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IVHS/RTI Institutional and Environmental Issues: A Strategic Policy Research and Outreach Agenda for the United States

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ABSTRACT

The implementation of intelligent vehicle-highway systems (IVHS, also known in Europe as Road Transport Informatics, or RTI) has raised a wide range of policy issues in the United States. Recent attention has focused on two major policy issues: (1) implementation issues related the roles of private industry, government and market forces; and (2) energy, environment, urban form and land use. These central policy themes give rise to a wide range of related social, economic and technical issues. What role should be played by government and industry, and within government between federal, state and local entities? How should system development and deployment be financed? What are appropriate standards and how should they be developed? What are the costs and benefits of IVHS and what is their incidence across various socio-economic groups? How will air quality be affected? Who will bear the liability for system failures? How will individual privacy be protected? How will IVHS affect the shape of metropolitan areas? These related policy areas are examined and discussed in order to identify and prioritize strategic policy research topics.

INTRODUCTION

The recent advent of advanced communications and control technologies in road transport, known variously as intelligent vehicle-highway systems (IVHS) in the U.S. and road transport informatics (RTI) in Europe, has created considerable enthusiasm in the transportation community (the term IVHS will be used hereinafter). These technologies have the potential to reduce highway congestion and delay, reduce air pollution, improve the quality and timeliness of travel-related information for both single- and multiple-occupant vehicles and transit, among other things.

Until recently, much of this enthusiasm has materialized in examinations of technical capabilities and the technical challenges associated with the design and widespread implementation of IVHS. While concern over policy and implementation has raised some concerns, attention has appropriately focused on the technical challenges that had to be overcome before IVHS could be implemented on a widespread basis.

Recently, however, attention has begun to focus on the policy issues implicit in the continued development and implementation of these technologies. Indeed, increased attention to these issues is in part a logical extension of the success of efforts in the technical sphere. These policy and implementation issues encompass a wide range, including legal liability, the respective roles of public and private institutions, intergovernmental relations, international competitiveness, standardization, environmental impacts and land use and urban form.

Attention to IVHS policy and implementation issues has emerged in several studies of the potential for a national IVHS program. For example, a study by U.S. General Accounting Office (a unit of the U.S. Congress) noted the importance of cost and institutional issues. A report by Transportation Research Board (a national transportation research organization) stressed these as well as the need to reform tort liability and to enhance

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private sector participation [1] [2]. The importance of these policy issues were underscored by the inclusion of a "nontechnical" report requirement in the 1991 national surface transportation legislation [3].

Pursuant to this law, vigorous attention to these issues has emerged in various forums in the last year. The strategic plan of the Intelligent Vehicle Society of America (IVHS AMERICA, a national IVHS professional advisory organization) has noted these as "challenges" that confront the program [4]. The U.S. Federal Highway Administration (the national highway agency) has begun a series of efforts to address the issues related to the relationship between the public and private sector [5]. And there is now a rapidly emerging literature on different facets of the IVHS policy domain (see, e.g., [6] [7] [8]).

This paper reports on recent developments in the policy and implementation domain in the U.S. It begins with a brief overview of a workshop on institutional and environmental issues and a summary of the key policy issues that it helped identify. It then describes more recent activities in the IVHS policy and implementation domain in the U.S., followed by concluding remarks.

Key IVHS Policy and Implementation Issues

These heightened interest in policy issues gave rise to a workshop on IVHS policy issues at the Asilomar Conference Center in Monterey, California, in April, 1992. The specific objectives of the workshop were: (1) to identify the core institutional and environmental policy areas that warrant further attention; and (2) to identify what actions need to be taken at the policy, research, testing and other levels to ensure adequate attention to these core policy areas [8].

