TRB

ESTIMATING DEMAND FOR THE NATIONAL ADVANCED DRIVING SIMULATOR

Committee for Assessment of Capacity and Demand for the National Advanced Driving Simulator

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Preface

At the request of the U.S. Congress, the National Research Council, operating through the Transportation Research Board (TRB), assembled a committee of 13 to assess the capacity and demand for the National Advanced Driving Simulator (NADS). Aaron Cohen, Zachry Professor of Engineering at Texas A&M University, served as chairman. The committee included individuals with experience in highway and vehicle safety, vehicle dynamics, human factors research, simulator technologies, economics, and university-related research administration. Specifically, the committee was asked to determine whether "it is highly likely that NADS will be used to at least 80 percent of capacity, as defined by the TRB, after a start-up period of two years; provided that for the purposes of TRB determination, no more than 50 percent of capacity usage is attributed to the National Highway Traffic Safety Administration (NHTSA)." The committee was not asked to assess the need for NADS nor was it asked to assess the NADS program; opinions about these topics are not expressed in the report.

NADS is planned to be the most sophisticated driving simulator in the world. In 1990 it was estimated to cost approximately $32 million. It will be financed mostly by NHTSA, which expects to provide about $21 million; the state of Iowa will provide the remaining $11 million. NHTSA chose to site NADS at a university in order to create a shared-use production facility that could be used by public and private researchers and could be partially funded by other organizations. NHTSA will contract for the

construction of NADS; user charges will cover the operating costs.

The committee held three full meetings over 4 months; in addition, a subgroup of the committee traveled to Detroit to visit with representatives from the three major U.S. automobile manufacturers, and another subgroup traveled to Europe to examine the advanced driving simulators operated by Daimler-Benz in Berlin and the Swedish Road and Transport Research Institute in Linkoping and to discuss activities under way to develop an advanced driving simulator in France.

The committee reviewed previous attempts to identify potential users of NADS, heard presentations from NHTSA and researchers at the University of Iowa (where NADS will be located), interviewed potential users, and examined information on existing driving simulators and related technologies. It obtained cost and performance data from advanced driving simulator operators in Europe and at the University of Iowa, site of the Iowa Driving Simulator. In particular, it sought data and information on operating and maintenance costs and simulator operating procedures and limitations. The committee also reviewed studies undertaken on the German, Swedish, and Iowa simulators and discussed other potential uses and users with the operators. Finally, the committee collected information from potential NADS users including the U.S. automobile industry, the U.S. Department of Defense, the intelligent transportation systems community, and the highway design community.

It is fair to say that the committee could have used more time to assemble and evaluate data and information, to consult with additional individuals who might be interested in using an advanced driving simulator, and to deliberate on the issues surrounding estimates of future use. Part of the difficulty of the committee's task arises because not all of the potential users--for the year 2000--can be readily identified for a facility that has not even been designed yet. Potential users expressed several uncertainties: how will NADS, which will be a very sophisticated research device unique in design, operate? Will it be an effective research tool? How will it be used? The lack of any operating cost data on which to predict use within constrained research budgets was also a limitation for the committee.

The committee consulted with nearly 100 individuals during this study; the willingness of these individuals to assist the committee by preparing information, responding to questions from committee and staff, and participating at committee meetings helped make this a more complete report. The first chapter consists of a statement of the committee's response followed by brief discussions of the assumptions that the committee made and the issues and concerns that it encountered and debated during its deliberations. Twelve committee members endorsed the committee's response. One member was unconvinced by the available evidence that NADS would achieve the level of use described in the task statement to the committee; his statement is included as part of the response.

The first chapter is followed by background material on the NADS project, simulator technology, uses of driving simulators, users of advanced driving simulators, and costs of using an advanced driving simulator. This information helped form the basis for the committee's response. The issue that the committee was asked to address is quite specific; however, in examining the potential demand for NADS, the committee had to interpret information about a range of issues. Ultimately, its opinion represents the collective judgment of the committee members.

The study was performed under the overall supervision of Stephen R. Godwin, Director of Studies and Information Services at TRB. The project director was Walter J. Diewald, who drafted the final report under the guidance of the committee. Suzanne Schneider, TRB Assistant Executive Director, arranged the report review process. Joseph Miklovich of the Link Division of Hughes Training, Inc. provided

valuable assistance to the committee in the areas of simulator technology and large simulator operations. Special appreciation is expressed to Marguerite E. Schneider, who prepared the final report for publication.

