, the Labor/Community Strategy Center, with the assistance of the NAACP Legal Defense and Education Fund, brought a lawsuit against the Metropolitan Transit Authority (MTA) when it decided to increase bus fares by 25 cents and eliminate the discounted $42 monthly pass. The lawsuit rests on Title VI of the 1964 Civil Rights Act, the first time this legislation has been applied to a transportation issue. The Labor/Community Strategy Center charges that the MTA is discriminating against low-income bus riders to support its light rail project, which primarily benefits affluent white commuters.

- In June 1989, the Sierra Club filed a lawsuit against the Metropolitan Transportation Commission (MTC) in the San Francisco Bay Area for failing to carry out its contingency plan when it failed to demonstrate reasonable further progress for meeting clean air goals in 1983 and subsequent years. In September 1989, the judge ruled that the "...MTC had failed to carry out specific transportation contingency measures in the 1982 Plan to reduce ozone and carbon monoxide pollution." In addition, in May 1990, the Court ruled that the MTC's conformity process was inadequate and were ordered to submit a new procedure. 13

SUMMARY

Given the Departmental and regulatory imperatives, it is important that the ITS Joint Program Office and other stakeholders in ITS deployment, identify and address potential societal impacts. In particular, the imperatives suggest that evaluators not only appraise impacts on community constituents, but also address how communities and individuals could access and use ITS user services.

ENDNOTES

1 This analysis was completed in October 1994. As a result, it makes use of the March 1994 Draft *National Program Plan for* IVHS and not the recently released version, the March 1995 *National ITS Program Plan.*

2 Kurt Finsterbusch, "The Potential Role of Social Impact Assessments in Instituting Public Policies," *in Methodology of Social Impact Assessment*, eds. Kurt Finsterbusch and C.P. Wolf, Stroudsburg, Pennsylvania: Dowden, Hutchinson & Ross, 1977, p. 5.

3. U.S. Department of Transportation, *Strategic Plan*, January 1994, unnumbered.

4. U. S. Department of Transportation, *IVHS Strategic Plan: Report* to Congress, Washington, D.C., December 1992, p. 39.

5 Congressional Record-House, November 26, 1991, H1 15 17.

6. Richard A. Liroff, "NEPA--Where Have We Been and Where *are* We Going?," *APA Journal*, April 1980, p. 154-161.

7 As reported by the *ADA Paratransit Handbook: Implementing the Complementary Paratransit Service Requiremnts of the Americans with Disabilities Act of* 1990, prepared for UMTA, September 1991, p. l-6 to l-7.

8 Richard Margolis and Barbara Rasin Price, "The Vital Link: Aging and Community Transportation," *Community Transportation Reporter*, February 199 1, p. 7

9 U.S. EPA, *Fact Sheet on Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" and Its Accompanying Presidential Memorandum*, undated, unnumbered.

10 As reported by Don Chen, *Social Equity, Transportation, Environment, Land Use, and Economic Development: The Livable Community,* Washington, D.C.: Surface Transportation Policy Project, undated.

11 Brian D. Taylor, "Public Perceptions, Fiscal Realities, and Freeway Planning: The California Case, *APA Journal*, Winter 1995, p. 43-56.

12 U.S. EPA, "U.S. EPA Complies with Court Orders to Propose Clean *Air* Plans," *EPA Environmental News*, February 14, 1994.

13. January 8, 1993 memorandum from the MTC to the Michael Jacobs, the Volpe Center, "Sierra Club vs. MTC Lawsuit," unnumbered.

BACKGROUND

WHAT IS ITS?

Intelligent Transportation Systems (ITS) employ electronics, communications, and/or information processing to improve the efficiency of surface transportation operations and provide real-time information about travel options. As shown in Exhibit 5, the DOT has identified 29 prospective ITS user services, categorized into seven "bundles." Appendix A summarizes the specific objectives of the 29 individual ITS user services and compares them with analogous conventional transportation services. The goals of each bundle are discussed below:

- ***Travel and Transportation Management*** collects and disseminates en-route information about modes, routes, incidents, and vehicular emissions to drivers. It also seeks to improve the efficiency of surface transportation through demand-responsive traffic control and incident response.

- ***Travel Demand Management*** collects and disseminates pre-trip information to travelers regarding best mode, departure times, and routes. It also seeks to facilitate demand management strategies (such as ridesharing) to reduce demand for single occupancy vehicle travel.

- ***Public Transportation Operations*** endeavor to make public transit more attractive by improving transit management and efficiency, and providing real-time en-route information to travelers about departure and arrival times, schedule, and connections. It also seeks to facilitate flexibly routed transit services based on real-time demand.

- ***Electronic Payment*** enables travelers to pay for transportation services electronically.

- ***Commercial Vehicle Operations*** aim to improve the safety and productivity of motor carriers.

- ***Emergency Management*** enables the police, fire, and rescue operations to better manage and respond to emergencies.

- ***Advanced Vehicle Control and Safety Systems*** seek to improve safety by employing passive safety equipment in vehicles to enhance vision, avoid collisions, and activate passenger restraints. In addition, automated highway systems aim to increase capacity and decrease accidents through automated steering of vehicles.

Exhibit 5[1]

Intelligent Transportation System User Services

Bundle	User Service
1. Travel and Traffic Management	1. En-Route Driver Information 2. Route Guidance 3. Traveler Services Information 4. Traffic Control 5. Incident Management 6. Emissions Testing and Mitigation
2. Travel Demand Management	1. Demand Management and Operations 2. Pre-Trip Travel Information 3. Ride Matching and Reservation
3. Public Transportation Operations	1. Public Transportation Management 2. En-Route Transit Information 3. Personalized Public Transit 4. Public Travel Security
4. Electronic Payment	1. Electronic Payment Services
5. Commercial Vehicle Operations	1. Commercial Vehicle Electronic Clearance 2. Automated Roadside Safety Inspection 3. On-Board Safety Monitoring 4. Commercial Vehicle Administrative Processes 5. Hazardous Materials Incident Response' 6. Freight Mobility
6. Emergency Management	1. Emergency Notification and Personal Security 2. Emergency Vehicle Management
7. Advanced Vehicle Control and Safety Systems	1. Longitudinal Collision Avoidance 2. Lateral Collision Avoidance 3. Intersection Collision Avoidance 4. Vision Enhancement for Crash Avoidance 5. Safety Readiness 6. Pre-Crash Restraint Deployment 7. Automated Highway Systems

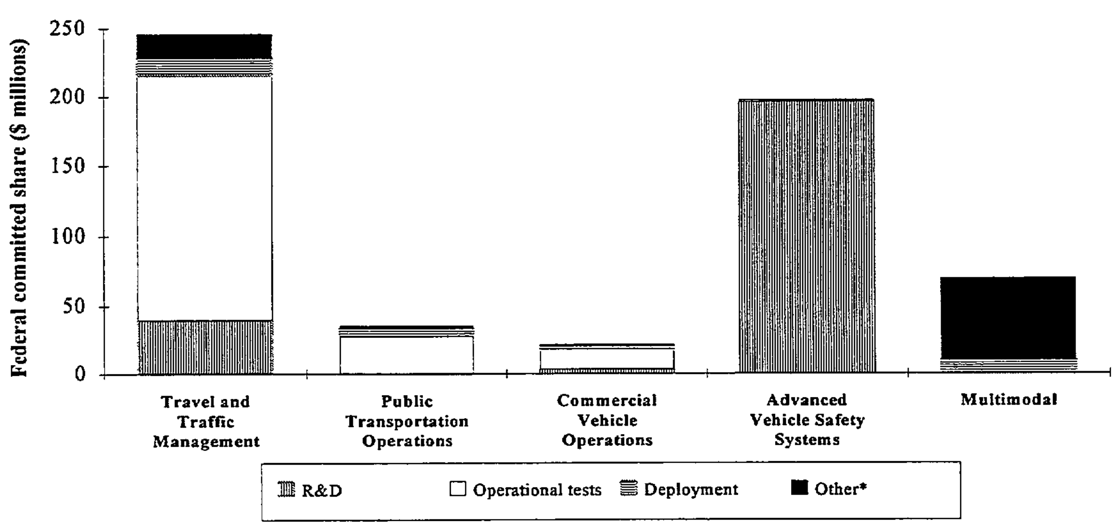
THE FEDERAL ITS PROGRAM

The U.S. DOT has committed significant resources for ITS development and deployment. Exhibit 6 shows the anticipated federal commitment to support IVHS programs and projects reported in the Department's March 1994 *Intelligent Vehicle Highway Systems Projects.*[2] The DOT has specifically invested in several activities: research and development, operational tests, deployment, architecture development, standards development, and planning.

Exhibit 6 is meant to be illustrative rather than to present an exact accounting of DOT's funding commitments for ITS, since we did not have budget information for newer projects. In addition, the Volpe Center used some subjective judgment to allocate funding into five ITS categories: Travel and Traffic Management, Public Transportation Operations, Commercial Vehicle Operations, Advanced Vehicle Control and Safety Systems (AVCS), and Multimodal. The multimodal category includes the travel demand management, electronic payment, and emergency management user service bundles, as well as projects that addressed more than one mode or general ITS applications. The AVCS bundle is particularly high since it includes research and development support for the automated highway system. In addition, we did not attempt to disaggregate the projects into precise modes and geographic areas, since many of the projects support general development (particularly the R&D and architecture investments) and because several projects have an intermodal focus.

Exhibit 6[3]

Total Federal Committed Funding for ITS Bundles as of March 1994



*Includes national compatibility planning, program assessment, and other related projects.

Despite Exhibit 6's imprecision, it qualitatively illustrates relative federal funding for broad categories of ITS user services. It shows that relatively more commitments have been made to support the travel and traffic management and advanced vehicle safety systems user service bundles, the primary beneficiaries of which are automobiles and road transportation. However, it is important to note that Exhibit 6 merely shows funding allocation; it does not indicate how much public funding each user service bundle requires to fully develop.

Although a far greater percentage of surface transportation needs are met by automobiles than by other modes, community and environmental advocates assert that this funding allocation reveals program bias toward automobile travel. For example, Mike Replogle of the Environmental Defense Fund, *in his* review of the 1994 Draft *National Program Plan for IVHS,* commented, "As it has been developed to date by US DOT, ITS emphasizes technologies which will increase effective highway capacity without concurrently managing growth of travel."[4]

Over the past few years, the ITS program has shifted its focus from research and development to testing and deployment. In Fall 1994, the DOT's ITS Joint Program Office (JPO) predicted that the public will adopt the majority of ITS user services within ten to fifteen years. In particular, the JPO believed that travel information (to facilitate mode choice and first level traffic/fleet management), electronic toll and traffic management, in-vehicle navigation, and intelligent cruise control are immediately deployable. The JPO also expected that, in the long-term, more sophisticated traffic management as well as on-board vehicle systems (lateral guidance, assisted braking, enhanced vision, and in-vehicle signing) would find markets. Automated highway systems would likely not be feasible until 2015 to 2020. Appendix I3 illustrates deployment time frames for several individual ITS user services, based on the JPO's expectations.

ENDNOTES

1 U.S. DOT, *National ITS National Program Plan* Synopsis, March 1995, Washington, D.C., p. 11.

2 The figures only reflect known estimates reported in the U.S. Department of Transportation, *Intelligent Vehicle Highway Systems Projects,* Washington D.C., March 1994.

3. *Ibid.*

4. Mike Replogle, *IVHS at Risk: A Review of the Draft National Program Plan for Intelligent Vehicle Highway Systems (IVHS),* November 1993, Washington, D.C., p. 7.

ITS FUNCTIONALITY, ACCESSIBILITY, AND USABILITY

INTRODUCTION

There are three fundamental factors that will determine the nature and magnitude of ITS' societal impacts for diverse constituents. These factors are: their functionality (what service will they provide), accessibility (who will have access), and usability (will they be used and how).

Functionality: Functionality relates to the objectives and services provided by ITS user services. Although ITS user services will likely create new markets for specialized information and products, many services improve the efficiency of conventional operations without altering their basic objectives. Appendix A compares ITS user services with closely related conventional services. Nearly all ITS user services share sirnilar objectives with conventional transportation services. Only automated highway systems would represent a radical shift in transportation infrastructure and function. As a result, ITS will share similar societal implications with their conventional counterparts. These implications have already been documented in social impact studies of analogous conventional transportation services (see Chapter 7, " A Comparative Analysis of ITS and Conventional Transportation").

However, a key issue concerning functionality relates to what extent ITS will create new, stand-alone service or support already existing conventional transportation services.

Accessibility: Accessibility refers to an individuals ability to obtain ITS user services. ITS' societal impacts, particularly its distributive impacts, will be largely influenced by who has access to which ITS user services. However, restricted private ownership of ITS services may or may not preclude large-scale societal benefits. For example, a few individuals who drive vehicles equipped with on-board route guidance and crash avoidance systems may experience improved mobility, fewer accidents, and less wasted time. As a result, use of these products have advantages for the individuals, but will not likely benefits other members of the public. However, when a critical number of private individuals own technologies that enhance their individual mobility, safety, and productivity, other individuals without the technologies may also indirectly experience similar benefits. However, access to conventional transportation services varies significantly among different groups of community constituents (e.g., income, elderly, disabled, etc.). These groups have diverse needs and often respond differently to changes in the transportation system.

Usability: The concept of usability embraces three questions about ITS: 1) will it be used?; 2) is it capable of being used?; and 3) how will it be used. First, ITS user services must be relevant to specific needs if it is to be useful. In addition, the public must be willing to use "interfacing" technologies and products (such as personal computers and cellular telephones) to obtain ITS information. Secondly, aside from its utility, certain constituents may be unable to use ITS user services because they are poorly designed for their physical or language difficulties. Finally, ITS societal impacts will largely be determined by whether users change their travel behavior as a result of ITS deployment. Again, members of different demographic groups have distinct characteristics that will affect how or if they can use ITS services.

ITS FUNCTIONALITY ISSUES

The following functionality issues have societal implications. Each of these issues are identified and briefly discussed below:

ITS Functionality Issues
• Objectives • Autonomous vs. supporting functions

Objectives: The objectives of ITS user services will influence the nature of impacts. For example, advanced public transportation systems may be more likely to affect those individuals reliant on transit, such as members of low-income groups. In addition, the degree to which ITS user services are used as amenities, efficiency enhancements, or for equity purposes will influence the nature of societal impacts. For example, Altshuler notes that localities have typically provided demand-responsive transit as "community luxuries" (with focus on children and commuters) or to achieve equity goals (with focus on the disabled, elderly, and carless poor). Altshuler acknowledges that demand-responsive transit could achieve both convenience and equity objectives, but concludes that their "relative weights are likely to influence choices made with respect to service area boundaries, patterns of operation, eligibility and fare policies, degree of advance notice required, system scale, and predominant sources of financing."'

Autonomous vs. supporting functions. It is uncertain to what extent ITS user services will create new, stand-alone services or support existing conventional transportation services. For example, will the possibility of personalized public transit increase the *quantity* of paratransit services or exclusively improve the *quality* of an already present paratransit service. Additionally, will the availability of technologies, such as automated vehicle identification enable the implementation of travel demand management strategies, such as congestion pricing?

ITS ACCESSIBILITY ISSUES

The following issues could potentially impact the accessibility of ITS user services. Each of these issues are identified and briefly discussed below:

ITS Accessibility Issues
• Market penetration • Access to "interfacing" technologies • Local priorities • Costs and financing • Public vs. private "ownership"

Market penetration. The extent of market penetration over the next ten to twenty years is uncertain as are the types of user services that will find ready markets. The DOT and ITS America have developed expected deployment time frames for individual ITS user services, which are shown in Appendix B. The projections show that most ITS user services will be widely available in ten to fifteen years. More technically complex systems, such as automated highway systems, will likely not be available until 20 15 to 2020. ITS deployment will most likely be driven by the private sector. As a result, the DOT must anticipate how it can address those societal needs not addressed by consumer markets.

Access to Interfacing Technologies. Interfacing technologies are the media that directly communicate ITS Formation to travelers. These media include in-vehicle technologies, telephones, personal computers, radios, television, and public systems. The affordability of these systems is the major factor who will have access to the information these media provide. Access for each of these media is briefly summarized below:

- In-vehicle technologies. Accessibility to in-vehicle technologies, such as in-vehicle navigation and safety systems, will be a function of car ownership. As evident in the 1990 NPTS, a higher percentage of adults in high income groups have access to cars than do adults in lower income households. In addition, access to ITS technologies may be additionally limited depending on whether on-board technologies become standard features or accessories. However, even if in-vehicle systems become standard or mandated equipment, it may have a questionable impact on the affordability of cars and car ownership since individuals may opt for lower priced new or used vehicles. New cars with in-vehicle systems could infiltrate the general consumer market within five to seven years of purchase once sold by their owners in the used car market.

- Telephones/Cellular phones. Cellular Telecommunications Industry Association estimated that there were 13,067,000 cellular phone subscribers as of January 1993. They estimate that there will be 15 million cellular telephone subscribers by 1 995.[2] Cellular phones are particularly instrumental for accessing real-time en-route information from moving vehicles. The cost and monthly fees for these technologies could place them out of reach of lower income groups. In addition, a study of a Dial-a-ride paratransit service in Boston also showed that conventional phone service was relatively less in lower-income neighborhoods than in higher-income areas.3

- Personal computers. A study by Mediamark Research, Inc. of New York found that the number of American households with personal computers will increase from 16 million in 1992 to 26 million in 2000, with a possible doubling depending on consumer interest. The number of households owning personal computers was 16.7 percent of all households in 1992 and by 2010, 33.6 percent of all households are expected to own personal computers.4 Again, the affordability of these systems may make access to ITS information; particularly pre-trip information, difficult.

- Radio. Stations that carry traffic reports attract listeners across gender, ethnicity, and income. This study also reported that one radio station increased its audience size by 30 percent when it began providing traffic information. In addition, in regions where public transportation is widely used, such as New York City, radio traffic broadcasts also provide public transit information.5 Radio ownership in the U.S. is nearly ubiquitous.

- Television. Television stations have typically provided traffic reports as part of their morning news programs, primarily dedicated to morning pre-commute hours. Some stations have also provided traffic reports on their evening news broadcast6 In the U.S., like radios, television ownership is nearly ubiquitous.