The workshop included solicited or related papers on a variety of topics. Gordon [9] and Sperling *et al.* [10] focused on environmental issues. Baird [11], Hill [12], Roberts and Bridges [13] and Ward [14] addressed institutional issues. Luce *et al.* [15] addressed behavioral issues. Behnke [16] addressed multimodal applications. Gifford [17] and Krauss [18] discussed standards. Horan [19] and Mudge [20] address evaluation and economic assessment. Brand [21], Brecher and Ritter [22] and Hempel [23] addressed cross-cutting issues. And Robertson and Roberts [24] address capital market issues. Many of these paper will appear shortly in a proceedings [25]. An annotated bibliography of most appears in [8].

The papers, presentations and discussions at Asilomar served to identify several core issues: the vision of IVHS, the public versus market implications of IVHS systems, the need for inquiring institutions, and the need for empirically-based debate. These are discussed briefly below.

The Need for Outreach on IVHS Vision

A vision for the long range future of IVHS is an essential ingredient for the overall visions that citizens, elected officials and planners have for their communities. In the absence of a unified rational vision of IVHS, it may be impossible to create—much less maintain—the necessary political support to bring an alternative future into being. A unifying vision for IVHS could galvanize the political support for the development of a dramatically different kind of transportation system. Not to have a vision risks IVHS' being nothing more than a "haphazard assortment of gadgets."

The standard vision of highway applications of IVHS, however, may not be particularly inspiring to the environmental community, who may be more responsive to goals related more directly to the quality of urban or metropolitan life. It is not that IVHS is inherently hostile to the environment. Rather, its potential to enable environmental enhancements has not been a central focus of the visions that have been developed to date.

The development of a shared vision suggests the need for outreach, education and responsiveness to involve those in the various policy domains and user groups potentially affected by IVHS, including the environmental and planning communities. Key to the success of such efforts would be keeping all parties informed about IVHS developments, involving a broad range of interests in policy and program development and responding to issues and concerns raised by the different groups.

One mechanism for effecting such outreach would be the development of a policy forum. An informal network of IVHS policy experts and analysts has developed that would benefit from such a forum to exchange research, assess current and future policy needs and encourage interdisciplinary approaches. This forum could include a workshop series, perhaps held on an annual basis, with each focusing on a particular policy theme.

The Need to Understand Public and Private Roles in IVHS Integration

A second key issue relates to the respective needs of public agencies versus markets in the design of IVHS systems. Should IVHS be devised in an integrated manner to achieve the synergistic goals of an integrated system or as "loosely coupled" systems that could be more responsive to immediate market interests and opportunities? System-level technological changes on the order of advanced vehicle control systems (AVCS) may not come about in the absence of a broad-scale system architecture. Thus, a failure to develop a system architecture may be essentially an abdication of the potential of IVHS to effect system-level changes. Moreover, immediate market interests may not necessarily encompass the public goals of IVHS (such as reduced congestion or improved air quality) and an integrated system may better support the public interest in these areas.

One the other hand, a "big technology," "top down" approach may be inappropriate to the nature of IVHS technology and to the institutions involved. System designers may be "out of sync" with broader market forces that favor the development of specialized, niche-oriented technology, as evidenced by the trend throughout the communications industry. Perhaps IVHS technologies should be decoupled in order to focus the technology as a mechanism to achieve other goals, such as using automated vehicle identification to develop market-based approaches to improved air quality.

For this reason, it is essential to examine the institutional implications of alternative IVHS system architectures. Appropriate directions for IVHS development should depend in part on the policy implications of various levels of coupling for IVHS technologies, from a tightly coupled universal architecture to a loosely coupled set of individual applications.

The Need for Flexible Institutions

A third key issue is the challenge that the policy arena poses to IVHS technical professionals, which highlights the need for inquiring, adaptive and flexible institutions to be responsive to the differing priorities and opportunities for IVHS. The appropriate application of IVHS requires careful attention to environmental and other resource constraints, as well as an understanding of technical feasibility. The ability to manage IVHS projects successfully also has implications for the education and training of transportation professionals, who will need a "dual competency" in the technology being developed and in the nature of institutional incentives and competing systems of values.

