1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

This document is the Final Evaluation Report for the Genesis Advanced Traveler Information System (ATIS) Field Operational Test (FOT). This test was co-sponsored by the Federal Highway Administration (FHWA), and the Minnesota Department of Transportation (Mn/DOT) as part of the Minnesota Guidestar program, with additional contributions from other project partners, including Loral Federal Systems, MinnComm, and Motorola.

The primary source of information for this Final Evaluation Report comes from the five Individual Test Reports, available under separate cover, including:

- Genesis System Effectiveness Test Report
- Genesis Modeling Test Report
- Genesis User Perception Test Report
- Genesis Human Factors Report

The Independent Evaluator for the Genesis FOT was Science Applications International Corporation (SAIC), which was assisted by the University of Minnesota (U of M) Human Factors Laboratory and Biko Association. The Human Factors Report was authored by U of M. The other four test reports were authored by SAIC.

Section 2 of this report provides an overview of the Genesis FOT, including early project history, organization, and test system descriptions. Section 3 covers the five individual tests in more detail; however, although examples of data are provided, the full set of data is found in the individual test reports. Section 4 is a follow-up analysis that addresses questions and issues that surfaced as a result of detailed review of the Individual Test Reports by SAIC. Section 5 provides the key lessons learned, including partner inputs to The Independent Evaluator regarding test goals, benefits, and risks. Section 6 provides the final conclusions from Booz-Allen & Hamilton.

1.2 GENESIS HISTORY

Genesis was one of the early projects sponsored by the US Department of Transportation (USDOT) Intelligent Transportation System (ITS) FOT program. The project originated from the formulation of the Minnesota Guidestar Program in 1989.

Mn/DOT proposed the Genesis ATIS project, which was accepted by FHWA and incorporated into the national ITS operational test program in 1991. The purpose of the project, as originally proposed, was to demonstrate and test a series of personal communications devices (PCDs) by broadcasting traffic information to test participants in an urban expressway corridor in the Minneapolis area, to determine the effect on traveler behavior and possibly traffic as well. Subsequently, the test area was expanded to include the City of Minneapolis and western sections of St. Paul (see Figure 1-1).

1.3 EVALUATION MANAGEMENT AND PLANNING

SAIC was selected to perform the duties of the Independent Evaluator for the Genesis FOT. SAIC performed all evaluation tasks except the Human Factors Test, which was performed by the U of M Human Factors Laboratory.

The Independent Evaluator published six final evaluation planning documents.

- Overall Evaluation Test Plan (April 12, 1995)
- Pilot System Effectiveness Test—Detailed Test Plan (March 7, 1995)
- Pilot User Perception Test—Detailed Test Plan (April 6, 1995)
- Pilot Modeling Test—Detailed Test Plan (April 12, 1995)
- Pilot Human Factors Test—Detailed Test Plan (March 21, 1995)
- Pilot Global Test—Detailed Test Plan (February 23, 1995).

These reports are available from FHWA Minnesota Division (Mr. Jim McCarthy) and Mn/DOT (Mr. Ray Starr).

1.4 GENESIS TESTS DESCRIPTIONS

The Genesis project was started by the Minnesota Guidestar Program in 1992, and supported by FHWA as one of the original projects under the then named Intelligent Vehicle Highway System (IVHS) operational test program. This test used wireless PCDs to send drivers formatted, alpha-numeric text travel information. The PCDs were of two variants—a Motorola pager and an Apple Newton Message Pad 110 with a Motorola message card paging receiver card. Eventually, the Motorola pagers became the
main focus of the test due to technical obstacles with the configuration of the Newton. Test data collection was performed during the second half of 1995 and early 1996.

The test was conducted in the Twin Cities area of Minnesota, primarily in Minneapolis and the western sections of St. Paul. Traffic information provided to the pager supplier and the users originated from the Mn/DOT Metro Division Traffic Management Center (TMC) in Minneapolis. The TMC monitors and responds to traffic situations on the Twin Cities urban expressway system and controls traffic volume through the use of ramp meters. The Genesis test coverage area is illustrated in Figure 1-1. The coverage area was divided into two sections—north and south. This segmentation was done to allow the two unused pager channels to be used to reduce message overload on just one channel.