- Public systems. Public systems, which are typically located at public transit stations, major employment centers and shopping areas, provide information on schedules and routes usually at no cost to users.

Local government priorities. There will be multiple, decentralized deployments of ITS user services, whose characteristics will vary from region to region, depending on local needs and priorities. These needs and priorities may be influenced by local politics that may or may not support efficiency and equity concerns. As another example, Brian Taylor, in his 199 1 article, “Unjust Equity: An Examination of California’s Transportation Development Act,” identified bias in California’s public transit funding in favor of suburban rail commuters at the expense of central city bus riders.7

Public vs. private ownership. The degree to which ITS user services can or will be deployed as public or private systems will affect accessibility. For example, traveler information could be provided through either public information kiosks as well as private devices, such as personal digital devices, phones, and personal computers. Other user services, such as in-vehicle navigation and collision avoidance systems, can only be accessed by private individuals vehicles.

Costs and financing. Accessibility will be affected by the capital costs and operations and maintenance expenses of the ITS user services, which will make them affordable or too expensive to public agencies. Public sector financing (subsidies) of ITS could affect both users and non-users. In addition, private individuals may have to pay for interfacing technologies and/or fees to obtain information. For example, until last year, the federal government subsidized a significant portion of Internet costs. More than three dozen companies now offer Internet access for monthly fees ranging from $10 for individual electronic mail to $2,000 for full-service corporate access.'

ITS USABILITY ISSUES

The following issues impact the ability to use ITS user services, which are identified and summarized below:

ITS Usability Issues
• Willingness to use information • Willingness to use "interfacing" technologies • Willingness to change travel behavior • Ergonomics and human factors • Literacy • English as a Second Language

Willingness to use information. Information must be relevant before constituents will be willing to use it. For example, ITS information aimed at suburban-to-city automobile commuters will be irrelevant to trip-chaining working women or city-to-suburb bus riders.

Willingness to use interfacing technologies. Although users may have access to technology, they may be unwilling to use it. For example, in a 1993 study, the University of Rhode Island's Research Institute for Telecommunications and Information Marketing surveyed 7 12 primary computer users from a sample of affluent and/or computer-owning households in five major cities and suburbs. The study found that, on average, 28 percent of men and 20 percent of women used on-line services while 2 1 percent of men and 15 percent of women used e-mail. The study found that for those users who owned computers for more than ten years, 36 percent of men and 46 percent of women used on-line services while 28 percent of men and 38 percent of women used e-mail.[9] In addition, people may be unwilling to use technologies for psychological or cultural reasons. A Nashville study found that their transit information service was infrequently used by poor blacks asking questions about bus scheduling. In contrast, affluent white patrons asked more frequent and detailed questions.[10]

Willingness to change travel behavior. Societal impacts can only result if users change travel behavior as a result of using the ITS service. This behavior includes trip-making, trip-chaining, route choice, mode choice, and departure times.

Ergonomics and human factors. Poorly designed systems that ignore special needs will make them unusable. Particularly sensitive groups include the elderly and the disabled (including physically disabled as well as hearing- and sight-impaired travelers). Several studies have documented how information overload adversely affect the travel experience for elderly. In addition, traffic signals that are of insufficiently short may put elderly, disabled, and pedestrians at risk for injury.

Literacy. In 1992, the U.S. Department of Education conducted a National Adult Literacy Study to assess the nation's competency to understand written and quantitative information. The survey population included 20,000 U.S. residents. .The survey found that 21 to 23 percent of adults demonstrated skills in the lowest level of prose, documentation, and quantitative proficiencies. These adults tended to be immigrants, individuals without a high school education, elderly (age 65 or older), and disabled persons (e.g., possessing physical, mental, health, visual acuity handicaps). The survey also found that another 25 to 28 percent of the nation tested in the next lowest proficiency level, whose skills were quite limited, but were able, for example, to locate a particular intersection on a map.'[1] In addition, the study identified particularly disadvantaged categories:

- Ethnicity/Race. The study found that blacks, American Indian/Alaskan Native, Hispanic, and Asians were more likely than white adults to perform in the lowest two literary levels due primarily to fewer years of school and English as a second language.[12]

- Income. In addition, 41 to 44 percent of all adults in the lowest two levels were living in poverty, compared with only 4 to 8 percent in the highest two proficiency levels.[13]

- Age. The survey also found that older adults were more likely than middle-aged and younger adults to demonstrate limited literacy skills. For example, adults over the age of 65 had literacy scores that were at least one level lower than adults 40 to 54 years of age, primarily due to fewer years of schooling. Given increases in education over next few years, elderly literacy rates will likely improve in the future.[14]

English as a Second Language. ITS user services that fail to address English language difficulties will be unusable for immigrant communities. The implications of English language difficulties were evident in a survey conducted by Commuter Transportation Services of small employers in Southern California. Fifty-five percent of the employee respondents said that they would need materials in Spanish as well as English. This percentage was even higher for larger employers and for restaurants and manufacturing sites.[15]

SUMMARY

The priorities of ITS developers and deployers, including the DOT's ITS program, will determine functionality, accessibility, and usability. As a result, it is important that they clearly acknowledge societal goals and potentially impacted constituents in decisionmaking.

ENDNOTES

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WHAT IS A "SOCIETAL" EVALUATION?

INTRODUCTION

Definition

The societal evaluation of ITS user services, which have not been widely implemented, presents an imposing challenge. As noted by Kurt Finsterbusch, social impact assessments can have several objectives,:

> "The term assessment has at least three different meanings, depending on the context in which it is used. It may involve a measurement of existing or future conditions, it may refer to an evaluation of the importance of a particular impact, or it may involve some working combination of the two. It requires a balancing of quantitative and qualitative analyses, although the relative weight of quantitative versus qualitative factors may differ from impact to impact, and from project to project."

Two fundamental approaches to policy evaluation are societal (or social) impact assessment and cost-benefit analysis.* As noted by Peter Sassone, both approaches ask the same fundamental question: is a proposed action in the best interests of society? However, the two approaches have significant differences:

Cost-Benefit Analysis	Social Impact Assessment
• Well-defined and widely accepted approach	• Ambiguous and contestable approach
• Assumes market or market-like values are meaningful quantities	• Accepts more than one criteria to measure value or worth
• Explores impacts for large, broadly defined groups	• Focuses on individuals and small groups
• Concerned with aggregate, absolute impacts	• Concerned with equity and social distribution of impacts
• Appraises tangible impacts	• Considers tangible and intangible effects
• Designed to evaluate policies that affect many people, but none substantially	• Designed to evaluate policies that affect relatively few people, but affects them substantially

Because ITS user services could have broad, national impacts, the DOT has committed significant resources to support cost-benefit research. However, there is also a need for a social impact assessment, which builds upon traditional cost-benefit analysis. Social impact assessment also expands the base of knowledge by valuing important intangible effects, which often cannot be quantified or monetized. For example, an advanced traffic management system's impact on neighborhood cohesion may greatly concern affected residents, but is difficult to define or quantify. In addition, social impact assessment addresses not only changes in absolute levels of benefits and costs, but how impacts are distributed among specific, carefully defined groups. It often seeks to resolve how deep and discriminating impacts affect individuals.[3]

Objectives of ITS Social Impact Assessments

Given a definition of social impact assessment, the purpose of this section is to briefly delineate five key objectives of social impact assessments in the context of clarifying ITS societal implications:

> **A. Choosing between alternatives:** How should we evaluate and value transportation alternatives
>
> **B. Identifying relevant impacts and constituents:** Which types of societal impact are most relevant to asses, given the characteristics and functions of ITS user services? Which constituent groups could be substantially impacted by ITS deployment?
>
> **C. Developing alternative futures:** When will impacts take place given the expected time frame for ITS deployment? What role will and should ITS play in meeting future transportation and social needs?
>
> **D. Estimating ITS' social impacts:** How can societal impacts be measured? What is an appropriate level of analysis to estimate societal impacts?
>
> **E. Identifying opportunities to affect social outcomes:** How can the DOT and other developers of ITS achieve desirable outcomes through design or administration.

Each of these objectives is discussed below:

A. CHOOSING BETWEEN ALTERNATIVES

One of the primary objectives of social impact assessments is to help identify the "best" policy or project among several options. For the DOT and local transportation planners, these options may include ITS user services, conventional transportation, or an acceptance of the status quo (e.g. the "no action" option). The term "best" is ultimately subjective; it is based on internal values and standards to evaluate the severity or importance of social impacts. This social welfare criteria must be explicit if social impact assessments are to help the DOT and other evaluators determine whether ITS alternatives could produce desirable, undesirable, or unacceptable societal effects relative to other options or baseline conditions. The sociological literature identifies a wide range of possible criteria:[4]

- ***Value conflict resolution*** allows evaluators to prioritize values by identifying which groups are most important and which impacts are most desirable. This prioritization enables evaluators to explicitly compare different options that have a variety of impacts. It also helps to resolve trade-offs between conflicting values, such as safety and mobility or air quality and safety.

- ***Pareto optimality*** favors an action that does not decrease anyone's welfare, but improves the welfare of at least one person. From a practical standpoint, however, Pareto-optimal solutions may not be available.

- ***Utilitarianism*** favors actions that produce the greatest good for the greatest number. It aims to maximize aggregate benefits minus costs.

- ***Equality in service distribution*** asserts that each individual is entitled to an equal share of public support regardless of need or financial contribution. This criteria, however, requires evaluators to determine whether service distribution should be measured in terms of added (net) benefits and costs relative to current conditions, or in terms of the total (absolute) level of service achieved.

- ***Distribution according to need asserts*** that each individual should receive a share of public support based on need, with service fees and costs predominantly paid for by those who are financially better off.

- ***Equal opportunity*** affirms that each person should have equal opportunity to take advantage of the positive impacts resulting from a given policy action, regardless of actual need or use.

- ***Sustainability,*** as defined in the 1987 report, Our Common Future, by the World Commission on Environment and Development, is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."'

B. IDENTIFYING IMPACTS AND CONSTITUENTS

Transportation is an integral part of the nation's economic and social structure; it impacts myriad demographic groups and organizations. As a result, it is a difficult, but critical task to narrow the assessment focus to those impacts and constituents that are most relevant to understanding ITS societal implications. The Interorganizational Committee on Guidelines and Principles for Social Impact Assessment define social impacts as:

> "the consequence to human populations of any public or private actions--that alter the ways in which people live, work, play, relate to one another, organize to meet their needs, and generally cope as members of society. The term also includes cultural impacts involving

changes to the norms, values, and beliefs that guide and rationalize their cognition of themselves and their society."6

Planners and evaluators of ITS deployment must also strive to identify potentially impacted community groups or organizations, particularly those that may be most sensitive to changes in transportation. As an example, a report prepared for the Association of Bay Area Governments Identified characteristics of potentially vulnerable or sensitive groups:7

Characteristics of Transportation-Sensitive Groups
• They have special mobility needs and encounter unique barriers in using transportation modes designed for the majority population. • They are impacted disproportionately from the negative and indirect effects of changes in the transportation system. • Their needs and interests have traditionally been underrepresented in transportation and public policy decisionmaking. • They have differing abilities to access or take part in transportation options.

Ideally, identification of relevant impacts and constituents should employ several methods: literature reviews, iterative interviews with potentially impacted parties, interviews with local government personnel, and Delphi interviews of experts.'

C. DEVELOPING ALTERNATIVE FUTURES

The introduction of ITS user services will take place gradually over the next 10 to 20 years. Some ITS user services, such as automated highways, may not be implemented for another twenty to thirty years.9 As a result, researchers must anticipate future deployments of ITS user services using social forecasting methods. Evan Vlachos defines social forecasting as:

> " Analysis of probable social consequences of current trends and events, projections of future technological and social developments, and understanding of the 'images of the future'--the anticipations, fears, hopes and goals that motivate present action toward the creation of desired future states.""

Vlachos goes on to define three categories of alternative futures:

Alternative Future	Approach	Policy Use
Extrapolative	Provides an historical and predictive model to forecast trends and events, based on knowledge about present conditions (forward looking).	Identify the degree to which current actions could influence future states of social, economic, and technological development.
Preferred (Normative)	Describes a future state of development, which reflects values, desired goals, and needs (backward looking).	Identifies actions that must happen in order to achieve a particular societal change.
Practicable	Synthesis of where we expect and desire to go from present conditions.	Identifies possible paths that could be taken, given probable trends and desired goals.

Program evaluators can employ alternative futures to establish baseline ("without ITS") and alternative ("with ITS") scenarios, which are discussed below:

Baseline ("Without ITS") Scenarios

Baseline profiling describes scenarios to which ITS implementation can be compared. They are primarily developed using extrapolative procedures. With respect to social impact assessment of the DOT's ITS program, baseline conditions could be defined in two ways:

- ITS technologies and services are not available from either the public or private sectors.

- ITS user services will be an inevitable result of market forces. As a result, the baseline is defined in terms of the level of ITS user services that would be offered absent government intervention.

There are difficulties in profiling the second baseline scenario. First, evaluators would have to estimate how much ITS implementation would occur without government involvement. Second, as a matter of public policy, the government is concerned about impacts resulting from market forces as well as government investment. As a result, the preferable baseline scenario is that which assumes no ITS at all. At a minimum, this baseline scenario must describe expected demographic and economic conditions absent ITS services, the degree to which transportation choices are available to specific groups, and the degree to which the groups already share in the benefits and costs of the conventional transportation system.

The Transportation Research Boards conference and 1988 report, *A Look Ahead: Year 2020,* would provide a useful resource for describing baseline conditions. The conference's objective was "to identify the nature and level of demand for future highway and public transit services and their role in the nation's future transportation system" through the year 2020. Specifically, the report identifies potential impacts on transportation by such factors as "future demographics and life-style, urbanization and suburbanization, new technologies, international business competition and economics, energy demand, technology, commercial freight transportation, personal mobility, and institutional arrangements."*1

"With ITS" Scenarios

Projecting ITS scenarios involves the difficult task of predicting future market penetration of ITS user services and their subsequent social impacts. Evaluators can employ each of the three types of alternative futures (extrapolative, preferred, and practicable) to help identify alternative policies, actions, and paths.

The development of future ITS scenarios was the focus of ITS America's Alternative Futures Symposium Transportation, Technology and Society in March 1995. A brief summary of this symposium is included in Chapter 6 section "State of the Knowledge: ITS Literature Review."

D. ESTIMATING SOCIETAL IMPACTS

The review of the theoretical literature and conventional transportation studies revealed a wide range of agreement about the validity of assessment techniques, particularly with respect to predicting future impacts. The literature provided few examples of frameworks able to investigate equity impacts of transportation projects. Those few frameworks we identified almost exclusively addressed procedures for evaluating the social and environmental impacts of highway improvements, particularly to satisfy National Environmental Protection Act (NEPA) requirements.

In May 1995, the University of Michigan will hold a workshop entitled, "Methodologies for Analysis of Societal Issues in Transportation," to identify precise methodologies to investigate social impacts. In addition, Walter Albers, for the ITS America Societal Implications Committee, inventoried methods and tools, which are provided in Appendix C.

Below we briefly identify three analysis concepts: macro vs. micro, qualitative vs. quantitative, and comparative analysis.

"Macro" vs. "Micro" Analysis

ITS societal impacts and potentially impacted constituents can be evaluated at any scale: national, regional, city, neighborhood, or individual. The size of the unit selected for assessment distinguishes "macro" and "micro" analysis.'*

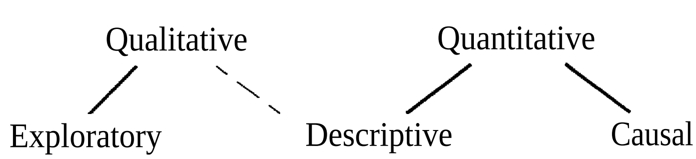
Macro-level assessment uses aggregated data to investigate large-scale phenomena. Macro analysis is particularly helpful for examining how transportation can accommodate broad economic, technological, and cultural forces, such as housing, economic, and demographic shifts. In addition, regional or global phenomena, such as ozone or greenhouse gases, should be investigated from a macro perspective.

In contrast, micro-scale analysis investigates smaller scale patterns and relationships. Because micro-scale analysis operates at the ground level, it is better able to identify specific opportunities and variables that policymakers could influence to achieve desired goals.

Both levels of analysis are useful for examining potential ITS impacts. Macro-level research would provide general knowledge of how specific ITS user services could impact and serve demographic groups. Because ITS deployments will vary from one location to another, micro-level research, particularly at the metropolitan area and neighborhood level, would provide insights into distributive impacts.

Qualitative vs. Quantitative Assessment

Successful and useful impact estimates require a well-defined research design. A research design provides a framework for data collection, analysis, and results interpretation. Ideally, this framework should move ITS social impact assessments from their current exploratory disposition to more conclusive research. Conclusive research consists of both descriptive and causal analysis. Both descriptive and causal research would be useful for discerning ITS societal implications. As shown in the diagram below, the emphasis on impact quantification increases as assessments move toward causal investigations:[13]



Exploratory Research. Exploratory research attempts to qualitatively delineate the boundaries of relevant issues. It’s primary purpose is one of identification of these issues with lesser emphasis on quantification and analysis. Most of the current ITS literature employs exploratory research.

Descriptive Research. Descriptive research could provide a general understanding of ITS societal impacts. It could describe the characteristics of specific constituent groups using demographic, socioeconomic, and geographic data as well as their travel and transportation habits, access, and preferences. Descriptive research could also summarize how these groups would share in ITS benefits, disbenefits, and costs.

Causal Research. Causal research could identify and measure those variables (causal factors) that affect the distribution of ITS social impacts as well as the relationships between causal factors and equity impacts. In particular, case studies are ideally suited for causal research. Case studies intensively investigate constituents' behavior and responses to a policy action within a specific geographic context. In the context of ITS evaluation, case studies should be selected to reflect expected ITS deployment scenarios in diverse environments, so that meaningful conclusions can be made about factors influencing transportation equity.

Comparative Analysis

Because ITS user services have not been widely deployed, analysis that extrapolates the social impacts of analogous conventional transportation services may provide some insights. This method is employed in this report in the section "Comparative Analysis of ITS and Conventional Transportation." The Volpe Center employed two techniques of comparative analysis: grounded theory and empirical generalizations.

