U.S. Department of Transportation
Federal Highway Administration
Federal Transit Administration

FINAL EVALUATION REPORT

GENESIS FIELD OPERATIONAL TEST

Prepared by:
BoozAllen & Hamilton
September 1997

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

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
- Genesis Institutional Issues 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 l-l).

1.3 EVALUATION MANAGEMENT ANDPLANNING

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 2 1, 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 l-l.

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

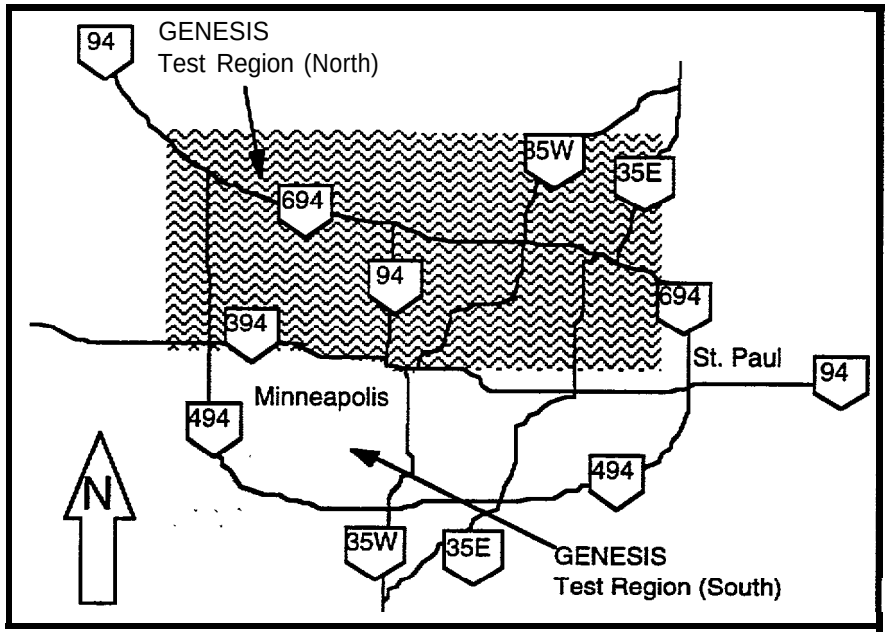

Figure l-l. Genesis Test Coverage Area

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
- 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.

Tbis 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. 1bis 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 NO, emissions by up to 5 percent

1.43 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.

SECTION 2. OVERVIEW OF THE GENESIS FIELD OPERATIONAL TEST

2.1 PROJECT PROPOSAL

Genesis was one of the early projects sponsored by the Intelligent Transportation System (ITS) Field Operational Test (FOT) program. The project originated in a 10-point anti-congestion plan developed by Mn/DOT in 1989, which included traveler information services as a congestion mitigation tool. Based on that plan, Minnesota formed the Minnesota Guidestar Program, which proposed the Genesis Advanced Traveler Information System project, which was accepted by FHWA and incorporated into the national ITS operational test program in 1991.

The original purpose of the project was to demonstrate and test a series of personal communications devices (PCDs) by broadcasting alphanumeric traffic information to test participants in an urban expressway corridor of the Minneapolis area, to determine the effect on traveler behavior and possibly overall traffic flow.

The original project goals are:

- Influence individual travel decisions
- Facilitate transit usage
- Determine technical feasibility
- Complement and integrate into Travlink and the ITMS program
- Expand traffic monitoring capabilities
- Integrate traffic and transit information databases
- Determine appropriate dissemination messages and advice
- Manage the traffic operations database
- Define, design, and implement the FOT through public/private, private/private, and public/public partnerships
- Improve transportation performance
- Evaluate costs, benefits, and infrastructure of the operational test
- Evaluate user acceptance of the PCDs.

2.2 PROJECT PLANS

The original plan called for four phases of the project (A-D), with each phase being funded separately. This phased plan is illustrated in Figure 2- 1.

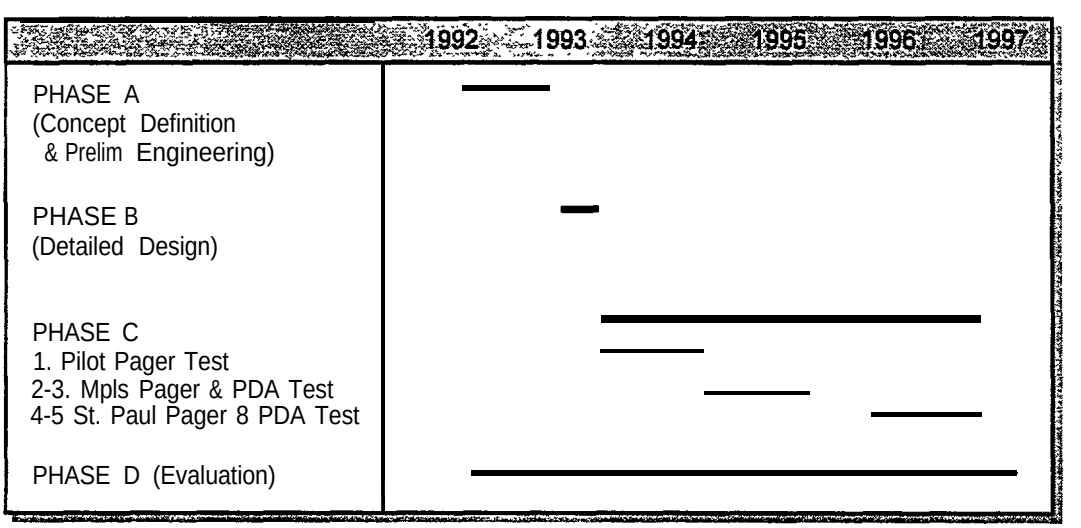

Figure 2-1. Genesis Project Planned Field Tests

Phase A (Concept Definition and Preliminary Engineering) was performed by BRW Inc., Battelle Memorial Institute. JHK & Associates, and Barrientos &

Associates. An additional participant was Motorola (December, 1991). The Concept Definition and Preliminary Engineering document was published in March, 1993.

The original vision called for the following functions to be provided by the PCD:

- Incident reports
- Trip planning with dynamic reminder alert
- Transit schedule information
- Parking availability information
- Planned event, road construction, and road maintenance information
- Weather-related roadway information
- Dynamic carp001 matching
- Request for roadside services
- Request for Paratransit services.

Phase B (Detailed System Design) was performed by all previous participants plus IBM (later to become Loral Federal Systems) and completed in February, 1994. Three types of PCDs were planned to be tested:

- Alphanumeric pager
- Personal Digital Assistant (PDA)
- Off-the-shelf traffic-information-only device (subsequently not included).

Phase C (Pager and PDA Tests) originally consisted of five separate tests, which included a pilot pager test, and a pager and PDA test each in Minneapolis, and then in St Paul. Due to-technical and funding constraints, this phase was truncated to a single combination pager/PDA test covering a major segment of the Minneapolis area, as illustrated in Figure 2-2 below. PDA functionality was significantly reduced from a dynamic trip planner/reminder to merely receiving the same alphanumeric messages as the pagers received.

Phase D [Independent Evaluation) was performed by SAIC Inc. and supported by the University of Minnesota Human Factors Laboratory. The test plans will be discussed further in Section 3 of this report.