A total of 492 participants were recruited to become Genesis users, who provided the primary data input for the System Effectiveness Test, the User Perception Test, and the Human Factors Evaluation. Data from the System Effectiveness Test was used as a baseline to support the Modeling Test. Forty-three of these participants were supplied with the Newton PDAs. The rest were either existing pager users from the customer list at MinnComm or new pager users recruited specifically for the test.

1.4.1 System Effectiveness Test

This test was designed to estimate travel time benefits for individuals using Genesis information. Genesis system users were classified as “existing” PCD users (those who already used the MinnComm pagers for other information like news, sports, stock market quotes, personal messages, etc.); “new” PCD users that were recruited for the test; and PDA users. All PDA users were new. The test employed user profile surveys, user driving profiles, telephone surveys, and an Origin-Destination (O-D) data collection protocol. The return percentage of data from users was high, although there was a problem getting sufficient feedback from existing users. However, the overall respondent percentage was such that the following conclusions were reached by the Independent Evaluator:

- Genesis users reported diverting from congestion resulting from incidents based on information received by PCDs
- Genesis was used as the primary means to obtain traffic information by 65 percent of the test users
- Reported frequency of use did not vary as a function of age, gender, income, education, driving experience, or computer experience.

The Independent Evaluator also noted the following, based on the driving trials:
- The results showed that, under baseline, or no incident conditions, travel times on alternate routes were longer than on primary routes

Figure 1-1. Genesis Test Coverage Area
• Under incident or congestion conditions, there was no significant difference in travel time between primary and alternate routes

• Congestion and travel times increase on both primary and alternate routes when incidents were reported, and congestion was significantly greater on the primary route.

This suggested to the Independent Evaluator that “whereas the results indicate that individual users may not reliably save travel time by acting on Genesis-provided incident information, they also do not pay a travel time penalty. This finding may be useful to transportation professionals in evaluating the benefits of encouraging travelers to avoid incident areas.”

1.4.2 Modeling Test

The Modeling Test used the Genesis System Effectiveness data and analysis as a baseline from which to model the effects of a much larger Level of Market Penetration (LMP) on a major corridor in the Genesis coverage area. This was considered necessary, since less than 500 actual users cannot possibly provide an impact on the test area traffic situation as a whole, and it was not possible to systematically collect all types of potential data on all test driver trips. It was also impossible to observe Genesis performance relative to parameters that were not evaluated in the field test, to include fuel consumption, emissions, and accident risk exposure of the test vehicles. These types of data can help characterize the effects of the overall Genesis system at higher LMP.

The desire to examine these unobserved factors resulted in the inclusion of a modeling exercise, using the microscopic INTEGRATION simulation/assignment model. This was intended to permit an objective and systematic extension of the findings from the FOT itself, and to generate performance estimates for a range of other conditions and configurations of interest to those contemplating a similar deployment.

The I-35W corridor from downtown Minneapolis to Bloomington was selected as the study area, which was modeled using Mn/DOT TRANPLAN data. TRANPLAN data and INTEGRATION modeling data were compared to obtain a level of calibration of the INTEGRATION model, which turned out to be high (above 90 percent).

The Modeling Study demonstrated that the PCDs can achieve benefits within the following ranges, as stated by the Evaluator in the Modeling Test Report:

• PCDs can reduce the average travel time of the entire system by up to 15 percent. Most of these benefits are achieved through a 20 percent LMP of the devices. Further benefits can be achieved during non-recurring congestion, depending on the severity of the incident.

• The benefits of using PCDs, in terms of savings in average travel time, increase as the level of congestion in the network increases.

• PCDs provide little reduction in average travel distance, CO emissions, and accident risk (benefits less than 1 percent).