Grounded Theory. Mark Shields defines "grounded theory" as:

> "a method of inductive, comparative analysis for discovering theory from the data of social research. It is inductive because it starts with the empirical findings of social impact studies and attempts to 'discover' theoretical concepts and generalizations from the data, rather than starting with a particular theory or group of propositions which are then tested against the available evidence. It is comparative because it calls for the analysis of a wide range of social impacts studies for the purpose of obtaining a variety of 'slices of data' for developing theoretical catagories."14

Empirical generalizations. Grounded theory is based on the development of what Shields calls "empirical generalizations," which he defines as:

> "Findings from the analytic bibliography are separately entered into an inventory of empirical generations...Apart from its importance in constructing grounded theory, the inventory is a useful accounting of the type and amount of empirical research devoted to various areas and, along with the analytic bibliography, can serve as a reference source in all subsequent and related research."'5

For each of the analogous conventional services, the Volpe Center found social impact assessment studies to develop empirical generalizations about:

- Susceptibility: The likelihood that different constituent groups will be affected by the transportation service.
- Attitudes: The perceptions by constituent groups about the transportation service.
- Impacts: The reported effects of the transportation service.

E. IDENTIFYING MECHANISMS TO AFFECT SOCIAL OUTCOMES

ITS social impact assessments should not only help in selecting "good" projects, but also seek to improve the design, funding, and administration of these projects. If properly conceived, social impact assessments could be used as a means to holistically integrate ITS deployments with other broad-based concerns of community planning, zoning, conventional transportation strategies, economic development' etc. In addition, social impact assessments could identify mechanisms to avoid, minimize, or compensate for potentially negative social impacts- Most importantly, they could proactively engage diverse stakeholders in design and planning activities to increase social benefits as much as possible and to ensure a more equitable distributive of those benefits.

ENDNOTES

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2. This section relies heavily on Peter G. Sassone's article, "Social Impact Assessment and Cost-Benefit Analysis," *in Methodology of Social Impact Assessment,* eds. Kurt Finsterbusch and C.P. Wolf, Stroudsburg, Pennsylvania: Dowden, Hutchinson & Ross, 1977, p. 74-82.

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4 *Ibid.,* p. 254.

5 As quoted *in Technology for a Sustainable Future: A Framework for Action,* Washington, D.C., June 1994.

6. Interorganizational Committee on Guidelines and Principles for Social Impact Assessment, "Guidelines and Principles for Social Impact Assessment," *Environmental Impact Assessment Review,* January 1995, p. 11.

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15. *Ibid.,* p. 67.

STATE OF THE KNOWLEDGE: ITS LITERATURE REVIEW

INTRODUCTION

This section reviews and critiques 30 published papers and studies to assess the current state of the knowledge of ITS societal impacts. In addition, this section includes a brief summary of the March 1995 Alternative Futures Symposium on Transportation, Technology and Society, which was sponsored, in part, by ITS America and the ITS Joint Program Office. Exhibit 7 illustrates the scope of the ITS societal issues literature; Appendix D summarizes the contents and conclusions of each paper.

The literature consists primarily of exploratory "think pieces." Few of the papers rigorously analyze social impacts of specific ITS user services. Although the papers cover many topics from different perspectives, they disclose four pervasive themes: First, the literature expresses optimism that ITS user services can technically satisfy numerous societal needs. Second, the literature voices concern that the ITS program is overlooking applications outside of urban/suburban automobile commuters. Third, the literature asserts that ITS applications will be more effective if constituents are involved in implementation planning and decisionmaking. Fourth, nearly all of the papers stress the need for further research.

The remainder of this section reviews the literature's findings with respect to the following topics:

- Potential impacts of specific ITS user services
- The types and magnitude of expected societal impacts
- Potential implications for specific demographic groups and organizations
- Alternative futures of ITS deployment
- Social impact assessment methods and criteria to value alternative actions

IMPACTS OF SPECIFIC ITS USER SERVICES

For the most part, the literature addresses ITS as a generic concept. Most significantly, the literature does not investigate the societal impacts of expected deployments of bundled ITS user services within a specific geographic and demographic context. Ten studies address societal impacts of specific ITS user services. Their conclusions are highlighted below:

On-board Vehicle Systems. In-vehicle route guidance could improve travel times and advanced vehicle safety systems could reduce vehicular accidents. However, if these systems are not properly designed, they could overload elderly drivers with information, resulting in more navigation errors and accidents (Source: Barham et al, Grieco, Parkes, Stamatiadis, Transportation Research Board, Walker). In addition, autonomous in-vehicle route guidance systems would provide marginal societal benefits (in terms of enhanced productivity and safety) if not integrated with traffic management systems, which could optimize aggregate traffic efficiency (Source: Swedish National Road Administration et al).

Advanced Traffic Management Systems. Society could achieve substantial gains from increased productivity and reduced accidents if advanced traffic management systems were integrated with in-vehicle route guidance (Source: Swedish National Road Administration et al).

Public Transportation Systems. Advanced public transportation systems could enhance the mobility of the elderly by making paratransit services more feasible (Source: Bedford, Grieco, Triulzi). IVHS user services could also make rural transit services more viable by attracting new riders, reducing costs, and increasing comfort and convenience. In particular, several rural fixed-route bus operators suggested that pre-trip information, in-terminal information, and HOV lanes could improve demand. They also noted that electronic ticketing and HOV lanes could potentially lower operating costs. In addition, these operators believed that electronic ticketing, integrated fares, HOV lanes and in-terminal information could increase user comfort and convenience. Operators of specialized rural transit services (such as ridesharing and paratransit) believed that automatic dispatching, in conjunction with automated vehicle location technologies, could improve reliability and increase demand, lower operating costs, and increase comfort and convenience (Source: Reay and Kiljan, Sobolewski and Wright, Wegmann, Zarean).

Intelligent Bicycling Routing. Intelligent bicycling routing is a feasible concept that would enable information technologies to aid bicyclists' route choice, connections to other modes (such as carpools and transit), and security (Source: Betz et al).

GENERAL IMPACTS

The ITS societal literature addresses the following issues and concerns, which are summarized below:

Issues	
• Definition	• Travel Convenience
• Societal Benefits	• Privacy
• Costs/Affordability	• Traffic Congestion
• Equity	• Air Quality and Energy Use
• Access to Basic Needs/Opportunity	• Land Use and Urban Form
• Productivity	• Aesthetics
• Profitability	• Natural habitat
• Institutional	• Mobility
• Safety	• Choice
• Personal Security	• Community Cohesion

Definition. The literature defines "societal" impacts in sweeping terms and embraces such diverse concepts as institutional issues (e.g., public-private partnerships, public financing, interagency cooperation), legal issues (e.g., liability, antitrust), privacy, user acceptance, travel demand (including latent demand), access (measured in person trips served), economic utility, and economic externalities. ***The National Program Plan for IVHS*** and Barbara Richardson's paper, "Socio-economic Issues and Intelligent Transportation Systems," comprehensively identify potential impacts.

Societal Benefits. The literature often calculates societal benefits in terms of productivity gains, pollution reduction, energy savings, and accident reduction. Some studies also include infrastructure maintenance savings. Although not summarized in this report, the DOT, ITS America, and others have investigated aggregate impacts of ITS user services on safety, energy, air quality, and mobility. In addition, the DOT and ITS America have carved out research areas pertaining to institutional issues, legal issues, and privacy. The results available from these efforts could provide a resource for ITS societal issues research.

Costs/Affordability. With one exception, the literature does not explicitly evaluate societal costs of ITS user services. The sole paper borrows its cost estimates from the ***Mobility 2000*** Report, which has not been recently updated (Source: Boghani) Most significantly, the literature does not address affordability issues. In addition, the literature does not address the implications of financing and funding to support ITS implementation, operations, and maintenance, particularly with respect to potential hidden costs for users and non-users of ITS technologies and services.

Equity. With one exception, the literature does not rigorously estimate equity issues. The paper by Myers and Saunders concludes that reductions in travel time would lessen income inequalities between white and non-white commuters, but not by much. However, this paper does not directly link travel time reductions with ITS applications (Source: Myers and Saunders).

Access to Basic Needs/Opportunity. Several papers express optimism that ITS user services have the potential to improve mobility, particularly for elderly and rural constituents. However, the literature does not relate enhanced mobility improvements to improved access to specific needs and opportunities, such as employment, housing, shopping, recreation, socializing, etc.

Productivity. The literature assesses ITS' productivity implications in terms of its impacts on individual travel time. These papers suggest that ITS user services will most likely reduce travel times and, therefore, increase productivity (Source: Boghani, Stafford, Swedish National Road Administration et al).

Profitability. The literature cites ITS' impact on profitability as an important concern for IVHS suppliers and passenger travel industries, but does not attempt to estimate impacts (Source: Chen and Ervin, Richardson, Underwood, Underwood et al, U.S. DOT, Wegmann).

Institutional, Several papers exclusively focus on institutional issues, with particular emphasis on public and private sector activities and relationships. Many papers also stress that IVHS developers and suppliers must include constituents and stakeholders in design and implementation activities or risk implementation delays and consumer rejection. (Source: Chen and Ervin, Greenberg, Underwood, Underwood et al, Waller (l), Waller (2)).

Safety. Although the papers generally believe that ITS user services will improve vehicular safety in urban and rural areas, the implications for pedestrians, bicyclists and the elderly are uncertain. Some papers voice concerns that ITS will increase the number of vehicles and deteriorate safety for non-motorized modes. In addition, in-vehicle navigation and other on-board systems, which increase the amount and complexity of information supplied to drivers, may overload older drivers and potentially increase their accident risks (Source: Barham et al, Betz et al, Boghani, Greenberg, Grieco, Parkes, Reay and Kiljan, Richardson, Sobolewski and Wright, Stamatiadis, Swedish National Road Administration et al, U.S. DOT, Transportation Research Board, Wallace and Kilpatrick, Zarean et al).

Personal Security. The literature cites personal security as a concern, but does not attempt to estimate ITS' potential impacts (Source: Richardson, U.S. DOT).

Travel Convenience. ITS user services have the potential to increase travel convenience and comfort for public transit users, bicyclists, and rural travelers. However, the papers assert that the ITS program is not giving enough attention to these constituents (Source: Betz et al, Richardson, U.S. DOT, Wegmann et al).

Traffic Congestion. ITS could reduce traffic congestion, thereby improving travel times and productivity (Source: Boghani, Swedish Road Transport Administration et al, U.S. DOT). The societal issues literature does not specifically estimate potential changes in traffic congestion that could result from ITS user services although such impacts are estimated in ITS cost-benefit studies.

Air Quality and Energy Use. A few papers cite the ability of ITS to improve air quality and reduce energy use in urban and suburban areas by reducing traffic congestion. However, a few papers assert that environmental benefits will be lost if ITS user services attract more single occupancy vehicle travel (Source: Hempel, Greenberg).

Land Use and Urban Form. The literature cites land use and urban form issues as societal concerns, but does not attempt to estimate ITS' potential impacts. (Source: Greenberg, Hempel, Richardson, U.S. DOT).

Aesthetics. The literature cites aesthetics as being potentially affected by ITS, but does not attempt to estimate impacts (Source: Greenberg, Richardson).

Natural Habitat. The literature cites natural habitat as being potentially affected by ITS, but does attempt to estimate impacts (Source: Richardson).

Mobility Several papers believe that ITS user services could enhance the mobility of the elderly, bicyclists, public transit users, and rural residents. However, the literature does not attempt to quantify mobility improvements, except by evaluating improved travel times for automobile commuters in urban areas (Source: Bedford, Betz et al, Grieco, Reay and Kiljan, Richardson, Sobolewski and Wright, Suen and Parviainen, Swedish National Road Administration, Triulzi, U.S. DOT, and Zarean et al).

Choice. ITS could increase transportation choices by making bicycling, walking, and transit more attractive and convenient, although the literature does not estimate specific impacts (Source: Bedford, Betz et al, Greenberg, Hempel, Richardson, Sobolewski and Wright, Starnatiadis, Triulzi, U.S. DOT). There is concern, however, that the ITS program is not doing enough to improve choices for non-automobile travel (Source: Bedford, Greenberg, Hempel).

Community Cohesion. The literature cites community cohesion as a societal concern, but does not attempt to estimate impacts (Source: Greenberg, Richardson, US. DOT).

CONSTITUENT GROUPS

The ITS societal literature addresses the following demographic groups and organizations:

Issues
• Public/private Sectors • Users and Non-users • Income Croups • Elderly • Disabled • Pedestrians/Bicyclists • Rural Residents • Race

Public/Private Sectors. Several papers explore institutional issues affecting ITS deployment, particularly the government's role and public-private partnerships. The literature cites the need for financing mechanisms, jurisdictional coordination, and consensual standards to advance ITS deployment (Source: Chen and Ervin, Schroeder and Clinger, Richardson, Underwood, U.S. DOT).

Users and Non-users. With one exception, the literature does not assess differential impacts experienced by ITS users and non-users. The sole paper hypothesizes that non-users of electronic toll collection and in-vehicle route guidance would not receive either benefits or disbenefits (Source: Chen and Ervin).

Income Groups. Only one paper explicitly examines potential impacts for low-income travelers. The paper by Myers and Saunders investigates the relationship between travel time reductions and income inequalities for disadvantaged groups in three cities. However, the study does not link travel time improvements directly to ITS applications (Source: Myers and Saunders). Other papers identify income groups as relevant to ITS societal research (Source: Richardson, U.S. DOT).

Elderly. ITS user services must engender a wide range of options, particularly public transit and paratransit, to improve the elderly's mobility. In addition, the number of elderly drivers will increase as the population ages. Although some ITS user services could enhance the elderly's visual acuity, on-board vehicle systems may overload elderly drivers with information and negatively affect their ability to navigate (Source: Barham et al, Bedford, Stamatiadis, Transportation Research Board, Walker et al, Waller (1)).

Disabled. The literature believes that disabled groups could benefit from ITS user services if properly designed, but does not attempt to estimate impacts (Source: Richardson, Suen and Parviainen, Triulzi, U.S. DOT).

Pedestrians/Bicyclists/Transit. The current perception is that the ITS program is not addressing the needs of bicyclists and pedestrians. In particular, the literature asserts that ITS user services, as currently envisioned, will degrade the transportation experience for bicyclists and pedestrians by increasing the number of vehicles on roads and secondary streets. However, there remains optimism that ITS user services, if properly focused and designed, can provide more accurate route information, improve safety, facilitate connections to transit and carpools, and increase the quality of the walking and cycling experience (Sources: Betz et al, Greenberg). Demand-response transit could compel auto users to switch to transit (Sources: Triulzi).

Rural Residents. In general, the literature sees great potential for ITS user services to address rural needs and priorities, specifically by providing information on travel conditions, weather, incidents, highway construction and maintenance, yellow pages information, and route planning. In addition, ITS user services, such as personalized transit, could enhance mobility for car-less, isolated, elderly, or disabled residents. The ITS applications cited as having the greatest promise include safety and incident detection, traveler information, pre-trip planning, en-route information, medical and emergency services, and public transportation (Source: Reay and Kiljan, Sobolewski and Wright, Wegmann, Zarean).

Race. Myers and Saunders discuss how non-whites and whites could benefit from reductions in travel times. Richardson's paper cites race as a potential issue that should be considered by ITS societal research. (Source: Myers and Saunders, Richardson).

ALTERNATIVE FUTURES

The following discussion addresses findings from both a review of ITS literature as well as a summary of the March 1995 Alternative Futures Symposium.

Literature Review

The literature addresses the following issues with respect to describing future scenarios of ITS deployment:

Issues
• Deployment/Market Penetration Time Horizon • Demographic Trends • Most Likely Futures • Preferred Futures

Deployment/Market Penetration Time Horizon. Most recently, the DOT's Intelligent Transportation Systems (ITS) Joint Program Office (JPO) predicted that the public will adopt the majority of ITS user services within ten to fifteen years.[1] In particular, the JPO believed that travel information (to facilitate mode choice and first level traffic/fleet management), electronic toll and traffic management, in-vehicle navigation, and intelligent cruise control are immediately deployable. The JPO also expected that, in the long-term, more sophisticated traffic management as well as on-board vehicle systems (lateral guidance, assisted braking, enhanced vision, and in-vehicle signing) would find markets.[2] However, automated highway systems would likely not be feasible until 2015 to 2020. Appendix B illustrates deployment time frames for several individual ITS user services, based on the JPO's current thinking.

In addition, in 1989, the University of Michigan used Delphi panels to identify expected market penetration for several ITS technologies (excluding public transit systems) through the year 2080. Their study concludes that, with the exception of automated guideway systems, commercial users would adopt most ITS technologies by the year 2000, followed quickly by public adoption. It should be noted, however, that both the U.S. DOT and the University of Michigan's projections are based on technical feasibility and consumer acceptance. They do not predict which ITS user services will be emphasized within a specific geographic context (U.S. DOT, Underwood, Underwood et al).

Demographic Trends. Few of the studies deeply address how changing demographics, land use, and economic factors will affect future transportation supply and demand, as well as ITS' ability to meet societal needs. Several studies cite the importance of understanding changes in demographics, such as the aging of the population, to ensure that ITS user services address future constituent needs (Source: Bedford, Richardson, U.S. DOT, Waller (l), Waller (2)).

Most Likely Futures. A Swedish study, ARISE, predicts the impacts of in-vehicle navigation and advanced traffic management on productivity and accidents from 1990 through 2040. Specifically, the study projects expected market penetration for these systems, societal characteristics (lifestyles and workplace), and expected travel patterns of drivers. The study concludes that society would experience a marginal gain from autonomous route guidance vehicles, but a substantial gain from integrated systems of route guidance and dynamic traffic management (Source: Swedish National Transportation Administration et al).

Preferred Futures. The literature does not describe preferred ITS deployment scenarios. In addition, the DOT's ITS Early Deployment Program will provide insights into how diverse metropolitan areas and intercity corridors expect to apply ITS user services to meet short- and long-term needs. The DOT expects to fund the deployment plans for 75 metropolitan areas and 3 0 corridors.

Summary of the Alternative Futures Symposium

On March 13,1995, ITS America, FHWA, and several other organizations, sponsored the Alternative Futures Symposium on Transportation, Technology, and Society. This summary borrows heavily from the observations and notes of Suzanne Sloan, who attended the symposium for the Volpe Center. The proceedings and papers developed for the symposium were unavailable at the time of writing.