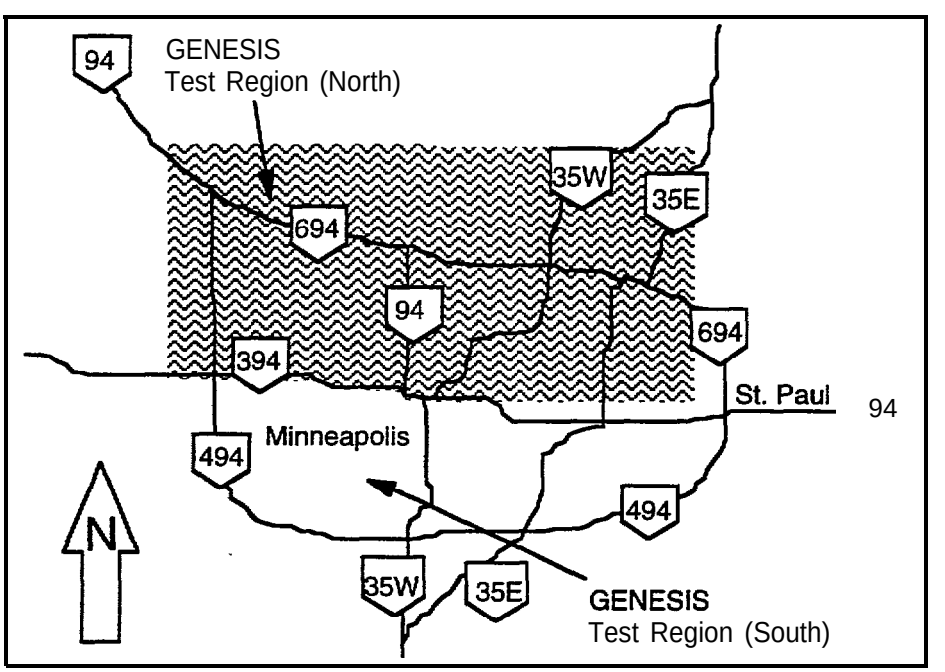

Figure 2-2. **Genesis Test Coverage Area**

2.3 PROJECT ORGANIZATION

Figure 2-3 provides an overview of the Genesis project organization during the implementation of the pilot test. This organization reflected one of the early public-private partnerships in ITS FOTs, and involved organizations from diverging backgrounds (i.e., JHK from traffic and transportation, Loral from the Department of Defense and Mn/DOT from the public transportation sector.

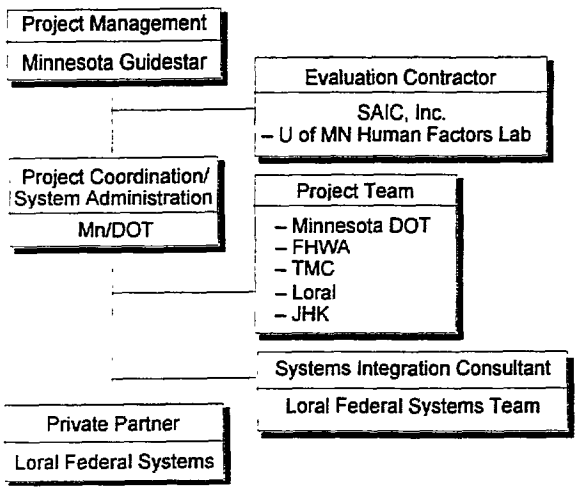

Figure 2-3. Genesis Project Organization

2.4 GENESIS SYSTEM DESCRIPTION

The Genesis system was configured into four subsystems, illustrated in Figure 2-4. The Data Collection Subsystem (DCS) included two workstations located in the Mn/DOT Metro Division TMC. Operators used the DCS to enter traffic incident and event messages into the Genesis system. Three types of messages were provided:

- Congestion (i.e., slow, heavy, stop-and-go)
- Incident (i.e., accidents, disabled vehicles, lane closures)
- Planned Event (e.g., stadium events, construction, etc.).

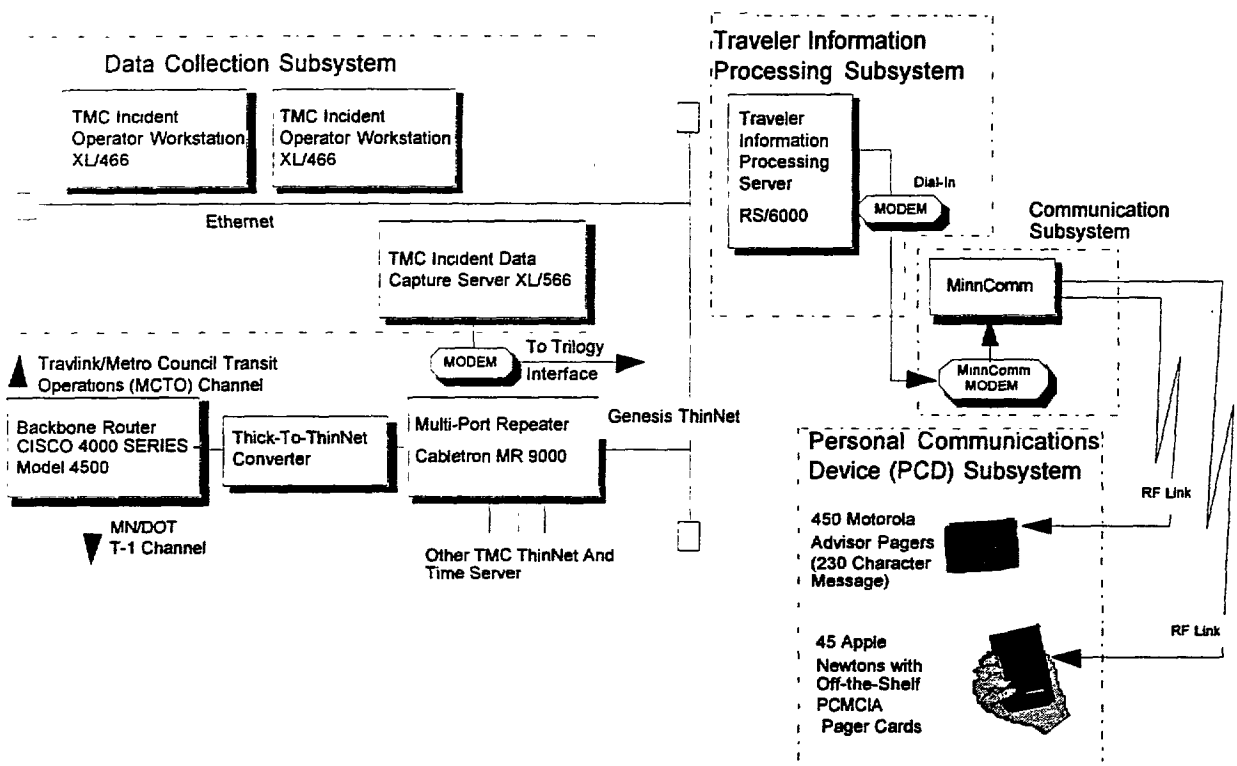

Figure 2-4. Genesis System Configuration

These messages were designed to conform to International Traveler Information Exchange Standards (ITIS), which specify the following message characteristics:

- Event description
- Location identification
- Traffic backup extent
- Expected duration estimation (not provided in the Genesis test).

Typical Genesis ITIS format messages are illustrated in Table 2- 1.

Table 2-l. Typical Genesis Traffic Information Messages

09/01/95 12:48 S:I-35W N roadway reduced to one lane. Slow traffic From: CR 42 To: HWY 13	09/01/95 06:17 S:I-35W S disabled vehicle From: I-94 (W JCT) To: 31ST ST
09/01/95 17:43 S:I-35W S road construction left lane closed From: 46TH ST To: DIAMOND LAKE RD (09/01) (20:00-24001	09/01/95 06:32 S:I-494 s stop and go traffic From: CARLSON PKWY To: HWY 7
09/05/95 16:46 N: I-35E N heavy traffic From: PENNSYLVANIA AVE To: LARPENTEUR AVE	09/01/95 08:01 N:I-35W S accident From: UNIVERSITY AVE To: HWY 55

The Traveler Information Processing Subsystem [TIPS) gathered, formatted, and addressed messages entered via the DCS. TIPS determined which portion of the Genesis coverage area (north or south) should receive the information, and transferred the information to the Communications Subsystem for broadcast to the PCDs. Traffic incident information was provided for limited access roadways (i.e., freeways) within the coverage areas. TIPS also stored Genesis messages in a relational database.