Committee Response

The committee, with one exception, believes that after a start-up period of at least 2 years, it is highly likely that the National Advanced Driving Simulator (NADS) will be used to at least 80 percent of its design capacity, assuming that no more than half of this use is attributed to the National Highway Traffic Safety Administration (NHTSA). This judgment is made within the context of several assumptions about the costs and operation of NADS and issues affecting its use. The key assumptions affecting the committee's estimate of the use of NADS are that it will be successfully built and will operate as designed, that it will operate at the design cost of $1,000 per hour, that non-NHTSA use will require $7 million to $8.4 million in annual research funding, and that reaching full operational use will require at least 2 years. The committee believes that future use of NADS will come from a variety of sources, predominantly federal agencies. Thus the future level of funding for federal research and development will directly influence whether NADS will be used to 80 percent of capacity. Moreover, the committee's estimate depends on an aggressive marketing effort by NHTSA and the University of Iowa.

For this analysis the committee estimates that the annual usable capacity of NADS is 3,500 hr, that NADS would be used for at least 2,800 hr, and that the researchers not under contract to NHTSA would account for 1,400 hr annually. This estimate of usage is for the year 2000; it cannot be made with certainty. It is based on the committee's experience with simulators, the likely uses of NADS identified in previous feasibility studies, current uses of advanced simulators in the United States and abroad, and potential applications identified during this study.

ASSUMPTIONS

The committee made the following assumptions about NADS, its costs, and its operation:

- NADS is primarily an extension of existing component technologies for driving simulators, although its visual and motion base systems involve technical risks, as does the integration of its component technologies into a shared-use production facility. (Information about simulator technology is presented in Chapter 3.)
- NADS will operate according to the functional specifications that have guided the work of NHTSA's two design contractors and that will apply to NHTSA's system development contractor. Specific design information under review by NHTSA at the time of the committee's deliberations was procurement-sensitive and therefore was unavailable to the committee.
- It is estimated that it will cost the University of Iowa approximately $1,000 per hour to operate NADS. It is estimated that it will cost researchers approximately $5,000 per hour (to collect data on NADS) because of the cost of setting up the experiment, preparing the simulator for the experiment, conducting the experiment, analyzing the data, and developing the findings. (Information about estimated NADS costs is presented in Chapter 6.)
- NADS use for 1,400 hr represents $7 million to $8.4 million in annual research project costs.
- The annual goal of 3,500 hr of capacity utilization for NADS is unlikely during the first 2 years of operation because as a one-of-a-kind prototype facility, NADS will probably experience periodic shutdowns for additional engineering and development of the system, routine operational testing,

and normal system and subsystem adjustments. It will also probably take at least 2 years for the University of Iowa to build a sufficient customer base to use the full capacity of NADS.

ISSUES AFFECTING COMMITTEE DELIBERATIONS

As mentioned, the committee estimated the potential use of NADS while interpreting information about a range of issues related to the identification of potential users, the development and operation of the simulator, and the management and organization of the facility. Key issues are summarized in the following paragraphs.

Potential Users

Although potential user groups were identified, the committee found that predicting users for the year 2000 and beyond is highly problematic. The committee's opinion is based on the best available information and the collective judgment of the committee rather than on user commitments and empirical evidence.

There is little specific information available about the future customers for NADS or the research projects that they would pursue. The committee was frustrated that NHTSA was unable to bring forward interested parties--other than the Department of Defense--who could make a commitment to use NADS in the future if their budgets permitted and who could articulate why they needed a driving simulator with a full motion base, what research they would conduct on NADS, and how much research they would conduct on it. Thus, the committee's opinion about future use of NADS is based on the following:

(*a*) information provided by representatives of the primary potential user groups;

(*b*) an assessment of potential uses of advanced driving simulators prepared by a Transportation Research Board (TRB) committee (TRB 1992);

(*c*) two studies of potential user organizations and simulator requirements prepared under contract to NHTSA (Allen et al. 1991; Weir and Heffley 1991);

(*d*) past and current experience with advanced driving simulators in Europe and with the Iowa Driving Simulator; and

(*e*) the collective expertise of the committee members with existing driving simulators and the use of simulators in automotive, aviation, space, and military applications.

The committee expects the primary users of the NADS (other than NHTSA) to be the U.S. Department of Defense and its contractors; the Federal Highway Administration, its contractors, and the developers of intelligent transportation systems technologies; the U.S. Department of Health and Human Services and its contractors; and medical researchers and pharmaceutical companies. The U.S. automobile manufacturers are potential users of NADS, but their representatives indicated that they would continue to develop their own driving simulator capabilities. Researchers and driving simulator experts in the U.S. automotive industry are not yet convinced that the component technologies for driving simulators are sufficiently developed to warrant an investment in an advanced driving simulator; as a result they favor a phased development of such a simulator. Industry executives stated that they believe existing driving simulators provide a high percentage of the results that they seek for a fraction of the investment that would be needed to build an advanced driving simulator. The automobile makers indicated that they would probably conduct occasional experiments on NADS and, if these experiments prove successful

and useful, decide later whether to develop their own advanced driving simulators.