The goals of the symposium were to:

- Incorporate a societal perspective into ITS deployment considerations
- Explore and document the perspectives of diverse stakeholders
- Develop a consensus about important and priority societal issues
- Develop alternative futures of ITS deployment for a fifteen year time horizon

The symposium's discussions revolved around four papers and futures modeling exercise, which are briefly highlighted below:

Robert Hodge, "Intelligent Transportation, Land Use and Sustainable Transportation".

Robert Hodge's primary question was: Does ITS fit into sustainable transportation? Many people are convinced that short term gains from ITS will lead to longer term use of the automobile and thus continue the inefficiencies of our current system. In addition, continued reliance on the automobile will further deteriorate mobility and safety.

Hodges presented near-term, mid-term and long-term strategies and identified key elements that could affect future transportation scenarios. These included such elements as R&D funding, regulation, metropolitan growth, and the commercialization of information.

In discussing the relationship between land use, growth management and transportation, Hodges noted that policies must relate to Americans' self-interest. He believes that policy solutions don't work "top down", but will work from "ground up" if they take advantage of basic human interests. His preference is to provide incentives to people to follow policies, but not to disadvantage people who don't. In other words, to give tax breaks and subsidies to people who implement social policies that are designed to change behavior and routines, but not to penalize those that choose not to. The more people take advantage of incentives, the more people will see it within their self-interest to follow and participate.

Jeffrey Hallet, "Industry and Employment Implications"

Heffrey Hallet of the PresentFutures Croup addressed how the social changes surrounding work and employment have impacted transportation. Specifically, activities such as downsizing, telecommuting, outsourcing of industrial logistics and distribution have all changed the face of transportation and will continue to do so. He also believes that the National Information Infrastructure ("the Information Superhighway") will integrate ITS and push its deployment progress forward.

Hallet discussed briefly the dynamic relationship between transportation and work and industry. Some observations he offered were:

- In the past, as transportation has changed, it has opened up economic opportunity, which, in turn, created transportation opportunities. Thus, when we improve our transportation system, we improve our economic efficiencies.

- The majority of infrastructure changes will occur overseas where the infrastructure is not as well established in the U.S., and where the majority of economic growth will occur.

- Overseas growth will present great emerging markets for what we develop here, mainly systems, supplies, and components.

- We anachronistically manage people, work, and traffic as though we worked in the industrial age when people came to factories at set times. Congestion doesn't happen because of the numbers of travelers and vehicles, but because of the management of habits and patterns.

During the discussion of this paper, Dick Schwing of General Motors presented a chart of communication growth and transportation growth since 1900. The chart related the numbers of phone calls to kilometers traveled; communication and transportation growth have "dogged" each other closely over the years. Hallet pointed out that communication opportunities relate directly to increased mobility.

Sandra Rosenbloom, "Deployment of ITS; Implications for Working Women and Elderly Travelers"

Sandra Rosenbloom presented the transportation needs of working women and elderly, noting how they differed from the mainstream commuting population, which has mostly been defmed as male automobile commuters. Given the increase in working women and given the baby boomers shift into older age, ITS developers must recognize that the mainstream commuter is no longer the lone male auto commuter.

For example, she noted how a primary ITS focus, in-vehicle route guidance, is not a help to elderly or working women. Although these working women are highly reliant on cars, they are not capable of deviating their route, because of lifestyle responsibilities, such as grocery shopping, children, and elder care. In addition, although technology was becoming more familiar to elders, the general physiological reality is that reaction and comprehension time slows as we age. As a result, more technology in a car can be confusing for some elderly, despite their familiarity and comfort with it.

Rosenbloom went on to observe that women and their trip-chaining travel patterns have had a major impact on transportation over the last twenty years. In addition, as men take on more of the household responsibilities, trip chaining will become more a part of their behavior. These activities are not currently acknowledged in present ITS concepts.

During the discussion, Rosenbloom was asked about sensible options for transportation investments. She offered Europe as a good example since they design new systems with heterogeneity in mind. They don't assume, for instance, that the elderly respond to new systems in a similar manner as the rest of the driving population.

Alan Pisarski, "Urban Demography and Travel"

Alan Pisarski traced national commuting trends and presented a largely undiscussed topic: the impact of immigration. Immigrants instantaneously add new drivers to the road, and their settlement pattern is basically unknown. Pisarski presented three scenarios for ITS deployment and eight key elements that influence these scenarios. He also noted that as incomes rise, people consume more transportation as a percent of their income, but not in absolute dollars.

Steve Millet, Futures Modeling Technique

Steve Millet presented modeling techniques during lunch which prompted the afternoon discussion about transportation priorities. During the discussion, Millet solicited priorities from the symposium participants. From these priorities, Millet developed thirteen descriptors and input them into a futures model. These descriptors included: investment in ITS, integration of the National Information Infrastructure with transportation, consumer benefits of ITS, infrastructure costs, workplace concentration, business logistics, ITS leadership, protocols and standards, bandwidth availability, number of available products, cost of ITS, mobility, and safety. He then produced three scenarios, which were presented at the end of the day. These scenarios will be published in the symposium proceedings, which were unavailable at the time of writing.

General Discussion

In particular, the symposium coordinators hoped to elicit opinions on ITS from environmental and community development organizations. The groups represented included the Environmental Defense Fund, the AARP, the Bicycle Federation of America, and the Surface Transportation Policy Project (STPP). As voiced during the conference, the majority of these representatives believe that ITS has great potential, but fear that the definition of "commuter" was too narrowly defined. Social and demographic trends have changed this definition, and, therefore, travel needs have changed.

ASSESSMENT METHODS AND CRITERIA

For the most part, the ITS papers do not rigorously estimate societal impacts. As a result, the literature provides limited insight into possible social impact assessment methods.

The current state of the practice is discussed below with respect to three issues:

Issues
• Analytical Framework • Measurement Tools • Evaluation Criteria

Analytical Framework. The ITS community has yet to develop an assessment framework to examine potential societal implications. Barbara Richardson's paper, entitled "Socioeconomic Issues and Intelligent Transportation Systems," provides the most all-encompassing definition of a socioeconomic "system," consisting of society, the environment, demographic groups, as well as economic and political institutions. One study employs social decision analysis as a framework to compare electronic toll collection and dynamic route guidance from user and non-user prospective (Source: Chen and Reed, Richardson, Stafford)

Measurement Tools. The literature employs few rigorous methods to measure social impacts. Most quantified estimates are confined to tangible impacts, most notably travel time savings (Source: Boghani, Chen and Reed, Myers and Saunders, Stafford, Swedish National Road Administration et al). Walter Albers, at the request of ITS America's Societal Implications Task Force, developed an analytical tools inventory (provided in Appendix D). However, the utility of these tools cannot be assessed without first knowing the questions of interest. The ability to measure and quantify the social impacts of transportation projects will be the focus of a May 1995 workshop conducted by the University of Michigan.

Evaluation Criteria. Few papers use criteria to value ITS alternatives. Those papers that do typically employ traditional benefit-cost ratios (Source: Boghani, Swedish National Transport Administration et al). One study, however, uses social decision analysis to compare the impacts of electronic toll collection and in-vehicle navigation systems on users and non-users (Source: Chen and Reed). In general, the literature does not specifically resolve value conflicts resulting from differential allocation of benefits, disbenefits, and costs among different constituent groups.

ENDNOTES

1 Appendix B, untitled handouts from ITS Joint Program Office.

2 Christine Johnson, ITS JPO, presentation to Volpe Center staff, September 26, 1994.

INSIGHTS FROM CONVENTIONAL TRANSPORTATION STUDIES

INTRODUCTION

Many of the ITS user services, as shown in Appendix A, aspire to perform the same function as conventional transportation services, albeit more effectively. This section infers knowledge about ITS' potential societal implications by reviewing several social impact studies of conventional transportation services. In particular, a large body of research exists examining the impacts of specific transportation system changes on various income groups, the elderly, the disabled, users of specific modes, and residents of diverse geographic areas.

The Volpe Center's investigation of the conventional transportation literature indicates that societal impacts vary from project to project and location to location. This section documents our findings of inferred knowledge for six categories of ITS user services:

ITS Categories Compared
A. Traffic management systems B. Traffic information C. On-board vehicle systems D. Travel demand management strategies E. Emissions mitigation and detection systems F. Public transportation systems

For each of these ITS services, the Volpe Center identified analogous conventional services, reviewed social impact assessment studies of these analogous services, and developed empirical generalizations about:

- ***Susceptibility:*** The likelihood that different constituent groups will be affected by the transportation service.
- ***Attitudes:*** The perceptions by constituent groups about the transportation service.
- ***Impacts:*** The reported effects of the transportation service.

Because of resource and time constraints, it was not possible to fully saturate each topic area (e.g., transportation service, constituent group, impact area). Instead, this section is meant to demonstrate that ITS' large-scale (macroscopic) societal implications can be inferred from what is known about conventional transportation. As a result, the empirical generalizations presented in this report provide some insights, but do not divulge the entire breadth of knowledge about the potential social impacts of ITS user services or conventional transportation services.

A. TRAFFIC MANAGEMENT SYSTEMS

This section investigates the following analogous conventional transportation services related to traffic management systems:

ITS User Service	Conventional Service
• Traffic control	• Traffic control • HOV priority lanes • Traffic "calming"
• Incident management	• Incident management
• Electronic toll and traffic management	• Toll stations

General

<u>Susceptibility</u>

- Traffic management systems are typically disproportionately paid by non-drivers. For example, a Pasadena study reported that drivers paid for only 25 percent for vehicle-related services, including motorcycle patrols, details for auto theft, parking and traffic and road engineering. Another study found that the individual transportation costs for motorist are much higher than the price of gasoline, with several hidden costs associated with accidents, environmental damage, government tax breaks for oil companies, etc. (MacKenzie et al 1992; Conservation Law Foundation 1994).

- Traffic management systems favor drivers over non-drivers (Altshuler 1979).

- In 1979, pedestrian fatal accidents represented 35 percent of all traffic deaths in urban areas and urban pedestrian fatalities constituted 71 percent of all pedestrian fatalities. Over 25 percent of those killed and almost 15 percent of those injured in pedestrian accident were under 15 years of age. Those over the age of 60 represent the next largest group involved in pedestrian accidents (Public Technology Inc. 1981).

- Research performed in San Francisco neighborhoods indicates a “strong inverse relationship between social interaction among neighbors and the amount of traffic on the street.” Specifically, heavily traveled residential streets are more likely to attract short-term residents with fewer children than are less traveled streets (Appleyard et. al. 1976).

Attitudes

- A survey of 104 community leaders in Baltimore and Pittsburgh found that the major perceived transportation-related problems were: streets in poor repair, insufficient parking, excessive through traffic, and lack of transportation for the elderly and those without automobiles (Bish 1978).1

- A study of "livable streets," expressed a belief that traffic "has a pervasive and repressive effect. It dominates the street space, it penetrates right through the houses, it prevents neighboring, thwarts street play, interferes with the intimacy of the home, spreads dust, fumes, noise, and litter, forces rigid controls over children's behavior, frightens old people, and kills or maims a goodly number of citizens every year" (Public Technology Inc 1 982).2

- In a 1980 U.S. Census Bureau survey of housing in metropolitan areas, 46 percent of the 51,000 people surveyed reported that street noise was the single most undesirable neighborhood characteristic. In central city residential areas, this figure reached 5 1 percent In particular, several respondents considered street noise to be more significant than crime, trash and litter, or deteriorated buildings (Public Technology Inc. 1982).

- The 199 1 Harris Poll for Bicycling Magazine indicated that 49 percent of all active riders and 20 percent of all adults claimed that the presence of safe bike lanes was the primary factor in the decision to bike to work (FHWA 1993).3

- According to a study conducted by the University of California, street traffic may have an adverse effect on the resident's perception of the status of the street; residents may withdraw almost entirely from street life and residential land values may deteriorate. As a result, excess traffic on residential streets reduce community cohesion and diminish the quality of the social environment (Appleyard et. al. 1976).

Impacts

- As traffic levels rise, the street environment becomes increasingly hostile. This risk is dealt with by curtailing activities, particularly those of children. Social interaction among neighbors decreases as traffic levels rise and the residential make-up changes. Families with children move away from busy streets; elderly people become shut-ins (David 1992).4

- Traffic management system that make automobile travel more efficient will encourage individuals to change their housing and mode choices in ways that would exacerbate suburban sprawl and isolate central cities. In particular, these changes could worsen air pollution, encourage wasteful energy consumption, impose undue hardship for those without cars, and limit the urban poor's access to employment (Authors' synthesis of several studies).

- The proceedings for the 1992 policy conference, entitled *Edge City and ISTEA - Examining the Transportation Implications of Suburban Development Patterns,* note that the explosion of new office construction in suburban areas was primarily a function of changes in the economic base from industrial manufacturing to information-based "white collar" jobs, which lessened location restrictions. The relatively lower cost and abundance of land in suburbs also motivated business relocation. As a result, the participants acknowledged that the Intermodal Surface Transportation Efficiency Act, which promotes intermodalism and supports the use of IVHS user services, would have "some effect on urban development, but the economy over the next ten years will say as much about further development as the transportation bill"[5]

- A 1980 study examined the effect of the Interstate Highway System on local development and land use patterns from 1950 through 1975 for all non-metropolitan counties in the 48 contiguous states. The study, using multiple regression analysis, concluded that spatial development patterns were primarily influenced by five non-transportation factors, including urbanization, economic base, social base, government activities, and amenity resources. The study went on to state that "because development in a community appears to be triggered primarily by forces other than the Interstate Highway System, the degree of association between Interstates and the spatial pattern of development is very weak (1980 Briggs)."[16]

- A 1983 study found little evidence that land use patterns could conversely influence travel patterns.[7] He concluded that higher density land use did not effectively reduce car use and that moving jobs and homes closer together would not significantly reduce total travel (1983 Bland).

- Most people will be priced out of the housing market unless "mobility investments" make land further out from high priced central housing markets competitive with land close to major work areas (Reno 1988).[8]

- Peak noise levels vary directly with traffic intensity. Traffic noise levels typically double as vehicle speed doubles (Public Technology Inc. 1982).

- An active neighborhood street life can reduce neighborhood crime and increase feelings of security. However, some studies show that streets with greater automobile accessibility may be more susceptible to residential crime such as burglaries (Jacobs 1976).

- A study of two adjacent neighborhoods, similar in all respects except that one had a residential traffic management plan, found that over a thirty year period, residential property values increased substantially in the neighborhood with the traffic management plan over those in the other neighborhood (Bagby 1980).[9]

Traffic Control Systems

<u>Susceptibility</u>

- See general traffic management systems

Attitudes

- See general traffic management systems

Impacts

- See general traffic management systems

- In order to reduce accidents, clearance intervals (including the yellow change and all-red clearance intervals) at signalized intersections must be long enough to enable bicyclists and pedestrians and elderly to cross safely, but not so long that they cause undue delay or unsafe conditions for automobiles (Taylor; Zegeer et al).

HOV Priority Lanes

Susceptibility

- The susceptibility of different groups to HOV priority systems will depend on the type of preferential treatment provided: 1) economic (preferential toll charges, preferential freeway congestion pricing, preferential parking pricing); 2) convenience (park & ride lots, preferential parking); 3) space (exclusive freeway ramps, transit malls, auto restricted zone, reduced parking with priority, turning movement restrictions); 4) time (separate roadway, contraflow freeway preferential lane, contraflow arterial preferential lane, concurrent flow freeway, concurrent flow arterial, exclusive bypass ramp, preferential bypass at a metered ramp, toll facility preferential lane, signal preemption) (Batz 1986)[10]

- Downtown commuters have typically been the main users and beneficiaries of HOV lanes and freeway project. This group is generally affluent and able-bodied (Altshuler 1979).

- The equity implications of HOV lanes depends on the degree to which they benefit all vehicles more or less equally, discriminate in favor of high occupancy vehicle users without imposing noticeable costs on other travelers, or discriminate in favor of HOV users and or pedestrians at some obvious cost to other travelers (Altshuler 1979).

Attitudes

- One community organization, the Chicago Institute on Urban Poverty, asserted that ISTEA's Congestion Mitigation and Air Quality Improvement (CMAQ) Program funds should support van or car pooling linking inner city workers to suburban jobs. They also asserted that these programs would be more effective in reducing automobile emissions than by adding HOV lanes to the region's congested highways (Chicago Institute on Urban Poverty 1994).[11]

- A 1988 survey performed by the Washington State Department of Transportation found that 84.6 percent of respondents felt carp001 lanes in the Seattle area were good ideas. Most of those sampled agreed that HOV lanes saved time for people who used the lanes (96 percent). The majority of those sampled also felt that HOV lanes did not worsen traffic in other lanes, were not unfair to drivers who could not use them, and did not increase the number of accidents. Only 39 percent of the sample felt that HOV lanes reduced traffic congestion in all lanes, approximately the same percentage that believed that HOV lanes did not reduce air pollution (Jacobson et al).[12]

- Interviews with twelve planning organizations found general agreement that high occupancy vehicles should be given preference. However, preferential treatments were not given high priority in the development of comprehensive transportation systems (Batz 1986).[13]

- A 1992 Southern California study surveyed 1,306 commuters who used freeways; 33 percent of these commuters had access to HOV lanes. Of the individuals who had access to commuter lanes, 34 percent used them. Of those who used the commuter lanes, 85 percent believed that the lane saved time on the average of 18 minutes with a median response of 15 minutes. Those who did not have access to commuter lanes on freeways were asked if the availability of these lanes would encourage them to carpool; 54 percent considered the lanes an encouragement (Collier and Christiansen 1 992).[14]

<u>Impacts</u>

- HOV lanes will likely not improve aggregate traffic congestion. However, they can reduce congestion for HOV occupants, but often at the expense of other travelers, except where the HOV vehicles are utilizing new or previously underutilized lane capacity (Altshuler 1979).

Traffic "Calming"

<u>Susceptibility</u>

- Traffic calming studies show that they must be implemented as area-wide strategies to avoid pushing congestion, accidents, and pollution onto neighboring areas. Preferential traffic management and traffic restrictions could enhance pedestrian and residential quality of life at the microscale level (FHWA 1990; Altshuler 1979).