The Communications Subsystem (CS) received messages from the TIPS and transmitted them via telephone modem to a local communications provider (MinnComm) that broadcast the messages to pagers and PDAs.

The Personal Communications Device Subsystem (PCDS) systems were predominantly Motorola Advisor pagers, with a liquid-crystal display, capable of displaying 20 alphanumeric characters on each of 4 lines. In addition to the power switch, there were four cursor buttons, arranged in a diamond shape for moving a cursor on the display and a button to read selected messages, as well as a button to access other pager functions. The pager measures 3.38 by 0.78 inches and weighs ***4.11*** ounces (see Figure 2-5).

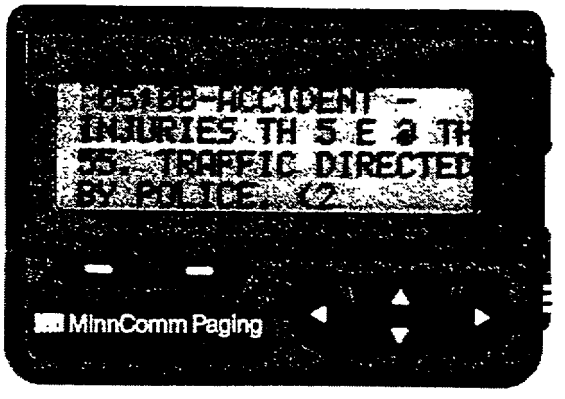

Figure 25. Motorola Advisor Pager

The main menu screen of the pager displayed two lines of triangle characters that represented messages. Each triangle symbol could represent a message, or messages, of up to 230 characters. The triangles were displayed only when messages were present.

- Triangles on the first line represented personal messages
- Triangles on the second line represented group page messages
- Non-Genesis page messages included news, weather, sports, and stock quotes on the second line
- Up to four triangles could be displayed for Genesis traffic messages: two for the north region and two for the south region.

When a message was being received, an icon resembling the back of an envelope was displayed on the screen. During the time that the envelope icon was displayed, the user could not review messages or use the cursor to navigate between mail slots. Thus, when a series of traffic messages was sent, users might have to wait 20 seconds or more before they were able to review or access messages.

The PDA was the Apple Newton MessagePad 110. a general purpose hand-held computer that comes with applications for maintaining personal information such as appointments, phone numbers, and reminders. Instead of a keyboard interface, the Newton has a

touch-sensitive surface over a reflective (no back light) liquid crystal display with a resolution of 320 pixels vertically and 240 pixels horizontally. The Newton configuration for the test had a paper card that inserted into a PCMCIA slot. The user operates the Newton by using a stylus to select icons on the screen. The MessagePad can recognize both cursive or printed handwriting and can accept hand-drawn objects. The device is 8 x 4 x 1.25 inches and weighs 1.28 pounds (see Figure 2-6).

Figure 2-6. Apple Newton MessagePad 110

2.5 EVALUATION MANAGEMENT

SAIC was chosen 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 University of Minnesota Human Factors Laboratory. The evaluation management structure is illustrated in Figure 2-7.

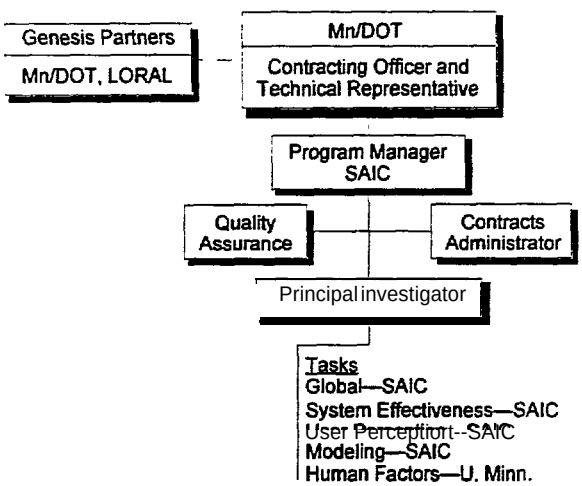

Figure 2-7. Genesis Evaluation Management Structure

2.6 EVALUATION PLAN DEVELOPMENT

The Independent Evaluator published six final evaluation planning documents beginning in February, 1995. All of these documents were in support of the Genesis "Pilot Phase" Evaluation:

- 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 2 1, 1995)
- Pilot Global Test-Detailed Test Plan (February 23. 1995).

Each test contained a specific goal, as identified in Table 2-2 below:

Table 2-2. Genesis Pilot Test Goals

Test	Goal
Global Evaluation*	Document the Genesis partnership arrangement
System Effectiveness	Evaluate Genesis benefits to users
User Perception	Evaluate the acceptability of the Genesis pager system
Modeling	Use a traffic network model to extrapolate from available Pilot Operational Test data what the effects would be of widespread deployment of the Genesis pager technology
Human Factors	Evaluate the adequacy of the Genesis user interface

*Name changed to "Institutional Issues Test;' however. the global nature of the test remained.

SECTION 3. GENESIS INDIVIDUAL OPERATIONAL TESTS

3.1 INTRODUCTION

This section describes each of the five individual tests that were conducted and documented for the Genesis FOT. Each description will contain:

- The purpose of the individual test, including the stated objectives
- A description of the test
- Findings by the Independent Evaluator
- Conclusions from the Independent Evaluator

Specific test hypotheses and measures can be found in the applicable Final Test Reports. All individual Test Report findings and conclusions are solely those of the Genesis Independent Evaluator. The final conclusions were developed by Booz-Allen & Hamilton.

3.2 SYSTEM EFFECTIVENESS TEST

3.2.1 Purpose

The Genesis System Effectiveness Test had three main purposes:

- Recruit Genesis pager users
- Determine changes in user trip behavior
- Estimate user travel time and travel distance changes that result from individual changes in travel behavior.

For the Independent Evaluator, the objectives of the test were to:

- Assess travel duration changes attributable to the use of the Genesis traffic information
- Assess changes in user reported levels of service or congestion encountered by Genesis pager users
- Assess travel distance changes attributable to the use of the Genesis information
- Assess users' travel pattern change (i.e., changes in time of arrival, time of departure, mode of travel, or route of travel) that is attributable to use of the Genesis information
- Assess users' reports of the impact of Genesis information and pager use on driving safety
- Assess impact of Genesis pager information on commercial vehicle operators and specialty operations (e.g., sales and service)
- Determine user reported accuracy of messages sent to Genesis pager users
- Assess users' experience of the reliability of the pagers and the ability of the pagers to receive transportation information
- Determine compatibility of Genesis pager and PDA applications with other user applications
- Describe frequency of Genesis pager use, by gender, age. income, education. computer experience, and driving expertise
- Assess frequency of use by user type (i.e., single occupancy vehicle (SOV), commuter, or commercial vehicle operator).

3.2.2 Test Description

The System Effectiveness test took place between July, 1995 and January, 1996. Test participants (a total of 492) were classified into three groups:

- Existing Users (2 1 0)--Traffic information added to their pagers, which were primarily used for other purposes
- New Users (239)-Not familiar with pagers and used them primarily for traffic information
- PDA Users (43)-Selected randomly from new users volunteer group and provided an Apple Newton PDA equipped with an alphanumeric pager card for receiving traffic information.

User profile surveys, user driving profiles, telephone surveys, and Origin-Destination (O-D) surveys were conducted on these groups. The basic experimental design for the test consisted of two independent variables:

- Route Type-based primarily on roadway frequency of use information derived from Genesis driving profiles. Thirteen 0-Ds were selected. For each O-D, a primary and alternate route was identified.

- Incident-refers to whether an incident was being reported on the primary route when the travel time data were recorded. Travel times for each O-D under both incident and non-incident conditions were recorded.

