

April 28, 2003

Mr. Jeffrey Paniati
Associate Administrator, Operations
Acting Director, ITS Joint Program Office
Federal Highway Administration
400 7th Street, S.W.
Room 3401
Washington, D.C. 20590

Dear Mr. Paniati:

At the request of the Intelligent Transportation Systems (ITS) Joint Program Office (JPO) of the U.S. Department of Transportation (DOT), the Transportation Research Board (TRB) of the National Research Council has convened a new committee—the Committee for the Review of the Intelligent Vehicle Initiative (IVI), Phase 2—to conduct a multiyear peer review of the IVI program. This activity is a follow-on to a prior 3-year, Phase 1, TRB peer review, which resulted in three letter reports.¹ The new committee has met twice in Washington, D.C.—on August 22–23, 2002, and most recently on February 13–14, 2003. This letter report is the first of the committee’s two annual written reviews of the IVI program.

The stated goal of the IVI program is to help prevent or reduce the severity of crashes through technologies that help drivers avoid hazardous mistakes. More specifically, the objectives of the program are to (a) prevent driver distraction and (b) facilitate accelerated development and deployment of crash avoidance systems (FHWA 2002, 5). The program is administered by the JPO through a management team representing the key modal administrations at DOT—the Federal Highway Administration, the National Highway Traffic Safety Administration (NHTSA), the Federal Motor Carrier Safety Administration, and the Federal Transit Administration. The JPO works in partnership with the private sector, primarily through automobile manufacturers and suppliers, as well as with state and local governments and other stakeholders, to accomplish the program goals.

This committee’s charge is to:

- Review the progress of the program toward meeting its goals.
- Offer guidance on the efficacy of establishing numerical outcomes to measure progress.

¹ For continuity, a core group of committee members from the first TRB review was asked to serve on the follow-on committee. See the list of committee members in the enclosure to this letter.

- Provide guidance on the nature and quality of the IVI collaboration with industry and other stakeholders.

In addition, the JPO requested that the committee:

- Determine whether human factors activities within the program are appropriate and adequate.
- With respect to light vehicles, comment on whether DOT is focused on the right issues, and provide guidance on how the agency can improve private-sector involvement.

In open sessions at its first meeting, the committee sought information for its review from DOT IVI program staff, who provided an overview of the program, its goals and objectives, its management structure, the role of human factors in the program, and the nature of the collaboration with the private sector. In open sessions at its second meeting, the committee heard presentations by representatives of industry and academia, as well as consultants, on several key IVI projects, including the Crash Avoidance Metrics Partnership (CAMP), the General Motors/Delphi Delco Automotive Collision Avoidance System (ACAS) Field Operational Test (FOT), the Freightliner Rollover Avoidance FOT, and the Virginia Tech–managed Naturalistic Driving Study. In addition, also in open sessions, the committee heard (a) a presentation on e-safety, focused largely on work under way in Europe by a joint industry–public-sector consortium and widely reported by DaimlerChrysler to deploy advanced safety-enhancing technologies on vehicles; and (b) an update on the effort of the Alliance of Automobile Manufacturers’ Telematics Working Group to develop voluntary standards for telematics to minimize driver distraction.

In this report, the committee comments on each item under its charge, with more discussion of some topics than others as appropriate; also provided is a discussion of the committee’s view on the future direction and focus of the IVI program. Included throughout the discussion are key observations and recommendations, presented in bold print.

In general, the committee commends the progress made on individual projects and the evidence of collaboration with the private sector—particularly with light vehicle manufacturers—at the project level. The projects are well conceived, address important issues, and demonstrate working public–private partnerships. The committee’s charge, however, is focused at a more strategic level. At this level, the committee had difficulty seeing how the results of individual projects are intended to fit together and lead to desired program outcomes. This difficulty is attributable to the lack of a program-level roadmap and measurable objectives by which to assess progress. The committee recognizes the difficulty of developing appropriate program goals and plans in a rapidly changing technological environment. Nevertheless, it offers several recommendations for developing appropriate measures of progress and modifying the program’s focus and activities—

changes that could also provide the impetus for more high-level government–private-sector collaboration regarding the program’s future.