<u>Attitudes</u>

- See general traffic management

<u>Impacts</u>

- Pedestrian amenities have positive impact on downtown sales, but will not likely substantially impact overall downtown development trends. Similarly, traffic restrictions in residential may significantly improve pedestrian safety and reduce noise (Altshuler 1979).[15]

Incident Management

See general traffic management systems

Toll Collection Stations

See general traffic management systems and travel demand management (congestion pricing).

B. TRAFFIC INFORMATION

This section investigates the following analogous conventional transportation services related to traffic information systems:

ITS User Service	Conventional Service
• En-route driver information • Traveler services information	• Traffic information

Susceptibility

- Consumers are often segmented by the traffic information industry into several categories according to travel-purpose, income, and occupational characteristics (The Volpe Center 1994).

- The mass broadcast media targets the largest segment, which is composed of commuters to and from work on a schedule that approximates a 9 to 5 workday. The majority of these commuters travel by private automobile, are employed, and reoresent "every major U.S. occupational, social, and ethnic group" (The Volpe Center 1994)

Attitudes

- Consumers use travel information for reasons of enhanced mobility and increased perception of control. Surveys have shown that availability of traffic information helps to eliminate aggravation with congestion (The Volpe Center 1994).[17]

Impacts

- The research has been inconclusive in describing the ability of mass traffic information to influence traffic congestion or affect air quality, safety, or productivity (Authors note).

C. ON-BOARD VEHICLE SYSTEMS

This section investigates the following analogous conventional transportation services related to on-board vehicle systems:

ITS User Service	Conventional Service
• En-route driver information • Route guidance • Collision avoidance • Vision enhancement • Incident management	• Pave safety devices • Speed limiters

<u>Susceptibility</u>

- Susceptible groups include primarily affluent drivers, who could benefit from productivity gains and enhanced mobility and safety.

- A study of automobile prices between 1960 and 1980 found that roughly two-thirds of the regulatory costs were passed on to consumers after one year, although these costs were absorbed immediately by the automobile companies. Eventually the price of cars reflects the full estimated cost of regulation (Crandall et al 1986).18

<u>Attitudes</u>

- The Traffic Safety Group of the Department of Transport Planning and Engineering at the Lund Institute in Sweden investigated the safety implications of speed limiters in cars. These devices automatically limit the vehicle's maximum speed to a specific speed limit. The study found that test drivers believed that their behavior toward pedestrians became less responsible (Almqvist et al. 1991).19

- Market research data based on participants recruited from 8,000 households in Santa Clara, California found that avid users of cruise control valued it as a driving aid more than as a means to relax and, as a result, had little interest in more advanced automated controls. In addition, less frequent users were attracted to automated controls because of the "increased safety benefits they could provide in emergencies, although the users expressed concern about reliance on those automations in inappropriate circumstances" (Turrentine et al. 1991).20

- The willingness to pay for safety systems in automobiles has usually been low, with some more pronounced preference for systems, even passive belt systems, among some buyers of higher-priced cars. However, as noted by one study, "most car buyers not only fail to purchase additional safety equipment but refuse to use the manual belt systems that they have been required to purchase" (Mashaw and Harfst 1990)21

Impacts

- Rush-hour driving strategies that maximize an individual driver's convenience may contribute to overall congestion (Arnott and Small 1 994).22
- Time-series evidence shows that inherently safer cars decreased the fatality rate for passenger-car occupants substantially, but they may have had some detrimental impact on pedestrians, bicyclists, and motorcyclists due to offsetting behavior by passenger-car drivers.23 Other studies have shown that the presence of safety systems in cars do not compel riskier driving (Crandall et al 1986).
- In 1981 dollars, air bags added $200 to 400 more per car, although the lifesaving effectiveness rate is less than that for passive belts. In 198 1 dollars, NHTSA regulation adds $700 to $1000 per car to perhaps as much as $900 to $1400 per car (Crandall et al 1986).24
- A study of 105 subjects found a strong positive correlation between driving performance and vision factors of depth perception and peripheral vision. However, the study did not find a correlation between chronological age and driving behavior (Tarawneh 1 994).25

D. TRAVEL DEMAND MANAGEMENT

This section investigates the following analogous conventional transportation services related to travel demand management systems:

ITS User Service	Conventional Service
• Pre-trip travel information	• Pre-trip travel information
• Ride matching and reservation	• Ridesharing programs
• Demand management and operations	• Congestion pricing • Parking restrictions

Pre-Trip Travel Information

No conventional transportation studies were found documenting the influence of pre-trip travel information, except with respect to findings already presented for impacts of traffic information. However, the means by which information will be disseminated will affect access to information.

Ridesharing Programs

Susceptibility

- A survey performed for the Federal Highway Administration revealed that ridesharers' average income was relatively high; 90 percent of respondents' had personal incomes of more than $15,000 while 60 percent had incomes of more than $25,000 annually (Ayele and Byun 1984).

- In low-density areas, carpooling is attractive, particularly to lower income groups, because of its lower costs (Zupan 1992).

Attitudes

- A 1980 survey conducted by the MTA found that 52.1 percent of the respondents joined carpools for primarily economic reasons. Another survey conducted in 1981 by the Maryland DOT discovered that 61 percent of the commuters were primarily interested in the cost savings provided by vanpooling, specifically savings for gasoline, parking, and vehicle repairs. Only 4.5 percent reported that they joined a carp001 to avoid owning a car while another 1.3 percent indicated they joined a carp001 to meet people (Ayele and Byun 1984).[26]

- It is unclear whether attitudes about ridesharing influence mode choice behavior or whether attitudes change as a result of changes in behavior. One study found that solo drivers held more extreme views about ridesharing than did active carpoolers. For example, solo drivers and carpoolers both believed that carpooling limited independence, but the solo drivers held stronger negative opinions. Both groups also perceived that car-pooling increased fuel savings, but the carpoolers valued the savings to a greater degree (Brunso et al. 1979).[27]

- The economics of carpooling are perceived favorably by carpoolers and non-carpoolers alike, but do not influence behavior. As a result, promotional strategies that stress the positive economic benefits of carpooling may not be effective in changing carpooling behavior (Brunso et al 1979).[28]

Impacts

- An analysis of three roadway corridors in the New York region calculated that 38 percent of drivers of single occupancy vehicles would need to form four-person carpools to bring the highway level of service to D, where F is the most congested (Zupan 1992).

- As noted by Altshuler, "substantial increases in ride sharing have been achieved only where employers have played vigorous promotional and organizing roles or with preferential road treatment. By contrast, regionwide publicity campaigns and offers of free matching service aimed directly at commuters has been almost without impact" (Altshuler 1979).

Congestion Pricing

Susceptibility

- Susceptibility of various groups to congestion pricing will be a function of the pricing schedules by time of day, day of week, vehicle occupancy, and vehicle type (Zupan 1992).

- The perceived "winners" of congestion pricing include: 1) motorists who remain on the tolled road and place a higher value on the travel time savings than the price of the toll; 2) travelers in bus or HOV lanes who benefit from improved speeds while paying little or no toll; 3) taxpayers, if tolls reduce the their tax burden; or 4) the clients of government programs, if tolls are used to finance an expansion of government services. Other beneficiaries might include current operators and users of HOV lanes and businesses that rely on deliveries (FHWA 1993).

- The perceived "losers" of congestion pricing include: 1) motorists who remain on the tolled road and place a lower value on travel time savings; 2) motorists who shift from the tolled road to a competing untolled road; 3) other users of the competing, and now more congested, untolled facility; and 4) motorists who choose not to make the trip at all or drive at a less convenient time of day because of the toll. Other losers might include those who cannot afford to pay the increased tolls and perhaps businesses in the vicinity of the priced roads (FHWA 1993).

- Because the above winning or losing groups are not disproportionately rich or poor, the "progressivity of congestion pricing will depend on the compositions and relative sizes of the several groups as well as the relative sizes of their gains and losses." Of particular importance is who will receive the toll revenues (Gomez-Ibanez 1993).29

- Congestion pricing may hurt road users on average. Absent compensation, nearly all users of the transportation system are made worse off by congestion pricing. As discussed by one researcher, "only a fraction of drivers who value their time will feel that their time saved is worth more than the toll; the vast majority will be made worse off. Those who are tolled off experience reduced welfare because they are forced to travel by a less preferred mode or route, or at a less preferred time of day. Those who are on public transit may be made worse off, because of more crowded buses and subways" (Hau 1993).30

Attitudes

- Participants at an FHWA seminar expressed concerns about the possible negative effects of congestion pricing. Concerns were expressed abut the effects of congestion pricing on low income groups, on people with limited transportation alternatives, or on businesses, particularly those which depend heavily on road use. The participants agreed that further work is needed to better identify groups that would be adversely affected by congestion pricing and to examine compensation schemes that might be used to mitigate those impacts (FHWA 1993).31

- Full-scale congestion pricing has been implemented only once, in downtown Singapore. In the 1970s, many cities evaluated congestion pricing proposals and universally rejected them. UMTA supported the U.S. studies and offered to fund demonstration projects. Because of local opposition, however, no city accepted UMTA's offer. Opposition was attributed to: anticipated and undesirable impacts on driver patterns, doubts about technological feasibility, legal barriers and concerns about invasion of privacy related to automatic toll collection, possible averse impacts on the poor and businesses, and the feeling that congestion was not severe enough to warrant such an extreme measure (Bhatt 1993).

- In the 1970s, UMTA attempted to implement areawide congestion pricing by using windshield stickers similar to those used in Singapore. Of the 12 cities invited to participate, Boston, San Francisco, Berkeley, Ann Arbor, and Honolulu responded. Because of strong local opposition, the projects never progressed beyond the planning phase. No demonstrations were performed. The issues that defeated the project were the potential impacts on low-income commuters, the concept of freedom of the road, legal and enforcement issues, and possible adverse effects on business (Arrillaga 1993).

<u>Impacts</u>

- The effectiveness of congestion pricing will be influenced by the price elasticities for the following behavior: shifts of traffic to different time periods and modes as well as the elimination of some traffic. Potential measures of effectiveness could be: vehicle hours of delay reduced, distribution of VMT at varying levels of service, emission reductions, and revenue gained and lost be type of user (SOV, carpooler, truck) (Zupan 1 992).32

- Although congestion pricing can be easily implemented technically, it may not lead to the desired reductions because commuter traffic demand appears to be highly price inelastic. Studies indicate that commuters are willing to pay tolls as high as 25 cents/mile to save time (Steiner 1992).

- To operate successfully, a congestion pricing system must be able to collect charges and cite violators without significantly slowing traffic (Bhatt 1993).33

- A 1978 study for downtown Boston suggested that road pricing of $1.00 to $2.00 per day on local streets in the 3.5 square-mile central area would drop peak period automobile trips and VMT by up to 50 percent; transit trips would increase by more than 40 percent; and traffic speeds would increase as much as 150 percent. On the regional level, the VMT reductions could be up to 10 percent. The study implies that "50 percent-or-greater reduction in CO emissions in the Central Area, as much as 11 percent reduction in regional hydrocarbon emissions and up to 109 percent reduction in the regional fuel consumption. These prices also could generate as much as 20 million dollars annually in new revenues. The annual costs, not estimated in the he study, might be on the order of $2.0 million" (FHWA 1 993).34

- A model-based study for the Los Angeles Basin suggested that a $5.00 road use charge could cut peak period traffic by roughly 25 percent, at a system cost of $0.15 to $0.309 per trip. As a result, regional traffic and related emissions would be reduced by 4.5 percent (FHWA 1993).35

- A 1986 study of area-wide congestion pricing for the area south of 64th Street in Manhattan estimated that a daily price of $5.00 per automobile entering the areas between 6 a.m. and noon could reduce the six-hour trips entering into Manhattan by 20 percent. As a result, total daily trips to Manhattan would be reduced by 3.7 percent. The program could generate over $100 million in annual revenues at a start-up cost of $12 million and an annual operating cost of under $10 million (FHWA 1993).36

- In the 1970s, the Urban Institute appraised the potential impacts of congestion pricing in six U.S. cities. Their assessments suggested that a daily peak period charge of $2.00 for downtown would reduce peak period trips by 25 percent, and generate annual revenues of $5 to $10 million at an annual cost around $0.5 million (FHWA 1993).37

- New York, Los Angeles, San Francisco, and Seattle have recently completed or are currently conducting studies (Bhatt 1993).38

Parking Restrictions

<u>Susceptibility</u>

- The most susceptible group are drivers, particularly single occupancy vehicle commuters to work places located in high-density areas.

<u>Attitudes</u>

- The ratio of parking spaces to office floor space has traditionally been set in suburban developments at four spaces per 1,000 square feet of office space, reflecting the assumption that the average employee occupies 250 square feet and that one parking space is needed for each employee. Financial institutions typically favor developers who use this ratio. In addition, suburban thinking about parking access pervades urban planning. For example, Newark, a city with extensive transit service, attempted to require the same high 4:1,000 ratio (Zupan 1992).

- Where pervasive parking charges exist, employers provide parking spaces to commuters as an employee benefit. A 1990 study performed by the Metropolitan Washington Council of Government found that in the central business district, 38 percent of those who drove to work received free parking while 62 percent paid full or discounted rates. In the outlying business districts, 67 percent of commuters parked for free. For the entire region, 82 percent of the commuters parked for free. Employers had strong economic reasons for offering parking benefits, even when spaces cost as much as $150 per month. These reasons included elimination of taxes, social security liabilities, and cost-of-living adjustments for bonuses and beliefs that employees with a parking place may be better able to work extra hours (Williams 1993).

Impacts

- Parking price and availability is a critical consideration in a traveler's decision on how to make a trip. In those situations where parking is unrestricted, efforts to reduce single occupancy vehicle trips is significantly compromised (FHWA 1993).

- Tailoring the parking to office space ratios to the amount and availability of public transportation, with lower ratios where transit is widely available could be an effective means of controlling unnecessary driving (Zupan 1992).

E. EMISSIONS MITIGATION AND DETECTION SYSTEMS

This section investigates the transportation services related which employ infrared remote sensing and light detection and range (LIDAR) emissions and air quality measurements.

Susceptibility

- The primary group affected are owners of super-emitting automobiles. Remote sensing studies show that less that 10 percent of vehicles are responsible for 50 percent of carbon monoxide emissions. However, new cars as well as old can emit high emissions.

Attitudes

- Sunoco offered drivers of 1,700 high-emission cars free exhaust system repairs if they would participate in a program worth up to $450 in savings and $100 cash. Only 18 percent accepted. The company believed the poor acceptance rate was due to distrust of the oil industry and general apathy to environmental issues.[39]

Impacts

- A 1994 study by Sierra Research, Inc., entitled *Analysis of the Effectiveness and Cost-*effectiveness of *Remote Sensing Devices*, states that "the wide-spread use of RSDs [remote sensing devices] to screen vehicles...or to replace a conventional I/M program decreases the emission reductions that would otherwise be achieved."[40]

F. PUBLIC TRANSPORTATION SERVICES

This section investigates the following analogous conventional transportation services related to public transportation systems:

ITS User Service	Conventional Service
• Management improvements	• Management improvements
• En-route transit information	• Static transit information
• Personalized public transit	• Paratransit services
• Public travel security	• Security improvements

Management Improvements

Management improvements include methods that could be used to increase ridership and service quality by affecting one or more of the following: vehicle arrival time at trip origin and destination, wait time, in-vehicle travel time, physical safety, seat availability, headway, en-route breakdowns or delays, information, vehicle cleanliness, and vehicle no-shows.

Susceptibility

- Studies indicate that higher income groups may have benefited disproportionately from transit subsidies. The studies note that the poor constitute a disproportionately large share of bus passengers, but are underrepresented on rapid transit and commuter rail lines, two services that generally receive the highest level of capital assistance (GAO 1985; Taylor 199 1; Altshuler 1979).

- A possible measure of transit's ability to provide mobility to low-income persons might be the number of transit stops located within certain distance of low-income populations. However, such criteria do not consider other factors, which can also affect the mobility of low-income persons, such as service frequency, service cost, and the destinations that can be reached by transit service (GAO 1985).

Attitudes

- Transit travel time is composed of two elements: ride time and access/wait time. Transit ride time is related to the vehicle operating speed while access/wait time is a function of the density of the route network, the frequency of service, and the provision of effective transfer options. Research suggests that travelers view these times differently; access/wait time is seen as roughly 2.5 times more burdensome than ride time (FHWA 1993).

- Transit reliability is a serious and complex problem as perceived by transit operators (Abkowitz 1983).

- In 1983, Charles River Associates conducted a non-random survey of the actions being taken by 26 transit authorities to improve performance. The study identified 256 examples of 146 different actions underway (or recently completed) by transit operators around the country. Most of the actions (about 71 percent) concerned "production efficiency." Another 19 percent of the actions sought to reduce factor prices, such as the cost per labor hour, 7 percent focused on improved service designs, while the remaining 3 percent proposed changes in service pricing (UMTA 1987).

Impacts

- Studies indicate that increases in service quality or reduced travel time may have a greater effect on ridership than fares. For example, as reported by the GAO, offkials in four systems stated that service quality influenced ridership levels. MBTA noted that reliability problems between 1980 and 1982, where the percent of missed trips increased from 2.21 to 3.58 percent, contributed to a drop in ridership from about 158.3 million to 144.4 million. As another example, APPTA stated that reliability and convenience were the most critical factors attracting transit riders (GAO 1985).

- Transit ridership is significantly influenced by uncontrollable factors, including changes in the size or location of the population, changes in or relocation of employment centers, and fluctuating gasoline prices. In addition, parking fees negatively influence transit ridership (GAO 1985).

Static Transit Information

Susceptibility

- Information programs which assume a relatively high mental ability will probably be inadequate for many travelers: the infrequent rider, young, physically handicapped (speech, hearing, sight, arthritic), and poor (Guran 1971).

- One Nashville study reported that their transit information service was used infrequently and in a very simple manner by poor blacks asking questions about bus scheduling. In contrast, affluent white patrons who were temporarily without their cars asked more frequent and detailed questions (Guran 1971).

Attitudes

- A survey of elderly transit riders found that 48 percent stated that they would ride the bus more often if they had more information about when the bus comes and where it goes (Patterson and Ralston 1983).

- A Chicago study indicated that users and potential users would use transit more extensively if they were more confident in their knowledge about how and where transit operates (Soot 1983).