3.2.3 Evaluator Findings

All statistics and quotes in this section are excerpted from the Genesis System Effectiveness Test Report, April 4, 1997 (SAIC).

3.2.3.1 Impact on Driving

Of the test participants that were contacted during the three telephone surveys:

- Sixty-five percent reported that they used the Genesis system every day

- The reported frequency of use varied little over the course of the 6-month test

- Of those participants who checked the Genesis system every day, 46 percent checked for traffic information before getting into their car

- Another 46 percent checked their systems after getting into their car.

The Independent Evaluator stated that "the implications of these findings are clear: Genesis participants found the traffic information presented on their PCD to be useful."

The Independent Evaluator also noted that "for developers of ITS programs, this finding could be interpreted to suggest that there is a need for both portable and in-vehicle ATIS devices."

Genesis users indicated that the system had an impact on their driving habits. Before the test, most participants stated in their driving profile (78%) that the radio was the most frequently used method of obtaining traffic information. Of the respondents who indicated reported strategies for avoiding traffic incidents, 55 percent chose an alternate route of travel.

The following are findings resulting from the telephone survey data:

- Genesis was the preferred means of obtaining traffic information for 52 percent of the respondents. Of these, 38.5 percent indicated they used Genesis before leaving, while 13.5 percent indicated they used Genesis while driving.

- The next most frequently cited means of obtaining traffic information was to see the signs of, or actually encounter an incident (22 percent).

- Analysis of user-reported responses to incidents indicated that taking an alternative route of travel was the most frequent choice (53 percent).

  - Twenty-six percent reported driving through the incident area

  - Thirteen percent diverted

  - Six percent delayed their trip based on receiving data before departure.

When considering strategies used by those who first learned of an incident through the use of Genesis, the following were found:

- Genesis decreased the percentage of users who drove through incident areas from 42 percent to 12 percent

- Genesis increased the percentage of users who took alternate routes of travel from 32 percent to 73 percent.

The independent Evaluator concluded that "Genesis was effective in affecting travel behavior." The Evaluator further proposed that "one reason for this may

have been that people put more credence in Genesis-provided traffic information." Another postulated reason was that "by keeping traffic information messages available on the pager, Genesis gave users greater opportunity to keep in mind and consider other alternatives."

3.2.3.2 Impact on Travel Times and Encountered Levels of Congestion

The following findings were derived from the O-D data sets developed for the test:

- The average length of the primary routes was 19.6 miles, and the average length of the alternate routes was 20.2 miles (3 percent longer). This contradicts the user impressions of the length of primary versus alternate routes as expressed in their driver profiles, where they indicated they thought their alternates were shorter than the primary routes.

- Users were generous in describing alternate and diversion routes in response to incidents, including multiple incidents and alternates in one trip. The Independent Evaluator concluded that this provided additional evidence that "users selected for the Genesis operational test actively seek to avoid congestion."

- Travel-time tests confirmed that under no incident (baseline) conditions, travel times were longer on alternate routes than primary routes. When Genesis reported congestion or incidents, the travel time difference was negligible. Congestion and travel times increased on both primary and alternate routes when incidents were reported on the primary route and congestion was significantly greater on the primary than the alternate.

3.2.4 Conclusions

The Independent Evaluator concluded that Genesis "demonstrated that an ATIS had an impact on travel behavior," due to the following findings:

- Genesis users reported diverting from congestion resulting from incidents based on information received by PCDs.

- Genesis was used to obtain traffic information by 65 percent of 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 travel time increased more for primary routes under incident conditions on the primary route, relative to alternate routes.

- Under these same conditions, there was no significant difference in travel time between primary and alternate routes.

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."

More results and conclusions with regards to travel time and savings are reported in the Modeling Test Report.

The Evaluator concluded that, Genesis was an effective ATIS that positively affected the driving habits of operational test participants in the Twin Cities area. Usage was high and sustained, and effects on the selection of driving strategies were discernible."

3.3 MODELING TEST

3.3.1 Purpose

The purpose of the Genesis Modeling Test was to provide an objective extension of the findings from the System Effectiveness Test, in order to generate performance estimates for a range of otherwise non-testable conditions that would be of interest to those contemplating the deployment of ATIS on a wider scale. The rationale for the Modeling Study was to address the limitations of scope in the data

collected from a very limited number of participating drivers (approximately 490) as compared to the magnitude of actual drivers in a metropolitan area, or even a single corridor, during any given period. The Modeling Test was intended to use data from the Systems Effectiveness Test and extrapolate for varying levels of market penetration, with regards to traveler speed, time, distance, and fuel emissions.

The objectives of the modeling study were threefold:

- To assess the impact of PCDs on the network level of congestion (e.g., travel time)
- To project the environmental impact of PCDs
- To assess the safety impact of PCDs.

3.3.2 Test Description

The Independent Evaluator selected the INTEGRATION traffic assignment model, developed during the mid-1980s. Details on the description and rationale for the use of the INTEGRATION model can be found in the Modeling Test Report, published December, 1996 (SAIC). The INTEGRATION model was chosen for the following six reasons:

- INTEGRATION models traffic microscopically and thus, information is available on an individual vehicle basis. This allows for the modeling of real-time traffic information that is provided to a specific class of vehicles.
- INTEGRATION can simulate five different vehicle classes, which allowed for the modeling of Genesis users and non-users.
- INTEGRATION models routing and assignment, thus allowing for the modeling of traffic re-routing in response to real-time traffic information.
- INTEGRATION allows for the integrated modeling of freeway and arterial systems. This capability allows for modeling of traffic diversion between the freeway and arterial facilities.
- INTEGRATION models a number of routing capabilities, including a macroscopic rate-based assignment and a microscopic feedback-based assignment. These assignment techniques can range ii-om static to dynamic assignment or from deterministic to stochastic assignment.
- INTEGRATION has been used in the evaluation of the TravTek route guidance system and the ITS systems architecture study.

The INTEGRATION model was calibrated to reflect conditions on the I-35W corridor network, which was selected as the Modeling Test area (Figure 3-l). The selected I-35W corridor is a major urban express-way corridor that runs north-south between Minneapolis and Bloomington, Minnesota and is inside the Genesis coverage area.

This corridor was chosen primarily because it contained four of the O-D field trials that were used in the Systems Effectiveness Test. The traffic flow parameters were derived from the Mn/DOT TRANPLAN node/link file, with some additional inputs from the Highway Capacity Manual (TRB, 1994).

Simulated link flows were compared to observed link flows that were provided from the TRANPLAN model and field data. The Independent Evaluator used a Pearson correlation test that revealed a strong correlation (92 percent) between simulated and observed link flows. However, very high link flows (greater than 3,000 vehicles/ hour) produced greater discrepancies between the two models. The following results were derived from the calibration of the INTEGRATION model to the I-35W traffic network, as stated by the Independent Evaluator:

- The calibration process demonstrated a high level of consistency between the simulated and input flows (92 percent coefficient of correlation)
- The calibration process demonstrated a high consistency with field travel time estimates (generally within the confidence limits).

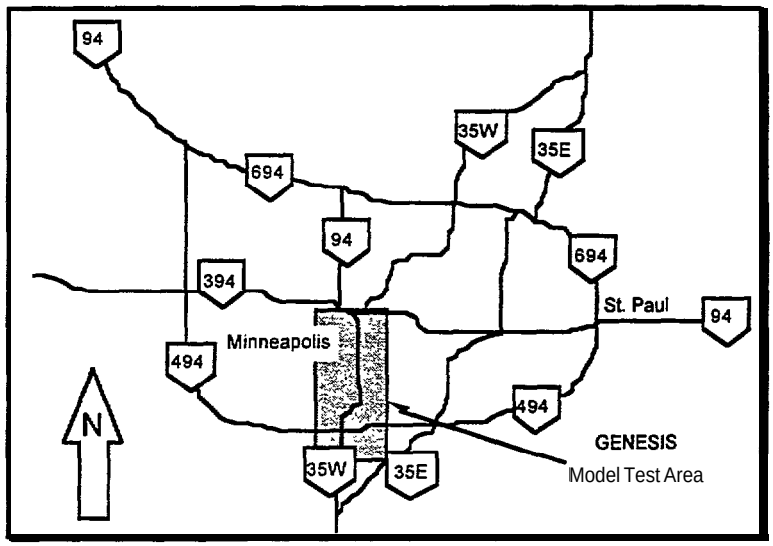

Figure 3-1. Genesis Modeling Test Area

The modeling exercise essentially assessed the impacts of three variables:

- Level of market penetration of PCD users (0 to 99 percent)
- Traffic demand level during the PM peak (80 to 100 percent peak]
- Incident severity (no incident to 2-lane blockage on 3-lane section).