REVIEW OF PROGRESS TOWARD PROGRAM GOALS AND EFFICACY OF ESTABLISHING NUMERICAL OUTCOMES TO MEASURE PROGRESS

The first two elements of the committee’s charge are related, and so are discussed together here. **The committee spent considerable time reviewing individual program projects, which, as noted above, appear to be well conceived and well carried out. On the basis of the information provided to the committee, however, it was not apparent how the individual projects are organized to form a series of steps leading to program goals, and hence whether resources are allocated appropriately among the various program activities. Nor were milestones evident against which the progress of the program could be measured.**

The committee recognizes the difficulty of establishing measurable and realistic goals for the IVI program, particularly desired safety outcomes in terms of expected crash reductions, lives saved, and injuries avoided. The realization of safety benefits from the program will depend on a lengthy sequence of intermediate steps—from research, to determination of the effectiveness of technologies in the field, to their adoption by drivers and widespread deployment in the fleet. Several of these steps, most notably the deployment and commercialization of technologies, are not under the control of DOT, but depend on action by the private sector. In addition, because technology is changing so rapidly, program objectives and activities must continually be reevaluated to ensure that the program is relevant and on target. Finally, some projects simply help advance the knowledge base; for these activities it is difficult to make a direct link between what is learned and expected crash reduction outcomes.

Given these complexities, how can the program best be organized, and how can progress best be measured? The committee considered the European model of setting ambitious safety goals for the IVI program, such as a 50 percent reduction in crashes or crash-free driving—the goal of DaimlerChrysler. It concluded that such goals are laudable as measures of what might be accomplished; however, they fall short as performance measures against which program progress can be evaluated.

Instead, **the committee offers a different way of conceptualizing IVI projects that could facilitate goal setting. Specifically, it suggests that program products could be grouped into two categories: (a) safety-enabling crash avoidance technologies, consisting of packages of technologies believed to be effective in addressing various crash-related problems; and (b) knowledge-enabling projects, aimed at providing a basis for the development of more-effective technologies. The latter efforts could encompass baseline studies that would involve, for example, tracking driver behavior to improve understanding of crash causation and near misses, as well as projects focused on understanding driver distraction resulting from in-vehicle driver assistance technologies.**

Categorizing program activities in this way would help in setting goals. **For the first product category—safety-enabling crash avoidance technologies—quantitative objectives, such as desired reductions in crashes, are appropriate.** Here it is possible to define a sequence of measures, starting with the size of the crash problem amenable to assistance from a technology, the expected effectiveness of the technology, and the anticipated outcomes (i.e., lives saved and injuries averted) and the time frame within which they could be realized if the technology were fully deployed and effective. **For the second product category—knowledge-enabling projects—quantitative goals are inappropriate.** Instead, measuring progress requires the identification of key problems ranked in order of priority, the definition of major gaps in knowledge, the design of projects to help fill those gaps, the development of means for transferring the knowledge gained for practical application, and the provision of a feedback mechanism so this knowledge can be used to refine the problem definition. The committee believes that rethinking the program along the above lines would go a long way toward clarifying programmatic objectives and establishing appropriate milestones for measuring the program's progress.

COLLABORATION WITH INDUSTRY AND OTHER STAKEHOLDERS

The individual IVI projects reviewed by the committee, such as CAMP and the FOTs, showed evidence of partnering and collaboration between government and industry at the research and project implementation levels. However, there was little evidence of such interaction at higher organizational levels within either the automobile manufacturers or DOT. Policy-level decision makers in the private sector appeared to be uninvolved in program goal-setting activities, the identification of major program research areas and priorities, or formulation of the program's future agenda.

One possible exception is the non-light vehicle platforms, where the presence of smaller, more-flexible companies appears to facilitate increased high-level interaction. The presentation made to the committee by Freightliner on the Rollover Advisor for heavy trucks indicated that the leadership of Praxair, the company involved in the FOT, was heavily involved in the project and the decision to deploy the technology on its trucks on a limited basis. This type of exchange may be taking place more broadly, but the committee has limited data on which to base any conclusive observations in this regard.

The committee traced the general lack of higher-level private-sector involvement in the IVI program in part to a lack of incentive because of the program's relatively small size, with an average annual budget of about \$25 million, and in part to the lack of an appropriate point of contact. For interaction to take place at the policy level, there must be a compelling reason for such interaction and an enabling mechanism. Thus, policy-level collaboration is probably unlikely unless the IVI program becomes part of a broader DOT initiative that would warrant such high-level private-sector involvement. If embraced by the JPO, however, several of the activities enumerated later in the section on

the program's future direction and focus could provide opportunities for engagement with the private sector on a broader range of IVI activities.

The JPO itself could become more of a focal point within DOT for bringing the relevant agencies together to assess the potential effectiveness and safety impacts of advanced vehicle technologies. For example, addressing intersection crashes through technology will require the combined efforts of state and local infrastructure providers, vehicle manufacturers, mapping and global positioning providers, and others to develop effective cooperative vehicle–infrastructure systems. The JPO could also attempt to involve a broader range of companies than the traditional automobile manufacturers and suppliers—electronics and communications firms, for example—in the program. As DOT reconstitutes the Federal Advisory Committee for intelligent transportation systems (ITS) activities under JPO management,² it has an opportunity to seek such a broadened membership.