Impacts

- No findings are reported since empirical studies did not quantify impacts of public transit information.

Paratransit Transit

Susceptibility

- Demand-responsive transit can meet the needs of various income groups. Although conventional fixed route transit may be equipped to handle handicapped riders, some individuals are unable to get to transit stops to use the service (Guran 1971; Altshuler 1979; GAO 1985).

- The primary difficulty for groups to use demand-responsive transit involves access to phones and computers. For example, a 1971 study of a dial-a-ride service in the Boston area reported that roughly 82 to 84 percent of households in poverty areas such as Roxbury and North Dorchester, and the South Boston, had telephone service, compared to 97 to 98 percent of household in other areas. The gap may be due in part because of the higher number of vacant dwelling units in the poorer areas (Guran 1971).

- Overall, roughly 10,000 community transit systems serve more than 15 million people every year. Community transportation has become a $2 billion industry, employing more than 50,000 buses, vans and other vehicles (Margolis 1992).[41]

Attitudes

- A 1981 survey conducted by the U.K. Department of the Environment found that the elderly were generally enthusiastic about a demand-responsive transit service, ReadiBus. The study also revealed increased mobility and a latent demand for travel for the elderly (Bowlby et al 1981).[42]

- The same U.K. study also found that the ReadiBus service provided benefits to non-users, particularly care-givers who assist the disabled and elderly (Bowlby et al 1981).

- Non-users are often in the highest income brackets and already have sophisticated travel demand characteristics involving private automobiles. Latent demand for demand-responsive transit is typically very low for this group (Bowlby et al 198 1).

- Despite user benefits, interviews with both elderly and younger disabled non-users indicated that the financial costs of Readibus outweighed its advantages. In addition, other users noted that the time and effort required to book the service were disincentives to use (Bowlby et al. 1981.

Impacts

- Demand responsive transit does not have great potential for alleviating transportation problems other than equity. DRT service expansion requires increased energy consumption and emissions. In addition, because the services are operated primarily in low-density areas, they serve few commuter trips. Their primary impact will be influenced by local planners decision to use demand-responsive transit as a community luxury or to promote equity (Altshuler 1979).

Public Transit Security

Susceptibility

- All transit users

Attitudes

- Concern about personal security in public transit facilities is particularly pronounced among elderly. A 1983 study of Philadelphia's elderly bus users revealed that most were concerned about going to and from stops and not so fearful while on the buses. A 1978 survey conducted by AARP of 20,000 elderly in Northeastern cities found that more than 66 percent indicated that they were afraid of crime while traveling. Most of the fear related to inadequate police protection and lack of bus dependability (Patterson and Ralston 1983).

- In April 1993, bus riders and residents in Greensboro, North Carolina, were surveyed to determine attitudes, ridership levels, and motivations for riding the bus. Resident concerns about personal safety were two to three times greater than riders' concerns, but both groups were less concerned about personal safety on or near the bus system than about general safety in the community. Both residents and riders saw the major bus-related problems as disorderly conduct, drunkenness, and panhandling. More than 50% of residents took precautions to protect personal safety; women were more cautious than men. The study concluded that reduced concerns about safety would not increase bus ridership as much as \ basic service improvements (Ingalls et al 1994).43

- A survey of 500 riders in Charlotte, North Carolina revealed that transit use rates and certain safety-related measures are related, but only mildly. Transit use would probably not increase substantially if these public transit implemented security measures. In addition, the study found no link between ridership and crime perceptions (Hartgen and Owen 1994).44

Impacts

- The impact of public traveler security on ridership is largely unknown. However, transit use will remain low as long as potential users are apprehensive about safety, particularly among the elderly and the disabled (Altshuler 1979).

- As stated by one study “transport innovations only make sense if they are linked with other policy developments. For example, it is of little benefit to riders if they are deposited in central city areas in which wheel chair access has not been provided or, more fundamentally, if they lack sufficient disposable income to allow them to buy goods on a shopping trip” (Behnke and McLeod).

- The effectiveness and efficiency of a demand responsive transportation system for elderly and disabled depends heavily on the vehicle dispatching scheme, which affects operating efficiency, operating costs, vehicle and driver requirements, and passenger satisfaction. For example, in 1983, the Delaware Administration for Specialized Transportation’ found that 35 percent of total annual vehicle miles for its paratransit service were empty while 50 percent of annual driver hour were empty travel or spent idling (Shinya).

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CONCLUSIONS

This section summarizes key findings, identifies research needs, and recommends specific actions to better comprehend the societal implications of ITS user services.

FINDINGS

Knowledge of ITS Societal Impacts is Insufficient

The 30 ITS papers we reviewed for this report are highly exploratory. There is no consensus on what and who should be evaluated, although most of the papers focus on community constituents (the public) rather than institutions (industry, academia, government, etc.). As a result, the literature does not offer a comprehensive framework to assess ITS societal impacts. The literature also does not resolve whether ITS is expected to have a positive, neutral, or negative social impact. However, several papers express concern that there will be inevitable unintended, potentially negative consequences if designers and deployers of ITS user services do not involve diverse constituents in decision-making or acknowledge their specific needs.

The DOT has invested significant resources evaluating ITS impacts and costs. Although aggregate benefits, disbenefits, and costs of ITS user services are better understood, little is known about how they will be distributed among specific constituents at the community level. Furthermore, there is a pressing need to more formally identify alternative futures of ITS deployment that illustrate most likely as well as preferred outcomes.

By mapping societal impacts, community constituents, and organizations discussed in DOT's 1994 *Strategic Plan* and *the* May 1994 Draft *National Program Plan on IVHS* this paper identifies certain equity issues that may affect community constituents as the most important set of issues to address in this study. Constituent groups of concern include users and non-users of transportation services, income classes, geographic areas, elderly, disabled, and users of different travel modes. The equity issues of concern include economic, environmental, physical, and psychological impacts.

There should be explicit consideration of the distribution of potential ITS benefits, disbenefits, and costs among various users and non-users of ITS user services. Exhibit 8 displays proposed analysis boundaries, which identifies relevant constituents, ITS user services, and impacts. The primary research focus should be income, elderly, and disabled groups, stratified by ITS use/non-use, mode of travel, and geographic location (urban/suburban/rural). Race and gender issues are also important demographic groups. We also propose to stratify elderly and disabled groups by

Exhibit 8

Proposed Analysis Boundaries

CONSTITUENTS:

National
- income
- Elderly/Disabled
- Mode Use
- Suburban/Urban/Rural
- Users/Non-users

Income
- Mode Use
- Suburban/Urban/Rural
- Users/Non-users

Elderly/Disabled
- Mode Use
- Income
- Suburban/Urban/Rural
- Users/Non-users

ITS USER SERVICES:

Travel and Traffic Management
- En-Route Driver Information
- Route Guidance
- Traveler Services Information
- Traffic Control
- Incident Management
- Emission Testing & Mitigation

Travel Demand Management
- Pre-Trip Travel
- Ride Matching
- Demand Management

Public Trans. operations
- Public Trans. Mgmt
- En-route Transit Info
- Personalized Transit
- Public Travel Security

Electronic Payment
- Electronic Payment Services

Emergency Management
- Emergency Notification and Personal Security
- Emergency Vehicle Management

Advanced Vehicle Safely Systems
- Collision Avoidance
- Vision Enhancement
- Pre-crash Restraint
- Safety Readiness

IMPACTS:

Economic
- Equity
- Access to Basic Needs
- Affordability/Costs of IVHS
- Productivity

Physical and Psychological
- Safety from accidents
- Personal security
- Travel stress

Environmental
- Air pollution
- Traffic congestion
- Energy use
- Sustainability

Social
- Mobility
- Choice
- Community Cohesion

income. Because the three demographic groups are stratified by mode and geographic area, this will reveal ITS impacts on non-motorized travelers and non-urban areas.

Three Key ITS Societal Issues: Functionality, Accessibility and Usability

Three key issues factors will determine the nature and magnitude of ITS societal impacts: their function and objectives, their accessibility, and their usability.

Functionality: Although ITS user services will likely create new markets for specialized information and products, many services improve the efficiency of conventional operations without altering their basic objectives. Only automated highway systems would represent a major shift in transportation infrastructure and function. A key issue is to what extent ITS will create new, stand-alone services as opposed to augmenting existing conventional transportation services. For example, will the possibility of personalized public transit increase *the quantity* of paratransit services or exclusively improve *the quality* of an already present paratransit service. Additionally, will the availability of technologies, such as automated vehicle identification enable the implementation of travel demand management strategies, such as congestion pricing?

Accessibility: Accessibility refers to an individuals ability to obtain ITS user services. Access will be influenced by several factors: market penetration, access to technologies and products that communicate ITS information, local transportation priorities, costs and financing, and public availability of ITS user services. ITS' societal impacts, particularly its distributive impacts, will be largely influenced by who has access to which ITS user services. However, restricted private ownership of ITS services may or may not preclude large-scale societal benefits. For example, a few individuals who drive vehicles equipped with on-board route guidance and crash avoidance systems may experience improved mobility, fewer accidents, and less wasted time. As a result, use of these products have advantages for the individuals, but will not likely benefit other members of the public. However, when a critical number of private individuals own technologies that enhance their individual mobility, safety, and productivity, other individuals without the technologies may also indirectly experience similar benefits. However, access to conventional transportation services varies significantly among different groups of community constituents (e.g., income, elderly, disabled, etc.). These groups have diverse needs and often respond differently to changes in the transportation system.

Usability: The concept of usability embraces three questions about ITS:1) will it be used?; 2) is it capable of being used?; and 3) how will it be used. First, ITS user services must be relevant to specific needs if it is to be useful. In addition, in many cases the public must be willing to use "interfacing" technologies and products (such as personal computers and cellular telephones) to obtain ITS information. Secondly, aside from its utility, certain constituents may be unable to use ITS user services because they are poorly designed for their physical or language difficulties Finally, ITS societal impacts will be largely determined by whether constituents change their travel behavior as a result of ITS deployment. Again, members of different demographic groups have distinct characteristics that will affect how or if they use ITS services.

The Need for a Social Impact Assessment Approach

As discussed in Chapter 5 "What is a Societal Evaluation," there is a need for ITS research to move beyond traditional cost-benefit analysis to address distributive impacts as well as to acknowledge those intangible, but important, impacts that are not easily quantified or monetized. These issues are best addressed using social impact assessments, which build upon cost-benefit analysis. However, it is important to consider the relative value of using technical information to address societal issues. Who directs the analysis will likely influence the results.

The Need to Identify Program Priorities and Federal Role

The DOT's societal goals and its intentions should be more explicitly stated to guide ITS societal research.

RESEARCH NEEDS

As a result of our findings, the following research needs are identified:

ITS Societal Research Needs
1. Identify societal goals and evaluation criteria
2. Identify relevant impacts and constituent groups.
3. Develop alternative futures of ITS' potential role in supporting transportation and social needs.
4. Identify or develop methods to assess how ITS user services will impact societal welfare.
5. Identify how the DOT can design or administer ITS user services to increase benefits and eliminate or ameliorate disbenefits.

1. Identify societal goals and evaluation criteria

- *Clearly define the societal goals of the ITS program*

- *Identify criteria that can resolve value conflicts created by ITS deployment*

2. Identify relevant impacts and constituent groups

- *Societal research should address the distribution of ITS social impacts among community groups.*
- *Societal research should address ITS potential impacts on economic development and US. industry*
- *Evaluators should collect and review the most recent results of ITS cost-benefit analyses in order to strengthen the foundation of societal research*

3. Develop alternative futures of ITS

- *The DOT should identify most likely deployment scenarios for diverse metropolitan areas*
- *The DOT, with assistance from community constituents andprivate sector organization, should generate preferred ITS deployment scenarios.*

4. Identify or develop methods to estimate ITS societal impacts

- *A framework is required to assess equity impacts among community constituents*
- *A framework may help identify how ITS could impact economic development and industrial competitiveness*
- *Evaluators need to identify or deveiop methods to measure ITS' social impacts*
- *Societal evaluations should be address micro-level impacts since macroscopic analyses will likely return superficial results and mask real issues*
- *Societal evaluations should acknowledge that deployment characteristics will vary from region to region.*
- *Large demographic groups should be stratified into relevant subgroups.*

5. Identify mechanisms to increase societal benefits or ameliorate disbenefits for constituents

- *Societal research should identify opportunities and variables that can be leveraged or controlled to achieve desirable outcomes*

- *Find opportunities and forums for public participation and interaction in decisionmaking*

RESEARCH ACTIONS

Based on the above research needs four specific research actions are recommended

ITS Societal Research Actions
1. Commission white papers clarifying key ITS societal issues. 2. Develop and implement proactive outreach to grassroots transportation and community development groups and local government officials. 3. Develop case studies of how ITS deployment could impact diverse constituents. 4. Design programs and mechanisms that the DOT can leverage to achieve societal goals.

1. White Papers

Further research in the form of a small number of well focused white papers clarifying key ITS societal issues will be critical to tilling existing knowledge gaps. The areas requiring further investigation are 1.) the identification ITS Program's societal goals and objectives, 2.) ITS functionality, accessibility, and usability and their societal implications, 3.) a framework for estimating ITS societal impacts, and 4.) identifying the U.S. DOT role for achieving societal goals.

Additional effort is needed to identify the DOT's societal goals and objectives in the context of the various ITS Joint Program Office's projects and programs. It is necessary to further describe which constituents are important as well as how the Department values transportation alternatives.

A white paper identifying and discussing ITS functionality, accessibility, and usability from the perspective of diverse demographic groups is recommended to access what factors will determine how these groups access and use ITS user services. This paper should explore the implications for equitable distribution of ITS impacts across the population?

In the development of a framework for measuring the distribution of impacts among users and non-users of ITS user services the paper should identify and, if necessary, develop methodology and appropriate criteria for deciding whether ITS deployment will have beneficial, neutral, or detrimental social impacts for diverse constituents groups. The paper should also identify how published literature, secondary data, and primary data can be used to conduct ITS societal evaluations.

It is also recommended that additional consideration be given to the question of how the Federal DOT can support constituents and local governments in ensuring that ITS deployments result in desired and equitable social outcomes.

2. Develop an Public Involvement Plan to Reach Diverse Constituents

The DOT and other organizations involved in ITS should develop an effective public involvement plan to reach potentially affected publics. Three possible forums include: 1) informational presentations at conferences addressing transportation and community needs, such as the November 1994 conference on "Transportation, Environmental Justice and Social Equity," which was sponsored by the Surface Transportation Policy Project and various DOT administrations; 2) workshops with the objectives of discussing values, transportation needs, transportation alternatives, expected impacts, preferences, and mechanisms to increase societal benefits and ameliorate disbenefits; and 3) forums for providing feedback on DOT societal research to community groups and local planners.

3. Develop Case Studies

Case studies should be developed to identify impacts on specific groups such as income groups, elderly, disable, users of different travel modes, and different geographic areas. The cases could focus on areas currently involved in ITS deployment planning and have different demographic, economic, and transportation characteristics. Potential cases could include: 1) northeastern, high-density urban area with extensive transit; 2) western, low-density metropolitan area with limited transit; and 3) southeastern, high growth area. Cases should assess the current degree of access to transportation and current transportation choices for different groups, and identify how these groups could or would use ITS user services to specific needs. The case studies should be performed with the partnership of community organizations and local government planning agencies.

4. Identify Federal Government Opportunities

Based on the conclusions of the above activities, the DOT should identify opportunities to use its ITS program, through design, funding, or administration activities, to increase social benefits, ensure more equitable distribution of impacts, and ameliorate or eliminate potential disbenefits. In particular, the DOT should identify how ITS activities can be holistically integrated into transportation and community development planning.

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APPENDIX A

Comparison of ITS and Conventional Transportation Services

Appendix A

Comparison of ITS and Conventional Transportation Services

ITS User Service	Objective	Conventional Service	Similarities	Differences
Travel and Transportation Management En-Route Driver Information	Driver advisories and vehicle signing for convenience and safety	Radio news programs; physical road signs; changeable message signs	Genera1 information about traffic conditions, incidents, weather	More effective and precise information about route and mode options
Route Guidance	Provides travelers with instructions on how to reach their destinations	Maps	Provide locations and route options	Directions to destinations based on real-time information; less dependence on user knowledge
Traveler Services Information	Provides a business directory or "yellow pages" of service information	Hardcopy directories; some software	Potentially similar information	Quicker retrieval of information with directions for best routes
Traffic Control	Manages the movement of traffic on streets and highways	Fixed-time, pre-timed, and adaptive control systems; traffic management techniques	Emphasis on controlling traffic flow	More effective optimization of traffic flow on demand-responsive basis
Incident Management	Helps quickly identify incidents and implement a response to minimize their effects on traffic	Highway patrol	Emphasis on restoring capacity	More effective and timely incident removal
Emissions Testing and Mitigation	Identify super-emitting vehicles and promote vehicle maintenance	Regulatory programs concerned with automobile performance standards, such as inspection/maintenance programs	Emphasis on identifying emitter status of vehicles	May be less effective than I/M if vehicle maintenance is voluntary. May enable re-routing of high polluting vehicles

Appendix A

Comparison of ITS and Conventional Transportation Services

ITS User Service	Objective	Conventional Service	Similarities	Differences
Travel Demand Management				
Pre-Trip Travel Information	Provides information for selecting the best departure time, transportation modes and routes	Television/radio news programs	General information about traffic conditions and routes	More effective and precise information on routes and modes; active route guidance
Ride Matching and Reservation	Makes ride-sharing more convenient	Local employer and transportation programs, such as van pooling and car-pooling; dial-a-ride and shared-taxi	Same objective	More effective matching based on real-time demand.
Demand Management and Operations	Supports policies and regulations designed to mitigate the environmental and social impacts of traffic congestion	Employee ridesharing, public transit vouchers, parking restrictions, etc.	Same objective	More effective and efficient operations
Public Transportation Operations				
Public Transportation Management	Automates operations, planning, and management functions of public transit systems	Transit efficiency upgrades; electronic fare cards	Improve service and facilitate administrative reporting	More effective
En-route Transit Information	Provides information to travelers using public transportation after they begin their trips	Transit personnel; wall maps; schedules	Similar objective	More effective and precise information. Availability of real-time departures and arrivals, and connections

Appendix A

Comparison of ITS and Conventional Transportation Services

ITS User Service	Objective	Conventional Service	Similarities	Differences
Public Transportation Operations (cont.)				
Personalized Public Transit	Flexibly routed transit vehicles offer more convenient service to customers	Paratransit; taxis; dial-a-ride	Similar objective	More convenience to travelers
Public Travel Security	Creates a secure environment for public transportation patrons and operators	Surveillance cameras; transit police	Similar objective	More effective monitoring and response
Electronic Payment				
Electronic Payment Services	Allows travelers to pay for transportation services electronically	Transit fare cards; parking cards, toll booths	Payment for transportation services	More effective; allow implementation of road pricing policies

Appendix A

Comparison of ITS and Conventional Transportation Services

ITS User Service	Function	Conventional Service	Similarities	Differences
Commercial Vehicle Operations				
Commercial Vehicle Electronic Clearance	Facilitates domestic and international border clearance, minimizing stops	Manual clearance at checkpoints	Similar objective	More effective operations; "transparent" borders
Automated Roadside Safety Inspection	Facilitates roadside inspection	Manual inspections	Similar objective	More effective operations
On-Board Safety Monitoring	Senses the safety status of a commercial vehicle, cargo, and driver	Some on-board diagnostics	Some of the same information about vehicle and cargo status	More comprehensive and precise information;
Commercial Vehicle Administrative Processes	Provides electronic purchasing of credentials and automated mileage and fuel reporting and auditing	Manual processes	Similar objectives	More effective and precise operations
Hazardous Material Incident Response	Provides immediate description of hazardous materials to emergency responders	On-site assessment	Similar objectives	More effective operations and precise information
Commercial Fleet Management	Provides communications between drivers, dispatchers and intermodal transportation providers	CB Radio	Similar objectives	More effective and precise communications for route optimization, etc.