The modeling study was constrained by the following assumptions and caveats:

- Background traffic was modeled using a static deterministic, macroscopic, rate-based user equilibrium traffic assignment.
- PCD-equipped vehicle departure times were inelastic to traffic demands.
- PCD-equipped vehicles were provided real-time information every 15 minutes, resulting in an update frequency of 3 minutes.
- The study assumed both background traffic and vehicles equipped with PCDs could estimate travel times along routes perfectly.
- The study assumed the only source for providing drivers with real-time traffic information was the Genesis system.

A total of 60 runs were conducted, systematically quantifying the impacts of the three variables on the benefits of PCDs. Detailed results of these runs are found in the Modeling Test Report.

3.3.3 Evaluator Findings

Full details of the data are provided in the Modeling Test Report. Figures 3-2 through 3-4 are representative examples of the benefits realized by increasing levels of market penetration (LMP) of a Genesis-like device with motorists using the INTEGRATION model.

Figure 3-2 indicates that if, by giving a set of (PCD equipped) drivers real-time information, and that they elect to change their time of departure and reduce the traffic demand during the peak period, considerable benefits can be attained by all drivers in the corridor. For example. if the peak demand is reduced by 10 percent as a result of departure time shifts, the average trip duration is decreased by up to about 20 percent (100 percent demand level versus 90 percent demand level). However, it can also be seen that as the level of congestion decreases (80 percent line), the benefits also decrease.

From Figure 3-3, a fuller understanding of the benefits non-PCD equipped drivers can realize from increasing LMP is shown.

Figure 3-3 demonstrated that the average trip duration for non-PCD equipped drivers was reduced as the LMP of PCD-equipped drivers increased, particularly up to levels approximating 45 percent. This decrease occurred because the model assumed that PCD-equipped

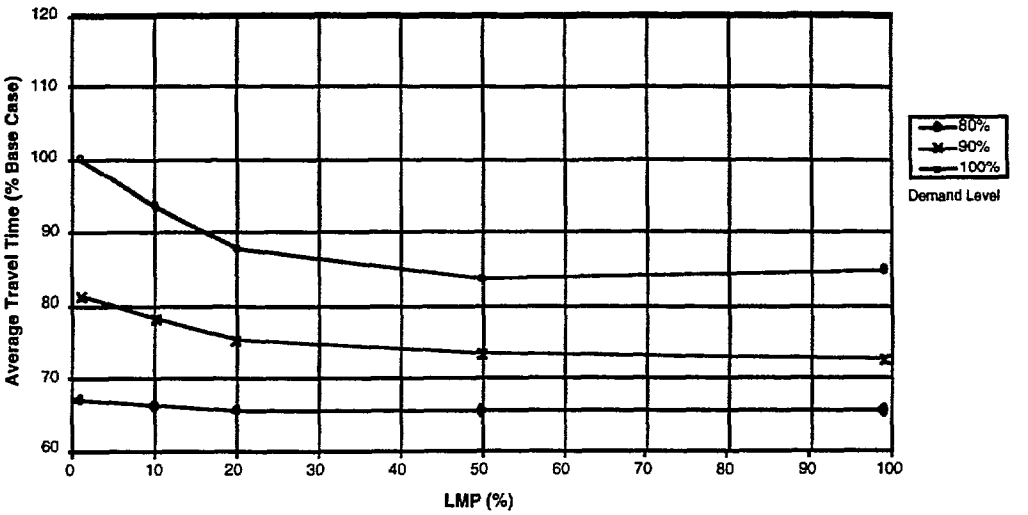

Figure 3-2. Variation in Average Trip Time of Entire Vehicle Population as a Function of LMP and Demand Level (No Incident)

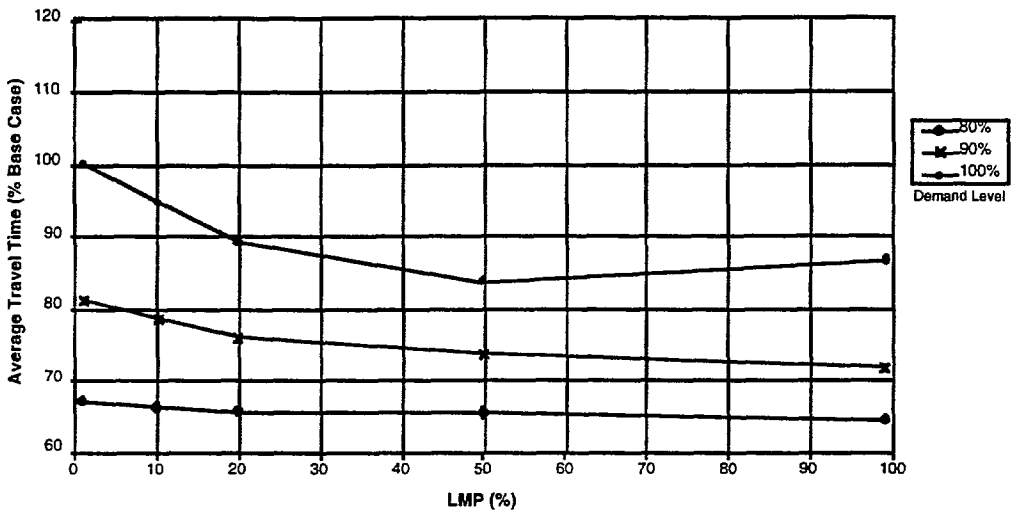

Figure 3-3. Variation in Average Trip Time of Background Traffic as a Function of LMP and Demand Level (No Incident)

drivers chose to divert from the I-35W freeway, thus reducing the level of congestion experienced by the background traffic.

In contrast, Figure 3-4 shows the variation in trip time for those drivers who are equipped with PCDs.

From the INTEGRATION model, Figure 3-4 indicates that the average trip time for PCD-equipped drivers would not vary greatly as a function of LMP. However, in contrast to Figure 3-2, it should be noted that the PCD equipped drivers selected routes that were 15 percent faster than routes utilized by background traffic (non-PCD equipped) even under no-incident conditions.

It is also important to note that the model indicated that having PCDs would result in a reduction in the average travel time during non-recurring congestion based on the assumption that these devices provided information on congestion and planned events in addition to incident information, which further assisted those drivers in avoiding congestion.

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

- PCDs may 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 these devices. Further benefits may be achieved during non-recurring congestion, depending on the severity of incidents.