To encourage broad participation, particularly of the private sector, in the IVI program, the committee recommends that DOT continue to work through CAMP; consider expanded membership, including industry, on the new Federal Advisory Committee; and further extend outreach through targeted workshops on specific technologies (e.g., completed IVI FOTs) and crash problems (e.g., intersection crashes).

APPROPRIATENESS AND ADEQUACY OF HUMAN FACTORS ACTIVITIES

The committee believes that great progress has been made in integrating human factors issues into the IVI program. The team leader for human factors appears to function as an integral member of the IVI management team. Greater recognition of human factors issues is evident in the FOTs, in which, for example, driver response to false alarms and optimal types and integration of multiple warnings for drivers are among the areas under investigation.

At the same time, however, the committee believes that more could be done in this area. For example, more attention could be devoted to drivers' mental models, that is, their understanding of how technology systems function. In addition, the FOTs could be structured to place greater emphasis on any unintended effects of new technologies on driver behavior (e.g., more eyes-off-the-road driving). **As technologies begin to appear in vehicles—in particular, technologies developed outside the IVI program—a critical role for the program will be to monitor how drivers respond to those technologies, to determine what behavioral adaptations they make, and to ascertain the extent to which the technologies are truly safety enhancing.** For example, will the availability of night vision systems cause motorists to drive more in hazardous conditions? **The committee recommends that the IVI program identify and study**

² DOT terminated ITS America's role as the Federal Advisory Committee for ITS activities, including the IVI program, effective March 2003.

“early adopters,” perhaps enlisting the support of private industry and market research firms to identify appropriate subjects for study.

Standardization is another important human factors issue as more advanced technologies become available. The inventorying function recommended below will be critical for understanding the ways in which technology systems differ among manufacturers, and the impact of these differences on how the systems affect driving behavior and, ultimately, help reduce crashes. For example, a recent review of commercially available adaptive cruise control systems (“Adaptive Cruise Control: Meet Your New Co-Pilot” 2003, 25) revealed apparent differences in system recognition of smaller vehicles, such as motorcycles, indicating the need for greater standardization if anticipated safety benefits are to be realized. **As more systems are deployed, the IVI program should conduct studies to identify critical operating differences that could lead to standards setting and improved compatibility among systems.**

LIGHT VEHICLE ISSUES

Because of the dominance of light vehicles in highway crashes, the JPO is particularly interested in the committee’s assessment of whether the light vehicle platform of the IVI program is focused on the right issues. **The committee noted many laudable projects, including the ACAS FOT, several precompetitive research projects under CAMP, and the naturalistic driving study. Because of the above-noted lack of programmatic information, however, the committee is no more able to determine how these projects fit together to address the light vehicle crash problem than it is to make this determination for the program as a whole. Thus, the committee is unable to respond to this part of its charge.**

The JPO is also interested in the committee’s guidance on enhancing private-sector involvement in IVI light vehicle-related projects. For the projects it reviewed, the committee noted the active participation of the automobile manufacturers and the evident collaboration with DOT IVI staff. This visible involvement was particularly gratifying to members of the predecessor committee, who had seen only limited evidence of such interaction. **In looking to the future, the committee is concerned that with the termination of ITS America’s governance role, the IVI program could lose a valuable mechanism for industry input, particularly through the light vehicle steering committee. The committee urges that, as DOT reconstitutes the new ITS Federal Advisory Committee, it give special attention to providing for a continuing mechanism to sustain public-private interaction at both the managerial and technical levels.**

FUTURE DIRECTION AND FOCUS OF THE PROGRAM

In this section, the committee offers several observations and recommendations with respect to the future focus and direction of the IVI program that it believes are directly

relevant to the previously discussed issues of setting appropriate program goals and milestones. In particular, the committee recognizes that relevance is an issue for a technology-focused program in which the technologies are changing rapidly, and many (e.g., electronic stability control systems) are being deployed without the benefit of field testing or evaluation through the IVI program.

The program's heavy focus on facilitating the development and deployment of safety-enhancing in-vehicle technologies is understandable in the context of the program's history. When the IVI program was conceived in 1997, it represented a major shift in emphasis for DOT. The goals of the agency's prior Automated Highway Program, which called for demonstration and technology selection for a fully automated highway system, had been recognized as overly ambitious (TRB 1998, 6-7). The IVI program was intended to focus on the early development and deployment of in-vehicle technologies that promised near-term safety benefits (TRB 1998, 8). A government role was deemed appropriate to help jump-start this technology development because industry leadership was not evident at the time. Once the program was under way, however, technology development accelerated as the automotive industry responded to growing consumer interest in safety-enhancing technologies (e.g., adaptive cruise control, lane keeping) and telematics (e.g., route guidance and navigation systems, cellular telephones).