It is necessary to develop educational programs to train professionals with dual competency to understand alternative systems of values and technology. Programs should be geared to all levels of higher education (undergraduate, graduate and continuing education).

The Need for Empirically-Based Debate

Perhaps the most significant policy challenge to emerge at Asilomar is the need and the difficulty of fashioning a successful technical program that is responsive to the different interests inherent in a major policy undertaking. As IVHS moves from the technical sphere into implementation and dissemination, attention is shifting from what is technically feasible to what is socially desirable, that is, to the appropriate social construction or arrangement of the technology [26]. At this level, the application of IVHS technology becomes subject to varying and competing notions of appropriate public policy and invariably involves evaluating or estimating tradeoffs among several dimensions of performance, including (in no particular order) mobility, accessibility, environmental quality, energy dependence and economic productivity.

Ideally, these discussion will be informed by scientific fact and by a recognition of uncertainty about the relationships between transportation, institutions and the environment. But values can color one's assessment of objective fact, and can also powerfully color one's assessment of what constitutes conservative treatment of

uncertainty. The treatment of uncertainty plays a powerful role in opinions regarding the positive versus adverse effects of IVHS technologies on environmental quality.

A key challenge to the IVHS community is to separate fact from value judgement systematically in order to ensure that even parties with rather different objectives can achieve improvements [27]. If the parties are able to identify a body of fact on which they can agree, then such improvements can be achieved. Which IVHS technologies, for example, can reinforce both the mobility and air quality goals of metropolitan dwellers. To the extent IVHS can jointly achieve both objectives, its future would appear to be auspicious indeed.

It is essential to learn more about the full costs and benefits, direct and indirect, of transportation investments, including IVHS. This will involve identifying fully the externalities associated with all modes of travel, including the automobile and transit. It will also require careful analysis of various approaches to internalizing the costs of travel, including both the environmental costs and the technological costs of IVHS.

It is also important to identify key areas of uncertainty, which must derive from the inclusion of the broad range of policy domains affected by IVHS and the body of scientific knowledge. Values and perspectives exert a powerful influence on the interpretation of uncertainty and assumptions about the conservative treatment of uncertainty. Research is needed on ways to recognize, assess and address the inherent uncertainties associated with IVHS technologies, especially in the assessment of environmental gains and/or tradeoffs from alternative IVHS configurations.

Finally, the IVHS field operational tests in the U.S. are key opportunities to obtain data that could inform several of the issues under discussion. While these tests often have a technological orientation, it may be appropriate to develop a more diversified research approach that would include non-technical elements.

Recent Developments in IVHS Institutional and Environmental Policy

Since the Asilomar workshop, IVHS AMERICA's Committee on Institutional Issues (chaired by G. Sadler Bridges) has moved to advance discussion of institutional and policy issues through the creation of working groups in several areas, including policy issues, investment capital issues, environmental issues and educational issues. The full committee convened a series of meetings during the summer of 1992 to develop a research agenda on institutional issues for consideration by the U.S. Department of Transportation [28]. Similar work within IVHS AMERICA's Benefits, Evaluation and Costs Committee (chaired by Don Orne) has also raised institutional and environmental policy issues.

The institutional research and development projects thus far identified in this process reinforce some of the themes raised at the Asilomar and other conferences [29]. There has been a strong emphasis on public and private roles, interjurisdictional issues, privacy, the relationship between metropolitan planning and IVHS, contracting and procurement, economic development, productivity and competitiveness, among others. In pursuit of these efforts, the Federal Highway Administration and the Federal Transit Administration have both put forward research agendas on a variety of topics related to IVHS institutional and environmental issues, including several major research procurements that are currently in process.