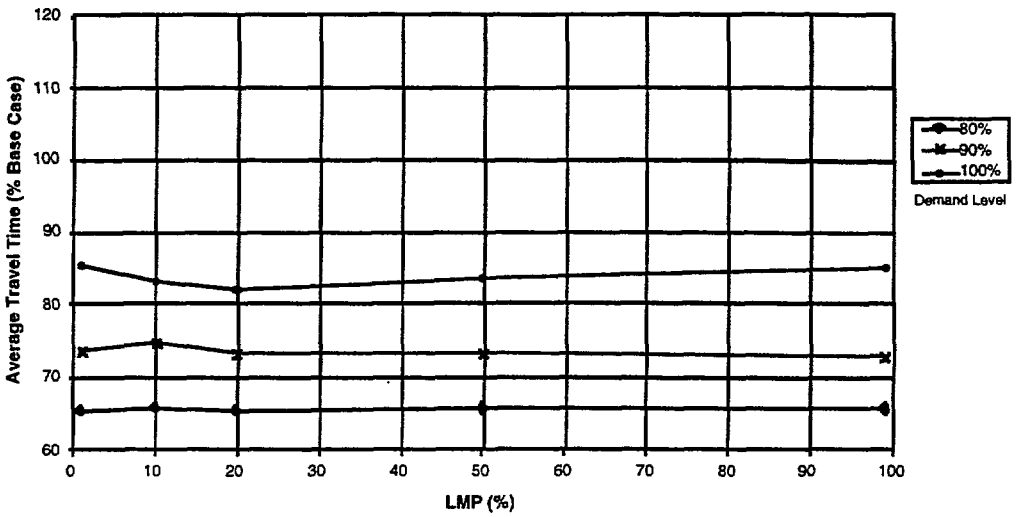

Figure 3-4. Variation in Average Trip Time of PCD Equipped Vehicles as a Function of LMP and Demand Level (No Incident)

- The benefits of PCDs, in terms of savings in average travel time, are expected to increase as the level of congestion in the network increases.
- PCDs provide little benefit in reducing average travel distance, CO emissions, and accident risk (benefits less than 1 percent).
- PCDs may reduce vehicle stops, fuel consumption, and HC emissions by up to 5 percent. Most of these benefits are expected to be achieved through a 20 percent utilization of these devices.
- PCDs may increase NO_x emissions by up to 5 percent.

3.3.4 Conclusions

Although the modeling results were consistent across the range of impacts (as detailed in the Modeling Test Report), it must be understood that a simulation study is an attempt to replicate reality. The results of a simulation should be carefully considered within a set margin of error, the assumptions, and the caveats. Furthermore, the Independent Evaluator reminds the reader that the results of this study were extrapolated from the traffic and network conditions within the I-35W network, and that discretion is required for comparing these results or extrapolating them to other network and traffic conditions.

3.4 USER PERCEPTION TEST

3.4.1 Purpose

The purpose of the Genesis User Perception Test was to evaluate users' perceptions of the Genesis system as measured by responses to questionnaires and focus groups.

The objectives of the User Perception Test were:

- Determine accuracy of messages sent to the Genesis PCD
- Assess usefulness of incident detection and reporting
- Assess understandability of messages received
- Assess Genesis PCD reliability
- Assess Genesis PCD signal availability
- Assess user impressions of message format
- Assess Genesis PCD ease of use
- Document improvements recommended by users
- Document actual benefits to the user
- Document Genesis benefits to society
- Assess willingness to pay for Genesis PCD

- Assess Genesis PCD usefulness
- Assess usefulness of real-time data in route planning
- Assess user perception of information reliability
- Assess user perception of communications reliability
- Assess use perception of PCD reliability
- Assess use perception of traveler safety.

Specific Measures of Effectiveness (MOEs) and Measures of Performance (MOPs), data sources, etc., for these objectives are found in the User Perception Test Report, December, 1996 (SAIC).

3.4.2 Test Description

Although the operational phase of the Genesis FOT began in July, 1995. the User Perception portion of data collection did not begin until the following December. Questionnaire surveys were distributed to the three groups of pager users (existing, new, and PDA users). Six focus groups (two for each device) were also conducted.

The majority of the questions on the survey were Likert-scale items: that is, affirmatively worded statements such as "Genesis traffic incident information messages were timely," and followed by a set of seven possible responses. A value of "1" meant the respondent strongly disagreed with the statement, and a "7" selection meant that they strongly agreed. Questionnaire items were prepared for each of the User Perception Test objectives.

Six focus groups were also conducted, during December, 1995 and January, 1996; two groups from each of the three pager groups (existing, new, and PDA). The Objective, Reflective, Interpretive, and Decisional (ORID) design method was used to conduct the focus group meetings. The ORID research design elicits responses from participants from the following four topic areas:

- Objective-Definitive and factual
- Reflective-Emotions, associations, and feelings
- Interpretive--Values and equivalent meanings
- Decisional-Future resolve (whether or not to buy, lease, etc.).

3.4.3 Evaluator Findings

All statistics and quotes in this section, unless indicated otherwise, come directly from the Genesis User Perception Test Report, December, 1996 (SAIC).

3.4.3.1 Questionnaire Results

Questionnaires were returned by 175 test participants. The majority of the respondents (123) were from the New User group. The Independent Evaluator speculated that the low rate of return among the Existing User group "may have been the result of dissatisfaction with the Genesis service. However, an unknown number of these individuals never received Genesis messages. Their failure to receive messages apparently resulted because their pagers were turned off when the signal was broadcast to initiate Genesis services, or they were in a poor coverage area. This initiation was a one-time event that set up the pagers to receive traffic information in the four slots reserved for it."

The following is a synopsis of the demographics of the questionnaire respondents:

- Approximately 75 percent were male
- Forty-four percent were 36 years of age or younger
- More than 75 percent reported holding a bachelor's degree or higher
- Most indicated they were familiar with high technology items (i.e., computers)
- The median annual driving mileage was approximately 25,000 miles.

Findings are categorized by user satisfaction, suggested improvements, perceived benefits, user perception of devices, willingness to pay, and safety. Specific statistics from the responses are provided in the User Perception Test Report

The following findings were made regarding user satisfaction:

- Users tended to view the messages as accurate, useful, and easy to understand.
- For the most part, users reported messages to be timely.
- Although ratings of understandability and accuracy were generally positive, they were not overwhelmingly so.
- Planned event messages were identified as particularly useful, timely, and accurate.
- Congestion messages were often mentioned as not useful because of uncertainty of the distinction between slow, stop and go, and heavy traffic.
- Previous users were least positive about congestion messages, and expressed more skepticism regarding timeliness of incident messages.

According to the Independent Evaluator, users seemed to consider the operational test as a suggestion of what is possible, rather than a final product demonstration. "Thus, whereas traffic information on the radio was viewed as comparable to the Genesis service, both in questionnaire and focus group findings, many of the participants suggested that they would continue to use Genesis if improvements were made."

Suggested improvements for Genesis included:

- Inclusion of more roadways
- Expansion of the coverage area
- Enabling of personalized reports- roads and times specified by the user
- Reporting of travel speed, time, and severity of congestion more clearly
- Suggestions of alternate routes
- Reporting anticipated clearance times for incidents and congestion.

With regards to perceived benefits. users perceived Genesis as helping them to avoid congestion by providing more information for route planning. Reducing travel time was not viewed as a major benefit. Respondents did not apply the information to decisions regarding transit and carp001 options.

The following findings were made concerning perception of the devices themselves:

- Pager users were generally satisfied with the Motorola Advisor. With few exceptions, users did not report problems receiving messages. However, members of the previous user group did not like the feature that prevented them from viewing messages while new pages were being received. This had a negative influence on their perception of Genesis messages, as volleys of traffic information messages could tie up the device for up to 20 seconds.
- PDA users were not satisfied with the MessagePad and Messagecard combination. The process of downloading messages was viewed as inconvenient. The PDA was regarded as too bulky and too valuable to be carried everywhere.

The following findings were made concerning user willingness to pay:

- Genesis was viewed as more valuable than a premium cable television subscription, a 1 -month daily newspaper subscription, an issue of a national magazine, or 4 hours of parking downtown.
- Traffic information was rated much more valuable than sports score and stock quote messages on the pager--- two services already a part of the package.

Regarding safety, the following findings were derived from the questionnaires:

- Approximately half the pager users and nearly all of the PDA users do not believe it is safe to consult their respective devices while driving.
- Many users (almost all of the pager users) at least occasionally

consulted their devices while driving.