DOT IVI staff have acknowledged the difficulty of keeping the program relevant—for example, selecting appropriate technologies, such as rear-end collision avoidance systems, for field testing that can require as much as 5 years or more to yield results, equivalent to two generations of technology development. Moreover, not only the technologies, but also the companies involved in their development (e.g., electronics firms and suppliers) have proliferated since the program began. Hence, identifying and involving the appropriate private-sector players in the program is a major challenge. Finally, in the face of a rapidly changing environment, the longevity of key current program projects and the limited ability to shift constrained program resources to new activities make it difficult for the program to stay focused on the future and “ahead of the curve.”

Today, private industry is rapidly commercializing technologies intended to enhance safety, and telematics capabilities are proliferating. **As the need for a government role in facilitating technology development has diminished, the need for a greater government role in monitoring and evaluating the impact of technologies and information systems on safety has grown. To this end, the IVI program could play a key role** in addressing a number of important questions. For example, what technologies are already commercially available? How do they differ among various manufacturers, and how do these differences affect driver behavior? How do drivers react to multiple technologies and information systems, and how can these technologies and systems best be integrated to assist them without distraction? How well do drivers understand the functions and capabilities of the new technologies? What are the unintended consequences of technology deployment? The committee offers several

recommendations for specific activities that could be undertaken by the IVI program to consolidate the knowledge gained thus far and help address these questions:

- *Inventory of available technologies*—**DOT, with the help of industry, should develop and keep updated an inventory of safety-enhancing technologies and telematics capabilities being deployed both in the United States and abroad.** This inventory should identify the salient characteristics of the technologies, as well as what is known about how they may differ in operation from manufacturer to manufacturer—information that should be particularly useful in understanding the potential effects of the technologies on driver behavior and crash avoidance. The inventory need not involve proprietary information, such as data on sensors, algorithms, and displays for collision warning systems, which could be difficult to obtain from manufacturers.
- *Systematic evaluation of commercially available technologies*—**As more and more technologies appear in vehicles, DOT should undertake systematic evaluations of their effects on driving behavior and crash avoidance.** (The human factors issues to be addressed were discussed above.) NHTSA has had experience with such evaluations in its studies of the safety impacts of antilock brakes and airbags. Deployment experience in other countries, such as Japan, Europe, and Australia, which are often ahead of the United States in technology deployment, could be monitored. This activity might appropriately be shared with NHTSA, but the IVI program could take a lead role in shaping the evaluation agenda. In the future, this activity could be extended to aftermarket products that are likely to appear once intelligent vehicle technologies have been deployed more extensively on new vehicles.
- *Integration of multiple technologies*—Typically, collision avoidance systems and telematics capabilities have been developed individually. **DOT should play a major role, working jointly with industry, in examining the effects of integrating key technologies (e.g., adaptive cruise control, navigation, and collision avoidance systems) to determine whether receiving input from multiple systems results in information overload or confusion among drivers.**
- *Standards development*—As multiple technologies become available, the issue of standardization will grow in importance. There is some evidence that DOT has already encouraged standards setting by such organizations as the Society of Automotive Engineers and the Institute of Electrical and Electronics Engineers through the development of performance specifications for the FOTs. **As technologies proliferate in the marketplace, DOT should step up its role in helping to facilitate standards-setting activities. IVI staff should be involved (through in-kind participation) in industry efforts to develop voluntary standards and guidelines.**

- *Completion reports for FOTs*—**As individual FOTs are completed, DOT should develop completion reports that summarize the knowledge gained, identify remaining gaps, and delineate appropriate next steps.** If such reports were developed jointly with industry—for example, in a peer review workshop format—they could be powerful tools for consolidating current knowledge and developing future priorities and strategies for the next generation of technology development and deployment.

NEXT STEPS

The committee is eager to discuss the observations and recommendations presented in this report with DOT program staff and other stakeholders. At its next meeting, the committee hopes to have an opportunity to view several of the IVI technologies in live demonstrations. The committee thanks the JPO for the opportunity to comment on the IVI program and looks forward to a continuing and constructive relationship.

Sincerely,

Craig Marks
Chair, Committee for the Review of the Intelligent Vehicle Initiative, Phase 2

References

Abbreviations

FHWA Federal Highway Administration
TRB Transportation Research Board

- “Adaptive Cruise Control: Meet Your New Co-Pilot.” 2003. *Popular Science*, March, pp. 24–25.
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Enclosure
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