• PCDs can reduce vehicle stops, fuel consumption, and HC emissions by up to 5 percent. Most of these benefits are achieved through a 20 percent LMP of these devices.

• PCDs can increase NOx emissions by up to 5 percent.

1.4.3 User Perception Test

The same set of users that responded to the System Effectiveness Test supported the User Perception Test. The purpose of this test was to assess user perceptions of the system features as measured by responses to questionnaires and focus groups. The same three classes of users were in effect (existing pager, new pager, and PDA).

Users were mailed questionnaires towards the end of month 6 of their participation. The questions contained items that addressed evaluation objectives. The focus groups were conducted with seven to ten participants each. Questionnaires were returned by 175 of the 448 participants who were sent the survey. New users and PDA users exhibited high return rates (51 and 47 percent respectively), while existing users had a relatively low return rate (15 percent) which is explained to some degree later in this report. Overall, Genesis users were well-educated, middle-income persons, and who compile high annual driving mileage (a median reported annual mileage of approximately 25,000).

According to the Independent Evaluator, the Genesis User Perception Test results suggest a demand for traffic information that may be met by PCDs. Pagers have become a critical tool for a large number of people. Users whose median annual mileage exceeded 25,000 miles reported that pagers were a convenient way to receive traffic messages.
Participants with reported annual incomes between $40,000 and $80,000 indicated a willingness to pay between $5 and $10 per month for a Genesis-like device that distributes timely, accurate traffic information for relevant routes.

Genesis users also indicated some disappointment with the service as they perceived it, primarily with the limited amounts of information with regards to the number of roadways and message content. More control over which messages are received was seen as a major improvement needed.

Existing users found that the streams of traffic information messages made it difficult for them to immediately access other, more personal or business oriented pager messages. Potential traffic information suppliers should be sensitive to interfering with other pager uses that are perceived as critical to users.

PDA users were more disappointed with their experience with Genesis. They found the MessagePad/Messagecard combination clumsy, and failed to perceive a compensating benefit. They felt that PDAs should provide more functions such as a graphical map that would allow them to input routes and request route-specific information.

1.4.4 Human Factors Test

This segment of the Genesis test had two objectives:

- Conduct a literature review and synthesis of human factors relating to the use of devices, such as cellular phones, radios, etc.
- Assess Genesis message format suitability.

The literature review examined recent previous tests and studies that examined the effects of driver multi-tasking on driver performance and safety. The main subject areas were:

- Divided attention issues in driving
- Workload and secondary tasks
- Multi-tasking
- Information processing workload.

Based on the literature review, the following are conclusions from the driver multi-tasking research task:

- Performing tasks other than driving, while driving, can lead to information processing overload and driving performance degradation.
- Information overload due to multi-tasking with devices or procedures is specific to the device or procedure.
- One cannot make generalizations from one set of multi-tasking circumstances to another when the tasks require the driver to use devices.
- Physical manipulation of the device is only a secondary problem compared to the need to divert attention from the primary task of driving when using the device.
- Based on the review and analysis of the literature, it cannot be stated that the use of pagers or PDAs in the Genesis environment will result in seriously degraded driving performance and accidents. It cannot be stated that drivers will even read the displayed messages when workload on the primary task of driving is high.

It can, however, be stated that if the Genesis pager or PDA is used, this will divert some attention from driving and add to the driver’s information processing load.

The message suitability assessment looked at three attributes of Genesis pager displays:

- Legibility
- Message content
- Hierarchical structure.

From the message format evaluation, the following findings were made:

- The Evaluator found deficiencies in message legibility, message content, format consistency, and hierarchical structure—mainly due to the current experimental nature of the Genesis project and to particular properties of the hardware, which was not originally designed for such purposes.
- Almost all of the deficiencies noted could be easily remedied.

1.4.5 Institutional Issues Test

This was originally named the “Global Evaluation” and dealt with technical and deployment issues, as
well as those issues that are more institutional in nature. There were four main objectives of the Institutional Test:

- Document methods used to promote institutional cooperation
- Document institutional issues and lessons learned
- Assess partner goals and perceptions of project success
- Identify future applications for, and improvements in, PCD technology.