Appendix A

Comparison of ITS and Conventional Transportation Services

ITS User Service	Objective	Conventional Service	Similarities	Differences
Emergency Management Emergency Notification and Personal Security	Provides immediate notification of an incident and an immediate request for assistance	Cellular telephone, Highway call boxes	Same function	More effective operations and precise information
Emergency Vehicle Management	Reduces the time it takes emergency vehicles to respond to an incident	Telephone; Radio dispatch	Same function	More effective operations and precise information
Advanced Vehicle Safety Systems Longitudinal Collision Avoidance	Helps prevent head-on and rear-end collisions between vehicles, or between vehicles and other objects or pedestrians	None		Equipment and information
Lateral Collision Avoidance	Helps prevent collisions when vehicles leaving their lane of travel	None		Equipment and information
Intersection Collision Avoidance	Helps prevent collisions at intersections	None		Equipment and information

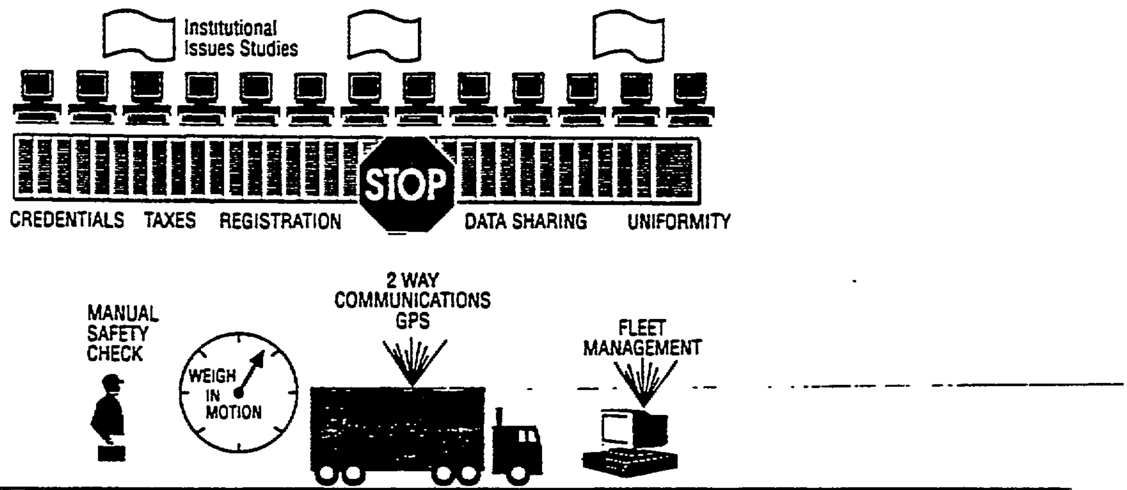
Appendix A

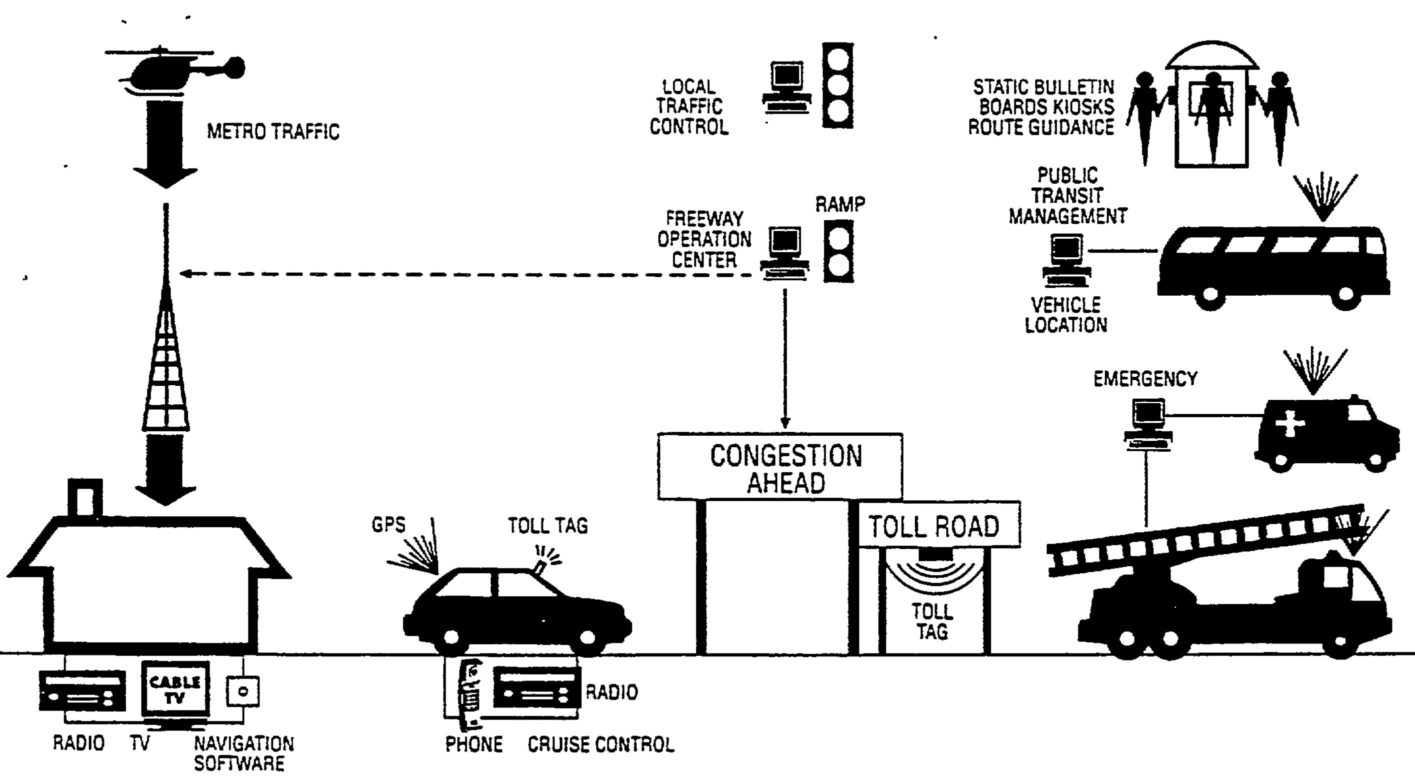
Comparison of ITS and Conventional Transportation Services

ITS User Service	Objective	Conventional Service	Similarities	Differences
Advanced Vehicle Safety Systems (cont.) Vision Enhancement for Crash Avoidance	Improves the driver's ability to see the roadway and objects that are on or along the roadway	None		Equipment and information
Pre-crash Restraint Deployment	Anticipates an imminent collision and activates passenger safety systems before the collision occurs	Passive safety restraints (air bags, passive seat belts)	Do no require passenger action	Equipment and information
Safety Readiness	Provides warnings about the condition of the driver, the vehicle, and the roadway	None		Equipment and information
Automated Vehicle Operation	Provides a fully automated, "hands off," operating environment	Highway capacity expansions	Increase capacity	Equipment, infrastructure, and information

APPENDIX B

ITS Deployment Time Frames



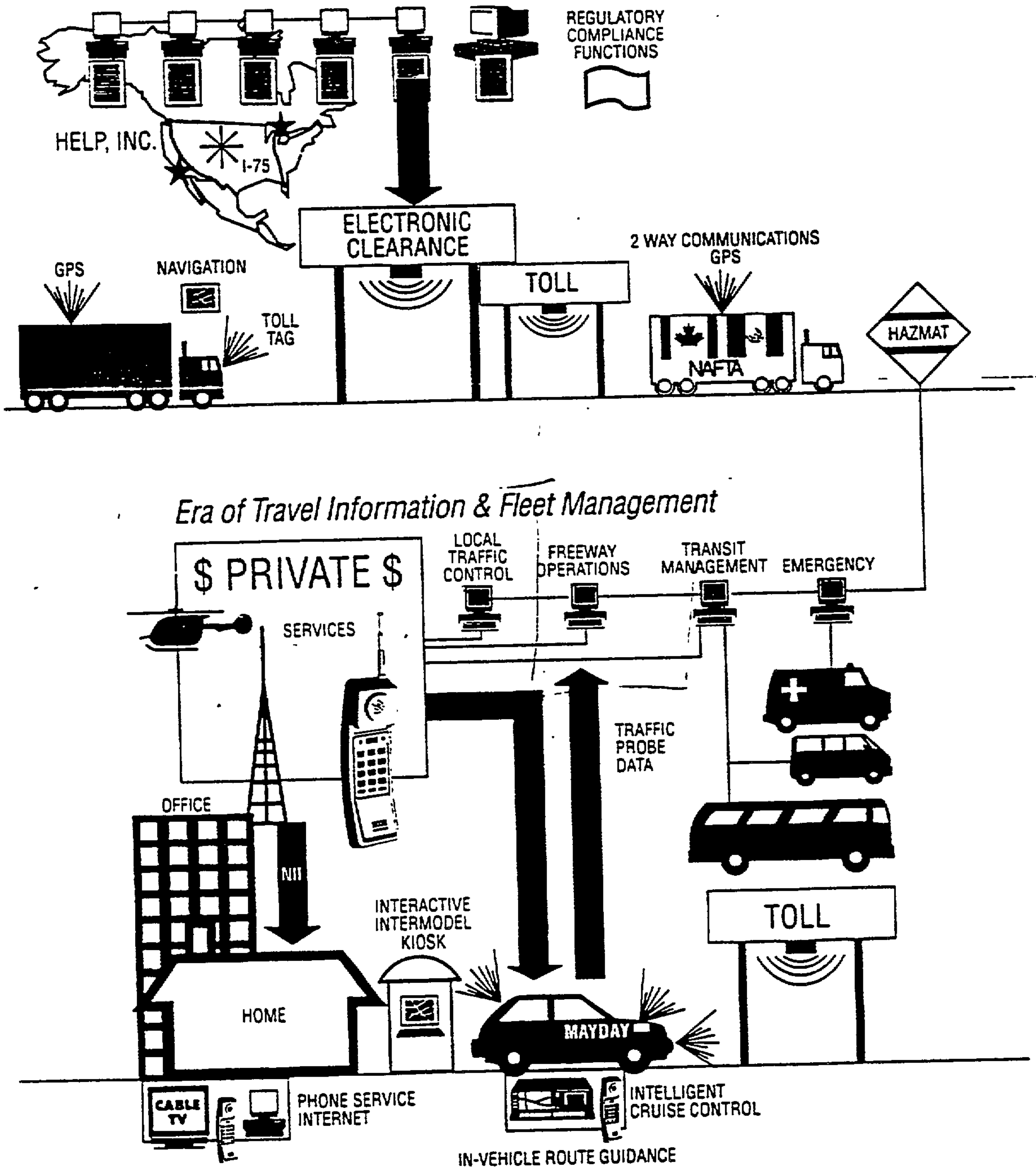


TODAY

1994-1995

65 Freeway Operations Centers
85 Local Traffic Control
14 Public Transit AVL
20 Automated Toll Collection

In-Vehicle Navigation on Market Media
Traffic Reports/Data Collection



1997-1999 Themes: Institutional Links • Systems/Software • Link Detection and Communication Infrastructure

Traffic Operations Centers
- Investment in Traffic Surveillance Infrastructure
- Data Base LINKAGE
- Institutional Coordination
- Arrangements to Receive/Sell Private Data
- Incident Response Protocols Refined

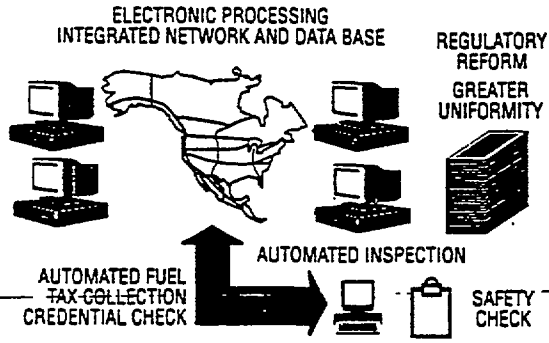
Private Services
- Packaging of Data
- Investment in "Broadcast" Infrastructure
- Investment in "Receivers"
- Investment in Other Outlet Media
- Arrangements to Receive/Sell Data to Public

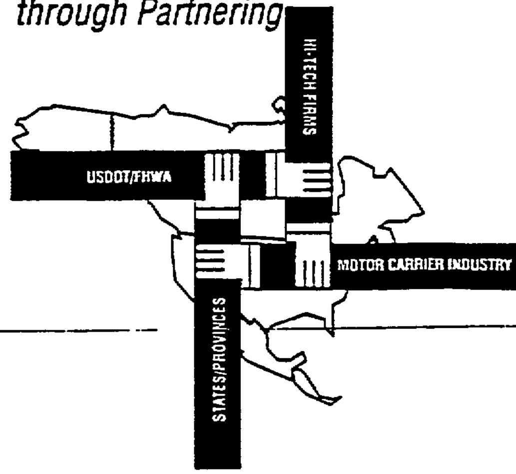
Wireless Surveillance Emerges

Congestion Pricing

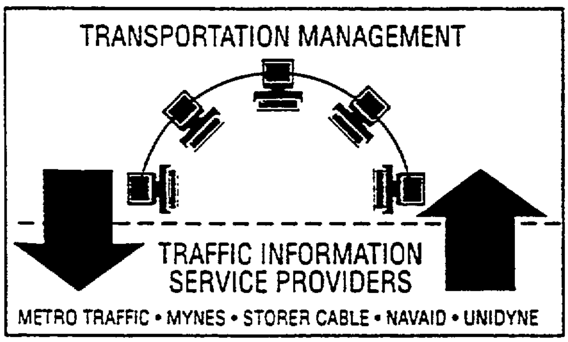
Vehicle
- In-Vehicle Route Guidance
- Cellular Phone Traffic Service
- Tags for Tolls
- "May Day" Devices
- Intelligent Cruise Control

Continuing Wide Spread Use of ITS/CVO Systems through Partnering

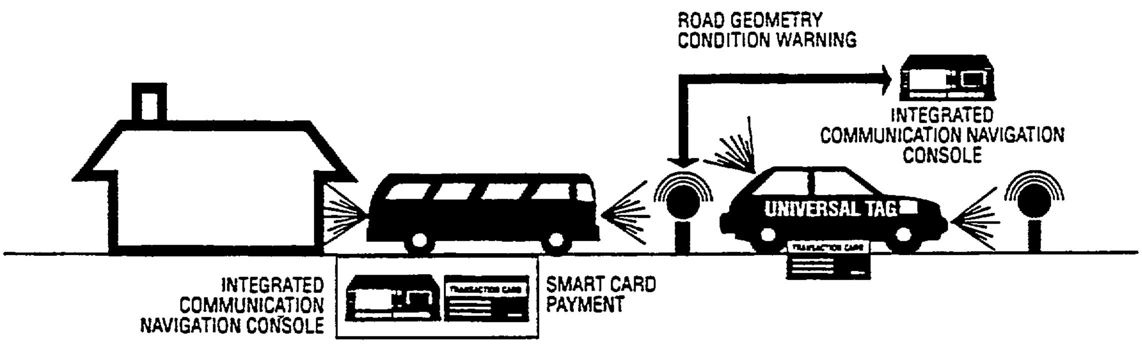


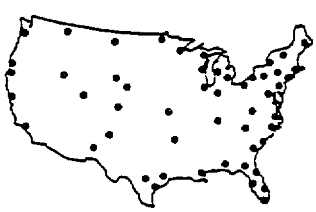


Era of Transportation Management



- ROUTE CALCULATION/ DYNAMIC ROUTE GUIDANMCE
- PARK-AND-RIDE, INFORMATION MANAGEMENT
- PUBLIC TRNSPORT
- WARNINGS
- YELLOW PAGES AND TOURIST INFORMATION
- FLEET MANAGEMENT
- TOLL/ROAD PRICING





2000-2005

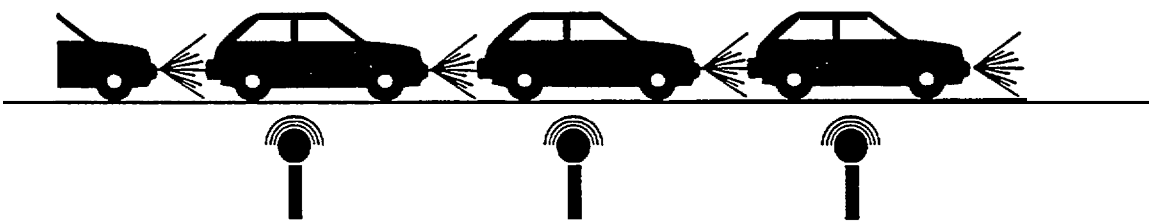
Integration of Public/Private Services

Integration of In-Vehicle Equipment/ Mainstream Market

Deployment of Richer Vehicle/Road-Side Communications

Mainstream of "Smart Transaction" Card

Era of the Enhanced Vehicle



2010

Lateral and Logitudinal Space control

Vehicle to Vehicle Communication

Enhance Vision

Advanced May Day/Emergency services

Automatic Variable Acceleration

Assisted Breaking

Assisted Steering

AHS

2015 - 2020

Strawman for Targeted Deployment

1997-1999	2005	2010	2010+
Mainstream deployment of travel information in major metro areas	More sophisticated travel information	Vehicle to vehicle communication	Automated Highway
ETTM on most toll roads	Advanced traffic management	Assisted steering	
CVO electronic clearance on 3-4 major corridors and several border crossings	Congestion pricing	Enhanced vision	
Commercial products In-vehicle navigation Mayday Intelligent cruise control	Electronic clearance on most interstate corridors and border crossings	In-vehicle signing	
	Assisted braking/lateral steering warning		
	In-vehicle warning at railroad crossings		

APPENDIX C

Inventory of Analytical Methods

May 16, 1994

Edith B. Page
Manager, Federal Programs
Bechtel Corporation
1015 15th St., NW, Suite 700
Washington, DC 20005-2605

Dear Edith:

Enclosed is my attempt to put together a "thought-starter" list of analytical tools that have proven useful in applications to societal analyses. I volunteered to help build an inventory of such analytical tools at the Atlanta meeting of the IVHS-America Societal Implications Task Force. The enclosure represents the first step towards that goal.