- There is no direct evidence that Genesis participants created a hazard when they consulted their pagers, and no evidence that providing traffic information on pagers will increase the overall incidence of traffic accidents.

3.4.3.2 Focus Group Results

The following findings were made by the Independent Evaluator, with regards to the same categories as the questionnaires:

- User Satisfaction-Focus group participants indicated they were not interested in "slow traffic" messages unless the traffic was significantly slower than usual. Reports of recurring congestion were not useful to the regular traveler who has already taken it into account.
  - The participants indicated they would prefer to receive travel time (in minutes) or travel speed (in miles per hour) over messages with imprecise adjectives or adverbs.
  - Previous users were least positive about congestion messages and expressed more skepticism regarding the timeliness of incident messages. These users were also sensitive to perceived interference of traffic information messages with the use of pagers for business and personal reasons. It appeared to the Independent Evaluator that ratings of timeliness and usefulness were negatively influenced, among previous users, by frustration with perceived interference between traffic and other messages.
  - Suggested Improvements-The focus groups reflected the questionnaires with regards to their perception of the test as a view of what is possible. Although traffic information on the radio was viewed as comparable to Genesis, many suggested they would continue to use Genesis if improvements were made.
- Perceived Benefits-Participants tended to stress the potential for benefits, rather than what was received during the test period. In particular, they stressed that the timeliness of incident messages would need to improve before they could expect actual benefits.
  - Participants were suspicious of potential benefits to be derived from widespread use of improved traffic information. Many expressed the belief that widespread use of real-time information would negatively affect personal benefits by increasing congestion on alternate routes.
- Perception of the Devices-no specific results from focus groups were identified in the report.
- Willingness to Pay-In focus groups, estimates of the value of Genesis tended to range between $5 and $10 a month. No other information from focus groups was provided.

3.4.4 Conclusions

According to the Independent Evaluator, the Genesis FOT 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 mileage exceeded 25,000 miles reported that pagers were a convenient way to receive traffic messages. Participants with reported annual incomes of 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 availability of information with regards to the number of roadways and message content. More control over what is actually received was seen as a major improvement needed.

Existing users stated #at 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 existing pager uses that are perceived as critical to those who use them for other reasons that are important to them as well.

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.

In summary, the Independent Evaluator concluded that the 'Genesis FOT provided a good indication of the types of traffic information service that travelers desire, and of the technical and infrastructure challenges to the successful implementation of such a service."

3.5 HUMAN FACTORS TEST

3.5.1 Purpose

The Human Factors Test had two objectives:

- Provide a literature review and synthesis of human factors relating to the use of devices, such as cellular phones, pagers, car radios, cigarettes, etc., (driver multi-tasking)
- Assess Genesis message format suitability.

3.5.2 Test Description

Driver Multi-Tasking-This task was limited to a review and analysis of the literature relating to multi-tasking and vehicle driving in normal traffic conditions. Previous research by the University of Minnesota Human Factors Laboratory was included in the review. This review was broken down into four basic research areas, which are summarized as follows:

- Divided Attention Issues in Driving-One of the main issues concerning in-vehicle ATIS systems is that of distributed attention. The literature research gravitated around the issue of increasing the driver's workload from basic driving tasks and the subsequent effects on safety (i.e., susceptibility to a collision).
- Workload and Secondary Tasks-This area concerns research done to understand the level of driver performance as secondary tasks increase, and the extent to which increasing the secondary task will impair either driving performance or the performance of the secondary task, depending on the overall and comparative loads on the driver.
- Multi-tasking-This research area concerns driver performance as it relates to performing other tasks that are completely unrelated to driving (i.e., putting on make-up, smoking, talking on the phone, etc.).
- Information Processing Workload-This research area is related to the first; however, the discriminating feature is the use of metrics in determining the total information processing rate of an individual, and the measures of degradations in performance when that rate is exceeded.

Message Format Evaluation-This task focused on three areas of message suitability, which are summarized as follows:

- Legibility-This area focused specifically on the readability of discrete messages from pagers and PDAs under varying light conditions in a vehicle.
- Message Content-This area focused on user ability to not just read, but also understand the messages presented, specifcally with regards to message consistency and representativeness (accuracy).
- Hierarchical Structure--This area focused on the conveyance of information on several levels, and as it relates to the needs of all users (i.e., what, where, and how long).

3.5.3 Evaluator Findings

From 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. We cannot state 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 pager or PDA is used, this will divert some attention from driving and add to the driver's information processing load.

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.

3.5.4 Conclusions

No specific conclusions were provided from the Human Factors Test.

3.6 INSTITUTIONAL ISSUES TEST

3.6.1 Purpose

The Genesis institutional Issues Test was derived from what was originally planned as the Global Test; the purpose being to document the overall Test Effort, with supporting objectives addressing institutional issues, system improvements, etc. The objectives of the Institutional Issues Test were as follows:

- 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 to PCD technology.

Section 3.6 will remain focused on the institutional issues identified in this evaluation task. Lessons learned, partner goals, and future applications are addressed in Section 5.

3.6.2 Test Description

The basis for the Institutional Issues Test was a Volpe Center document, published in June, 1994, entitled Review of the ***Travlink*** and Genesis ***Operational*** Tests. This document identified 44 "existing" and 18 "possible" institutional issues that, at the time, were seen to apply to both the Genesis and Travlink FOTs. These issues were grouped into what was known as "The Volpe Center Checklist."

The existing and possible institutional issues in the Volpe Checklist were grouped into 10 categories:

- New Business Relationships-How to establish and conduct ITS business relationships

- Contracting and Auditing-How to establish public-private ITS partnerships

- Organizational Coordination-Intra- and inter-agency coordination within Mn/DOT required for successful deployment of ITS programs

- Funding—What it takes to obtain public and private finding for ITS projects
- Human Resources—How to attract qualified staff to work in ITS and develop appropriate work habits
- Intellectual Property and Royalty Rights—How to sort out proprietary and ownership rights for ITS partnerships
- User Perception and Acceptance—How end users of ITS services perceive the usefulness of the product
- Project Evaluation—How to determine ITS benefits
- Implementation and Deployment—How to develop economies-of-scale to implement ITS programs most efficiently
- Standards and Regulation—How to develop appropriate standards and regulations for ITS without restricting development and deployment.

Semi-structured, individual interviews were conducted over a 5-week period with selected partner representatives at their base location. This interview began with a short survey that required about 15 minutes to complete, followed by question and answer. The questions were guided by a protocol that was divided into four areas:

- Partner-representative background
- Organizational perspective
- Identification of institutional issues and lessons learned
- Future solutions.

For identification of Institutional Issues, which constituted the bulk of the interviews, participants were first asked to score "existing" and "potential" Genesis institutional issues that were identified in the Volpe Center report for their actual impact on Genesis. The list of these issues included those applicable to both Genesis and Travlink. Each participant was then asked to discuss the three-to-five most important Genesis institutional issues, either previously identified by the Volpe report, or new issues.

3.6.3 Evaluator Findings

Knowledge gathered from the institutional issues test will be useful to Mn/DOT as the agency moves toward a broader-scale traffic information dissemination project for future full-scale deployment. This also provided a learning curve for Mn/DOT, Guidestar, and the Metro Division with regards to system integration and testing of technologies that were originally developed independently of each other.

3.6.3.1 Methods Used to Promote Institutional Cooperation

Figure 3-5 illustrates the organizational position of the Genesis FOT within Mn/DOT. The Genesis FOT was conducted under the programmatic auspices of Guidestar program and managed by the Mn/DOT office of Advanced Transportation Systems.