Data was collected by surveys of Genesis project partners during November and December, 1995. Overall, the results of the Institutional Issues Test emphasized:

- The importance of proper financial planning for ITS projects to ensure that project goals are realized
- The significance of understanding the myriad of factors involved with system development and deployment, especially as they relate to integration testing
- The need to communicate the operational impacts of newly-fielded ITS systems on the activities of other units within the organization.

The three categories of institutional issues that had the most impact on the conduct of the Genesis FOT were:

- Funding
- New technology implementation and deployment concerns
- Organizational coordination.

Pioneering technology projects are typically affected in many unforeseen ways by technical problems and institutional culture and biases. As an ITS FOT pioneer, Genesis was no exception. Specific lessons learned (Table 5-3) and potential future applications are provided in Section 5 of this report.

1.5 EVALUATION ISSUES AND RESPONSES

After a detailed review of the five Genesis test reports, a number of issues emerged that have relevance to the various subject areas of the FOT, particularly with regard to deployment, funding, and system effectiveness. These issues were addressed to some degree in at least one of the Genesis test reports; however, a follow-on review and response to these issues leads to a richer evaluation of the Genesis FOT. The responses to these issues were provided by the Genesis Project Manager and the Independent Evaluator. The cross-cutting issues covered the following topics:

- Deployment/funding—issues relating to funding and partner participation
- Modeling/system effectiveness—issues relating to discrepancies between system effectiveness and modeling results
- User-oriented issues—follow-on questions that related directly to user responses.

Complete responses to these issues are found in Section 4 of this report.

1.6 KEY LESSONS LEARNED

From a cross-cutting evaluation perspective, programmatic, management, technical, and institutional issues had a tendency to overlap to some degree, and were prevalent throughout the test. Genesis was a very typical early ITS operational test, in that the project began before all of the pieces were in place. The lessons learned, as portrayed in the Institutional Issues Test Report, revolved around four main themes:

- The funding for all the planned phases was not locked in
- The technology was not proven
- Complex ITS project management was new to the agency
- The project did not originate with the host organizational entity.

The individual lessons learned by the partners are a direct reflection of these characteristics. Nevertheless, the FOT was able to proceed successfully, and culminated in the rich evaluation provided by the Independent Evaluator.

1.7 FINAL CONCLUSIONS AND RECOMMENDATIONS

After a thorough review of the history and documents of this test, we offer the following final conclusions with regard to Genesis:

- The Genesis FOT was a successful demonstration of the benefits that can be realized from congestion
avoidance through the use of ATIS, and in particular, the use of personal communications devices. The data clearly shows that, given the option through the use of traffic information, people will tend to change their behavior about route choice, and if there is a significant market penetration rate of ATIS-type systems, they may save a little time reaching their destination. The data clearly show behavior trends that center around the desire to avoid congestion.

- The Genesis FOT was a successful technology demonstration of the application of ATIS through existing personal communications device technology. Although there were some setbacks with regards to system and software integration, the overall system became functional and served the technical requirements of the test.

- The Genesis FOT successfully demonstrated the potential for public/private cooperation in the dissemination of traffic information that is collected by a public agency and made available for commercial purposes. Although the test was not structured for an immediate follow-on deployment of this project, the potential was clearly demonstrated. Mn/DOT has indicated that they are still interested in providing this type of information to a third party as a value-added re-seller.

- The Genesis FOT successfully demonstrated the potential for ATIS information via PCDs as a viable commercial enterprise. The feedback from users indicates that there is a latent demand for this type of product, and within the realm of reason, a willingness to pay.

- The Genesis FOT successfully demonstrated the potential for ATIS information via PCDs to be used as part of a comprehensive ITS deployment in urban, suburban, and possibly even rural ITS applications. Based on the objective and subjective data, there is no reason to not consider this type of ATIS application as part of a larger traffic information package to be made available to the public.