Concluding Remarks

In closing, it is worthwhile to note that improved knowledge of a particular problem domain is not always welcomed by all parties. Climatological research, for example, has encountered serious political impediments. In connection with the acid rain research program, one observer remarked that

> [r]esearch on complex natural systems may have unpredictable outcomes and historically has not supported extremist views; nature's feedbacks tend to diminish the effects of change. Thus, to the doctrinaire "true believer," scientific research is a potential threat. To the politician who has championed a cause, future research findings might be very embarrassing. To the federal agency with embedded programs, external review and a diversion of funds challenge the stability of its staff and institutions. . . . There are only a few groups deeply interested in the success of a climate research program: the scientific community (professionally motivated), the affected production sector (economically motivated), and the few intellectual leaders genuinely concerned with the habitability of the world in the next century [30].

The institutional and environmental policy issues raised by the dissemination of IVHS technologies pose serious challenges to the conventional wisdom and operating assumptions of some of the stakeholders. While there is widespread agreement on the need to reduce peak period congestion, for example, some see mobility enhancement as a positive outcome, subject to the constraint that users pay its full cost, environmental and otherwise. Others are concerned that it might induce additional demand and possibly lead to additional urban sprawl.

Yet IVHS has the potential to enable a number of environmentally enhancing actions. Time-of-day congestion pricing might allow substantially better use of existing facilities and reduce tailpipe emissions related to peak-hour congestion. Emission monitoring and/or pricing might allow policy makers to target the worst polluters. Advanced public transportation systems (APTS) could substantially improve the accessibility of information about alternatives to the single occupant vehicle.

One can meet this challenge in two ways: consensus or confrontation between competing systems of values. Consensus implies a broad-based, inclusive process, with outreach to the diverse groups that have an interest in IVHS and the policy domains it will affect—planners, environmental interest groups, various units of government, to name a few. It is noteworthy, however, that some parties may have conflicting interests in improving the level of knowledge about IVHS and its social and environmental impacts.

Perhaps the most central policy issue facing the IVHS community is how to effect consensus among such diverse interests, and how to address confrontation and compromise where consensus is impossible.

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RTI Databases - Who Will Pay For Them?

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This paper briefly addresses three issues: the requirements for RTI databases, the obstacles facing the creation and maintenance of such databases in Europe, and some relevant current initiatives. Although the paper mentions the DRIVE II Topic Group on Databases and Traffic Data Interchange, of which the author is chairman, the views expressed in this paper are those of the author only.

The answer to the question posed in the title is that the motorist will pay, in the end. However, this means that some possible RTI products or services will never be successful in the market, as the cost of the RTI databases they need is too high. There is, therefore, a need to seek out the most efficient ways to collect, maintain and exchange this data, in order to support a commercially successful market in RTI products.

Requirements for RTI Databases

Several parts of the overall RTI/IVHS market cannot exist without databases. These are primarily vehicle navigation and fleet management systems, both of which require a digital road network in order to operate. These systems also can benefit from the receipt of traffic messages; the navigation system so that it can update its route and improve the quality of support given to the driver, and the fleet management system so that the vehicle scheduling and control performance can be maximised.

Note that in Japan, where navigation systems were brought early to the market, and are now selling in significant volumes, the production of the digital road network was seen as an essential prerequisite. In Europe, however, lack of a suitable industrial policy has meant that the production of such databases has been delayed, and now forms the critical task needed before navigation systems can be successfully introduced.

For these systems to be more than gadgets, they have to become mass-market products, to gain from economies of size. They therefore have to be sold on a European (or world-wide) scale. This means that RTI databases have to be available, *to a given level of content and quality*, for the whole of Europe.

This constraint on standard content and quality is onerous to meet, given the widely varying positions of the several European states. It is difficult enough when considering static digital mapping, but particularly ambitions when considering dynamic traffic and weather messages.

The setting of standards is central to RTI databases. Such standards need to focus on the exchange of data between parties (mapping agency to system manufacturer, traffic control centre to broadcaster, traffic data publisher to driver, etc), rather than directly on the content of public or private sector databases. Organisations should have the comparative freedom to carry out their data processing in a way that best meets their own objectives, but experience

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