By sharing this thought-starter with the people on the task force which are carbon-copied below, I am soliciting their (and your) comments, additions, deletions and revisions in order to present a eventual inventory that will be broad and deep in its coverage. I also request that the feedback that I receive include as many up-to-date references for each of the list entries as each individual can reasonably supply, and I will try to fill any gaps that might remain afterwards.

I've included in this mailing my business card attached to a brief biographical sketch of my professional experiences. This information may be used to respond to me by phone, fax, or the regular mail. It is my hope that all the cc'd individuals as well as yourself will respond. I assure you that any feedback is welcome and I will incorporate all that I receive into the final document.

Best regards.

Wally

Walter Albers, PhD.
Pres., Albers Systems

cc. Martin Abrams, TRW
Daniel Brand, Charles River Assoc., Inc.
Thomas Horan, George Mason Univ.
Christine Johnson, Parsons Brinckerhoff, etc.
Patricia Waller, Univ. of Michigan

WALTER A. ALBERS, JR.

Biographical Sketch

Walter (Wally) Albers recently retired from the General Motors Research Laboratories after 30+ years of service, where he was a member of the management team and headed up what was called Operating Sciences. His career at GMRL spanned a variety of responsibilities from Research Physicist and Group Leader of Solid State Physics to the establishment of the first Societal Analysis Department in an industrial research laboratory to the management of a large Operations Research/Management Sciences/Societal Analysis/Decision Support research activity. Prior to his employment with GM, he was employed by the Bendix Corporation Research Labs (1957 -1962) and was a Member of Technical Staff at the Bell Telephone Laboratories (1955 - 19570 where he carried out semiconductor research during those exciting early years of transistor development.

Wally is a native of McKeesport, Pennsylvania where he was born on July 19, 1930. He was awarded BS., MS., and PhD. Degrees, all in physics in the 1950's from Wayne State University. His professional membership include the American Physical society, Society for Risk Analysis (charter member), Society of Automotive Engineers. The Institute of Management Sciences, Society of Manufacturing Engineer and the American Association for the Advancement of Science. He's been a prolific contributor to the scientific and engineering literature, and has two books published. He has testified before U.S. congressional committees on several occasions, and it listed in most, of the prominent "Who's Who" publications. Since retiring from GM he has started his own consulting business, Albers Systems, Incorporated of which he is president.

Dr. Albers is an active member of a number of professional committees including the Sociotechnical Committee of the Society of Automotive Engineers, the Communications Committee of the Transportation Research Board, the ORSA/TIMS Academic/Practitioner Interface Committee and the Benefits, Evaluation and Costs Committee of IVHS America. He also serves on advisory committees to the United Way of America and to the United Fund of Southeastern Michigan.

Additional information would be gladly provided on request.

IVHS AMERICA

Societal Implications Task Force

Analytical Tools Inventory

Mathematics/Statistics

Math modeling

Statistics
- -regression and correlation techniques
- -curve-fitting
- -time-series analysis
- -stochastic programming
- -non-parametric techniques

Graph theory

Fuzzy logic (fuzzy set theory)

Catastrophe theory

Operations Research/Management Science

Linear programming
- -integer programming
- -goal programming

simulation

Queueing theory

Markov processes

Utility theory

Analytical Hierarchy Process (AMP)

Decision Sciences/Economics

Probability theory

Experimental design principles

Game theory

Dynamic programming

Influence diagrams/decision tree modeling

Conflict resolution/negotiation methodologies

Classification and regression trees

Decision-risk analysis

Cost/benefit and Cost/effectiveness analyses

Econometric modeling

Hazard theory (failure mode analysis)

<u>Forecasting/Strategic Planning</u>

Delphi methods

Trend-impact analysis

Cross-impact analysis

Demographics and actuarial statistics

<u>Sociology/Psychology</u>

Neural networks

Conjoint measurement techniques

Focus groups

Surveys

Social choice and voting methodology

Cultural stability models

Psychometrics

Expert Knowledge Systems

General systems theory

Self-organizing systems (homeostasis concepts)

Automata theory

Information/communication theory

Health and Life Sciences/Biology

Birth/death models

Predator/prey models

Ecological modeling

Dose/response methodology

Epidemeology

APPENDIX D

Summary of ITS Societal Issues Literature

Appendix D

Summary of ITS Societal Issues Literature

Author	Title	Year	Focus	Summary
Barham, P.A.J. et al	"What are the Benefits and Safety Implications of Route Guidance Systems for Elderly Drivers?"	1994	Elderly; Route guidance systems	Summarizes results of tests of the use of the Bosch Travelpilot route guidance systems by a sample of elderly drivers. During the tests, researchers observedimpacts on driving ability and duration of glances at the route guidance systems. The systems did not appear to adversely impact driving performance, although fatigue was a factor in those aged 71 and over. Also, drivers with better short term memories performed the best. The equipment was well-received by all participants.
Bedford, Gwendolyn M.	"IVHS and the Mobility of Older Americans"	1992	Elderly; General ITS	Argues that the growth in the number of older drivers increases the need for ITS. Stresses that driving is only one component of mobility. Other aspects of mobility, including urban and rural public transit, and paratransit, need to be addressed. Points out that adequate transportation access is critical in avoiding premature institutionalization of the elderly.
Betz, Joe et al	"Intelligent Bicycle Routing in the United States"	1993	Bicycling; Intelligent information	Information systems can promote and support bicycle use effectively within the existing infrastructure. Identifies methods to: 1) provide accurate route, safety, facilities information; 2) link bicycling options with Carpools and transit; 3) accomodate special needs; 4) improve administration and demand measurement. Discusses specific plans proposed in Minnesota.
Boghani, Ashok B.	"Comparing IVHS Benefits with Alternative National Transportation and Telecommunications Strategies"	1992	General societal benefits and costs; General ITS	Calculates societal benefits in terms of productivity gains, energy savings, pollution reductions, infrastructure maintenance savings, and accident reductions for urban areas. Also estimates implementation costs of $89 billion based on Mobility 2000 Report. Concludes that ITS would "provide significant societal benefits for relatively modest implementation cost." Also, asserts that ITS' societal benefits compare Favorably to telecommuting, alternative fuel programs, and high-speed rail/Maglev.
Chen, Kan and Robert D. Ervin	"Socioeconomic Aspects of Intelligent Vehicle-Highway Systems"	1990	Institutional issues; General ITS	Identifies institutional issues required to support an ITS program in the United States. Identifies stakeholders and "skeptics": motoring public, highway community, technology community, international competitors, early adopters of ITS, traffic safety community, academic research community. Identifies macro domestic policy issues: role of government, public-private partnerships, legal liabilities.' Identifies micro domestic policy issues: financing mechanisms, jurisdictions, coordination, standards.
Chen, Kan and Thomas B. Reed	"Social Decision Analysis for Intelligent Vehicle Highway Systems"	1993	Assessment criteria; General societal benefits and costs; Users and non-users; ETTM; In-vehicle route guidance	Proposes that social decision analysis can be used as a framework to evaluate societal impacts of ITS user services. Applies social decision analysis for two cases: electronic toll collections, dynamic route guidance. The framework uses multiattribute utility theory and pareto optimality to appraise benefits for users and non-users. The paper is based on hypothetical examples so it is not possible to draw conclusions about benefits.

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Summary of ITS Societal Issues Literature

Author	Title	Year	Focus	Summary
Greenberg, Allen	"Intelligent Vehicle-Highway Systems & Bicycling"	1994	Bicyclists; General ITS	Argues that ITS offers little to address the impediments currently facing bicyclists, and in fact may degrade the bicycling experience by increasing the number of vehicles on roads and rerouting vehicles onto secondary streets. In addressing efficiency concerns such as highway capacity and congestion, ITS user services may neglect issues that are important to bicyclists and other low-speed forms of transportation, such as the importance of neighborhoods and personal interaction. Expresses concern that the process of decision-making on ITS development is flawed.
Grieco, T.	"Breaking the Ice: The Role of New Transport Informatic Technologies in Improving Access for the Disadvantaged in Cold Climates"	1992	Elderly; General ITS	Lists ITS technologies that could help the elderly to drive more safely: route or parking guidance systems, trip planning systems, and automatic driving aids such as distance keeping systems, driver performance monitoring or overtaking warning systems. Asserts that the mass production on in-home information could reduce the need for a substantial percentage of on-road travel.
Hempel, Lamont C.	"The Greening of IVHS"	1994	Energy and environment; General ITS	Asserts that ITS development is occurring through "technology push" rather then "market pull" and that socioeconomic issues are seen as constraints rather than goals. Concludes that careful planning and policymaking are needed to ensure that ITS does not exacerbate current socioeconomic problems such as urban sprawl and inequity in transportation services.
Myers, Samuel L. and Lisa Saunders	"IVHS: Potential Impact on Disadvantaged Communities"	1994	Income and racial groups	Explores the relationship between commuting times and income inequality for income and racial groups in Houston, Minneapolis-St. Paul and Portland. Concludes that transportation policies that result in equal reductions in travel times among groups will lessen earnings inequality, although not by much.
Parkes, A.M. et al	Driving Future Vehicles. Chapter 10: Elderly Drivers and New Road Transport Technology	1993	Elderly; In-vehicle systems	Summarizes results of a test of the DRIVAGE project of the DRIVE field trial as well as results of simulator tests of elderly drivers. The author found that older drivers performed as well as younger drivers for simple driving tests. However, a minority of older drivers performed significantly worse when presented with multiple simultaneous tasks.
Reay, Matthew and John Kiljan	"A Needs Assessment for Advanced Rural Transportation Systems: A Colorado Perspective"	1993	Rural	Asserts that ITS technologies can play an important role in addressing rural needs. The paper contrasts rural and urban needs. Identifies following rural needs: tourist-related congestion, incident detection, driver fatigue and awareness, emergency response, road crew safety, runaway trucks, transit for isolated and aging population. Identifies following solutions: road weather information systems, highway advisory radio and variable message signs, dynamic warning signs, traveler information, mayday, cellular telephone networks, and transit.

Appendix D

Summary of ITS Societal Issues Literature

Author	Title	Year	Focus	Summary
Richardson, Barbara	"Socio-economic Issues and Intelligent Transportation Systems"	1994	General issues; General ITS	Points out that problems with the decision-making process have hurt the effectiveness of previous transportation programs. Argues that transportation must be seen as part of the larger complex socioeconomic system. Demographic trends should be taken into account to forecast ITS' potential role in transportation.
Schroeder, Barbara and Stephen Clinger	"Rural IVHS Outreach: Stimulating Local Agency Interest and Involvement"	1994	Rural; Public participation	Proposes strategy and guidelines for educating rural constituents about ITS and involving them in design and decisionmaking activities.
Sobolewski, Mike and James Wright	"Rural Applications of IVHS in Minnesota"	1993	Rural	The paper describes the Minnesota Guidestar's rural ITS program and its objectives to meet safety, traveler information, and personal mobility needs.
Stafford, Frank P.	"Social Benefits of IVHS Systems"	1990	Productivity; General ITS	Concludes that ITS could create social benefits by reducing both the level and distribution of individual travel time. Acknowledges that benefits and costs must be evaluated at project level.
Stamatiadis, Nikiforos	"IVHS and the Older Driver"	1994	Elderly: General ITS	Points out that although ITS could improve information processing, it could also result in more information that needs to be processed, which may negatively impact older drivers. Expresses concern that IVHS user services may be designed with younger drivers in mind and may not be optimized for older drivers.
Suen, S.L. and J.A. Parviainen	"Application of Micro-Electronic Technology to Assist Elderly and Disabled Travelers"	1992	Elderly; Disabled; General ITS	Asserts the importance of identifying elderly and disabled needs early in the design and development of ITS applications. Such considerations must not be an afterthought, since retrofits would be potentially cumbersome, user unfriendly, and unsafe.
Swedish National Road Administration et al	"Arise: Automobile Road Information System Evolution"	1985	Forecasting; Traveler information and traffic management	Swedish feasibility study of traveler information and traffic management user services. Develops scenarios for 1990, 1995,2000,2010,2025, and 2040 with respect to society, road transport, and automobile travel. Concludes that road traffic will play a more important role in the future "information society" due to further decentralization and dispersal of homes and workplaces. Based on expected benefits (productivity, safety) and costs, study also concludes that "society would achieve a marginal gain from autonomous systems for route guidance, but a substantial gain from integrated systems for route guidance and dynamic traffic management."
Transportation Research Board	Driver Performance Data Book Update: Older Drivers and IVHS	1994	Elderly; In-vehicle systems	Summarizes driver performance data from two areas of research: older drivers and ITS. This document does not provide a critical review of the summarized literature

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Summary of ITS Societal Issues Literature

Author	Title	Year	Focus	Summary
Triulzi, U.	"Non-technical Barriers to the Implementation of RTI Technologies on Urban/Interurban Mobility"	1992	Elderly; Disabled; Transit users; Advanced public transit systems	Describes the Italian Telebus pilot project. Telebus is a demand-responsive bus service running between Pelugia city center and its suburbs. A significant number of the users are disabled or elderly. Many users changed their transport mode from car to bus as a result of the service.
Underwood, Steven E.	"Social and Institutional Considerations in Intelligent Vehicle-Highway Systems	1990	Forecasting; Institutional issues	Identifies and ranks driving forces for implementation, barriers to market penetration, and government policy initiatives of ITS programs. Analysis based on 1989 Delphi study, discussed in following citation. Concludes that most systems will be implemented in year 2000 and shortly thereafter.
Underwood, SE., Kan Chen, and R.D. Ervin	"Future of Intelligent Vehicle-Highway Systems: A Delphi Forecast of Markets and Sociotechnological Determinants"	1991	Forecasting; Institutional issues	Addresses social impacts and institutional issues concerning implementation of ITS user services. Used Delphi panels, consisting of automotive companies, electronic component suppliers, telecommunications companies, state and federal transportation agencies, and representatives of transportation user groups. Develops forecasts from 1989 through 2080 of expected market penetration of automatic tolls and road pricing, automatic vehicle location, automatic vehicle navigation, motorist information, cooperative route guidance, collision warning, collision avoidance, speed and headway keeping, automated highways, and automated guideways. Also identifies potential barriers to implementation, driving forces, government policy, and social impacts. Expects that most commercial use of ITS will occur by 2000, followed quickly by public adoption.
U.S. DOT	"National Program Plan for Intelligent Vehicle-Highway Systems"	1994	General issues; General ITS	Outlines societal issues, questions, and potential policy actions concerning ITS impacts on privacy, elderly and disabled individuals, communities, and equity in distribution of benefits and costs.
Walker, J. et al	"In-Vehicle Navigation Devices: Effects on Safety and Driver Performance"	1990	Elderly; In-vehicle navigation systems	Tested seven navigational devices in FHWA's Driving Simulator for their effects on driving safety. Reports that older drivers performed less safely, drove more slowly, and were more likely to make navigational errors.
Wallace, Charles E. and Andrew Kilpatrick	"IVHS Applications for Rural Highways and Small Towns"	1993	Rural	States that 40% of all VMT and 57% of all fatal accidents occur on rural highways. Compares and contrasts rural and urban needs. Asserts that rural areas require information on travel conditions, information about alternative routes and modes, public transportation for disadvantaged. Cites several ITS services that could meet rural needs.

Appendix D

Summary of ITS Societal Issues Literature

Author	Title	Year	Focus	Summary
Waller, Patricia (I)	"IVHS: How Will it Change Society?'	1992	General ITS	Stresses that transportation planners should apply past experience to achieve future goals, and that transportation should be viewed as more than just the safe and efficient movement of goods. Points out that demographic trends can have an important impact on the role and purpose of ITS. Such demographic trends include the increased number of women, minority, and elderly drivers.
Waller, Patricia (2)	"IVHS and Social Policy"	1994	General ITS	Emphasizes that lessons learned from past transportation projects (such as the potential role of the Interstate Highway System in decentralizing urban areas) should be applied to ITS planning. Expresses a concern that participation in ITS America is not representative of the full range of stakeholders in ITS user services. Briefly discusses privacy concerns, and draws an analogy with the Human Genome Project.
Wegmann, Frederick et al	"Application of IVHS Technologies to Public Transportation in Rural and Smaller Urban Areas"	1993	Rural	Used "focal groups" of rural public transportation managers to ascertain specific needs that could be meet by ITS. The operators rated the effectiveness of various IVHS user services to increase demand, reduce operating costs, and increase the comfort and convenience of users. The areas of priority were electronic ticketing, HOV lanes, automated vehicle location and dispatching, and pre-trip information for choice riders.
Zarean, Mohsen et al	"Rural ATIS: Assessment of User Needs and Technologies"	1994	Rural	Discusses the application of ITS user services to meet rural user needs and priorities.