Three other factors are important. First, researchers have many options when choosing a driving simulator, hence demand for NADS will depend largely on its operating capabilities in combination with the extent to which the other options satisfy researchers' needs. In particular, because users are very sensitive to price, the costs of conducting research and development (R&D) on NADS compared with other options will be an important consideration. Second, federal research budgets at the agencies mentioned previously will have a dominant influence on demand for NADS; cutbacks in federal R&D funding probably would result in significantly less demand from federal agencies for NADS. Finally, future legislation requiring the evaluation and demonstration of vehicle or component safety could create additional demand for driving simulator research by the automobile industry, medical researchers, and pharmaceutical companies.

Scientific Justification

Part of the difficulty in assessing future use of NADS is that the scientific need has not been demonstrated for a driving simulator with a large motion base for a wide variety of research questions.

There may be a scientific justification for a large motion base to simulate crash-avoidance maneuvers in NHTSA-sponsored research. The need for a motion base in other applications, however, is less apparent and cannot be specified with confidence unless and until a simulator with a large motion base is built and tested. Even so, past assessments of potential uses of driving simulators have found that most research can be performed satisfactorily on simulators without the range of motion that NADS will provide. A large motion base probably would be useful in vehicle design applications, but, as noted, representatives of the automobile industry have indicated very limited interest in using the simulator. Nevertheless, this does not mean that others would not use it. NADS is intended to be the most advanced driving simulator in the world. If it functions as designed, there are likely to be users willing to pay a premium for the additional realism that its motion base will provide. Certainly the most advanced simulators built for space and aviation have been used heavily, often for applications that the builders could not have imagined.

Marketing

Because specific future customers for NADS are largely unidentifiable at this time, there is an urgent need for NHTSA and the University of Iowa, once the system development contractor is selected and under contract, to prepare and execute a marketing plan for the simulator.

The committee believes that NHTSA and the University of Iowa need to conduct an intense and far-reaching marketing effort to ensure that potential NADS users are identified, informed about the facility, and made aware of its performance potential and research value. The three advanced driving simulator developments in Europe exhibited a high level of commitment and interest from potential user groups in the early stages of their programs, but this was not achieved in the NADS program. The program cannot be reorganized at this time to achieve a closer relationship between the developer of NADS and the potential users, but an intense marketing effort could help identify and inform potential customers so they will be prepared to use NADS.

Development Oversight

In view of NHTSA's inexperience with procuring driving simulators, the committee believes that the U.S.

Department of Transportation should organize an oversight committee now to assist NHTSA with the NADS system development contractor in completing the project within time and budget constraints.

The committee believes that NHTSA is relatively inexperienced with driving simulator development projects. Because NADS is projected to be the most advanced driving simulator in the world, and because neither of the potential system development contractors is a major simulator manufacturer, the committee believes that the U.S. Department of Transportation should organize an oversight committee to work with NHTSA to review the work of the system development contractor--once the contract is signed--to help bring the NADS project to successful completion. The oversight committee should include experts in such areas as simulator development, automotive engineering, human factors research, shared-use facility management, and university-based research administration. Such a committee could be a precursor to the government-industry panel proposed by NHTSA to monitor the operation of NADS.

SUMMARY OF STATEMENT OF DISSENTING COMMITTEE MEMBER

One member of the committee, Lawrence Shepp, is unconvinced by the available evidence that there will be enough demand for NADS to account for 1,400 hr of use not funded by NHTSA. Most important, he is not persuaded that an adequate research need has been established for an advanced driving simulator with a large-excursion motion base. He is concerned that very few potential users, outside of NHTSA and the University of Iowa, are actively supporting the NADS project. Moreover, he believes that the benefits of a driving simulator with a large-excursion motion base--which accounts for a substantial portion of the total cost--are being overstated. It is possible that research on the NADS will indicate that a large-excursion motion base is needed for only a small number of experiments. Given the relatively high cost of conducting research on NADS compared with that of using existing fixed base or limited-motion simulators, a lack of widespread application could undercut future demand. Such a shortage of users would be compounded if federally funded research is reduced in coming years. Finally, Dr. Shepp does not believe that the capital cost of NADS is warranted, given that the research need has not been demonstrated to his satisfaction.

ORGANIZATION OF REPORT

The rest of the report presents background material about the NADS program and information about driving simulator technology, driving simulator research, the demand for advanced simulators for driving research, and the costs associated with the development, operations, and maintenance of an advanced driving simulator. The issue that the committee was asked to address is quite specific. However, in estimating the potential demand for NADS, the committee had to gather information on a range of issues, interpret this information using its best judgment, and make critical assumptions in order to complete its task within the time available. The following sections provide much of the material that formed the basis for the committee's response.

REFERENCES

ABBREVIATIONS

NRC - National Research Council
TRB - Transportation Research Board

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