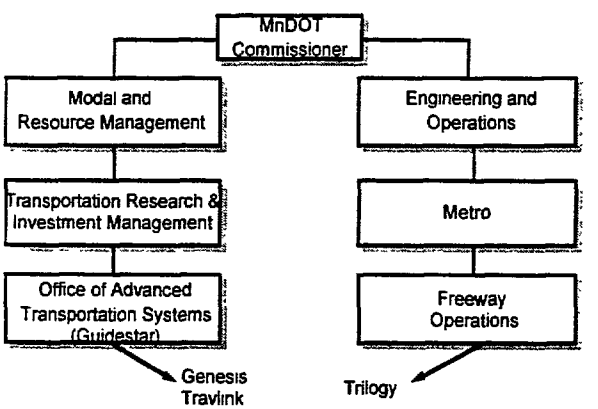

Figure 3-5. Mn/DOT ITS Operational Test Organization for Genesis

Although a Guidestar program, the Genesis project location resided in the TMC in Minneapolis, which belongs to the Metro Division, which is a part of the Engineering and Operations Bureau. Furthermore, the Genesis FOT required technical interface with the Trilogy Operational Test, which was being conducted under the direction of the Metro Division.

To address this situation, a Genesis Working Committee was established, with participation from the project partners and other affected organizations and projects. This committee met approximately every 6 weeks to address development and

deployment issues related to Genesis, and to coordinate with the other projects.

The Genesis project shared equipment resources with other projects whenever possible. For instance, the Genesis and Trilogy FOTs shared a workstation at the TMC. In addition, although the two ATIS projects were to coordinate with each other technically, software algorithms for determining incident locations were discovered to be different between the two. This required the two projects to work closely together to determine how incident locations needed to be differently formatted so as to best facilitate message transmission for each project.

The Genesis and Trilogy project also agreed to share the expenses of a System Administrator and operators to save money. Specifically, Genesis paid for the System Administrator and Trilogy paid for the operators.

3.6.3.2 Institutional Issues

This was the main focus of the Institutional Issues Test.

- Twenty-seven institutional issues were discussed by partner representatives
  - Twelve issues (4.4 percent) were identified as being existing or possible issues as identified in the Volpe Report
  - Fifteen issues (56 percent) were newly identified issues
- Thus, of the 62 (44 existing, 18 possible) issues previously identified by the Volpe Report, only 12 were selected to be discussed by partner representatives
  - Most issues discussed were new issues
  - The development and deployment experience apparently brought issues to the forefront that were previously not known.

The major findings of the Institutional Issues Test are best grouped by describing (11 the most significant existing and possible issues that were identified by the Volpe Center and (2) newly identified issues that actually impacted the conduct of the test.

3.6.3.2.1 Existing Issues

Of the Volpe Study issues, the most commonly identified issues were grouped into two areas, funding and organizational coordination.

- Funding-The three main issues identified were:
  - Funding limitations can negatively impact the scope and level of the functionality of an operational test
  - Funds have not been committed for implementation of products and services after the test is complete
  - Federal funds for ITS projects are not released as quickly as possible.

The major concerns expressed were that the lack of expected FHWA funding for phases 2 and 3 of Genesis severely impacted the evaluation of the test and impaired the ability of Mn/DOT to deploy Genesis after the test was complete. It was asserted that the system would have received better feedback and evaluation if phases 2 and 3 were funded, thus providing an opportunity for improvements in the PCDs to take hold. Furthermore, some participants allegedly questioned the long-term commitment that is being provided to ITS. Nevertheless. the Independent Evaluator observed that the test was conducted "pretty much on schedule, with feedback that was fairly encouraging regarding the need to continue the dissemination of traffic information to Twin Cities area travelers."

- Organizational Coordination-The two main issues identified were:
  - Operations personnel within Mn/DOT view ITS activities as add-on functions
  - Changes in Mn/DOT executives could affect the ITS program.

The operations personnel topic was the second-most frequently discussed topic in the interviews, and indicates that Mn/DOT could have done a better job coordinating the development and deployment of ITS

projects. Given the fact that other ITS projects were also conducted in the TMC, this points to the need for a more thorough analysis of the operational impacts of ITS, especially on operations personnel.

The second topic reflected a concern at the time due to the very new, and somewhat "upstart" status of ITS (then known as Intelligent Vehicle Highway Systems, or, IVHS). ITS was new to the rank-and-file members of Mn/DOT, and the idea of public-private partnerships and projects that crossed organizational lines were previously unknown to people who were accustomed to doing business in much more traditional ways. Among the participants, it was feared that if certain people in upper management left their positions, that the future of ITS programs in Mn/DOT would be in jeopardy.

3.6.3.2.2 Significant New Issues

The 15 new issues identified by the Genesis representatives were condensed into 11 topics. which were in turn grouped into three categories (1) implementation and deployment, (2) contracting and auditing, and (3) organizational coordination.

The seven topics that were newly identified as implementation and deployment issues were:

- Feasibility of PDA operations should have been determined in advance
- Integration of related projects was not a high priority
- Better technical support was needed from the development contractor
- The development process was not clearly specified
- Software changes caused development delays
- Performance requirements were not specified
- Sustainability of Genesis is questionable.

These new issues made sense to the Evaluator. since these issues were not obvious or anticipated before the start of the project. However, it should be pointed out that these are mainly technical issues, and not institutional.

Two topics that were identified as contracting and auditing issues were:

- Viability of the partners needs to be determined in advance-For example, a supplier of one of the early PDAs proposed for the project became insolvent. This caused problems for the develppment contractor, because a new, compatible PDA needed to be found quickly.
- Strategic negotiation process for ITS projects is diificult-For example, it was felt that the free-form negotiations that initially took place between the public and private sector partners could have proceeded more smoothly if both parties had a better understanding of each other's contracting history. contracting preferences, and what each party wanted to derive from the project. Factors to be considered are the differing contracting requirements/perspectives of federal and state agencies, the fact that ITS partners may not share a common framework for negotiation, and the parameters surrounding the new and special contracting requirements imposed by ITS partnership agreements promoted by FHWA.

Two topics were newly identified as organizational coordination issues:

- Metro and Guidestar divisions of Mn/DOT need to work more effectively together-There was an identified need to better coordinate the installation, testing and updating procedures for any future ITS software placed in the TMC.
- A gap in expectations for ITS projects exists between regional and national FHWA offices-An example cited in this regard was the differing perspectives forwarded by FHWA personnel regarding the significance of Genesis phase 2 and ***3,*** and the need, on particular, to fund these latter phases.

56.4 Conclusions

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 operating units.

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

- Funding cut-backs
- Newly-Identified Implementation and Deployment Concerns
- Organizational Coordination.

Funding cutbacks were felt to be the major problem for Genesis because they resulted in a reduced scope of services.

- In particular, the poor user interface for both users and system operators occurred because improvements to these systems were supposed to be identified in the first phase of Genesis and implemented before the start of phases 2 and 3.
- In addition, functions that were planned for phases 2 and 3 (e.g., providing route-specific information, two-way communication capabilities) and that had the potential of significantly improving user satisfaction were not implemented.
- Finally, the lack of continuation funds put a damper on the purported significance of the Genesis FOT.

Newly identified implementation and deployment issues were considered to have significant impacts on the FOT because they hindered deployment of the system. Among the specific requirements identified were:

- The need to conduct feasibility analyses in advance of system development
- Make system integration a high priority
- Provide timely technical support
- Clearly delineate an overall development process
- Minimize software changes
- Delineate system performance requirements
- Build a sustainable system.

Organizational coordination was one of the top three Genesis FOT institutional issues because it highlighted the need for improved coordination between Mn/DOT operating units. In short, the concerns expressed primarily appear to be communications-better communications regarding the planned ITS activities of the Guidestar program of Mn/DOT is needed because these projects may have very real impacts on the activities of other offices (e.g., Operations) within Mn/DOT. In addition, coordination of integration testing activities of the various ITS projects that were being fielded in the TMC could have been better planned.

SECTION 4. GENESIS EVALUATION ISSUES

4.1 OVERVIEW

The Genesis FOT was one of the early operational tests in the FHWA program. Due to the pioneering nature of the project, some aspects with regard to structure and funding were new and unique to everyone involved, particularly to those from the traditional road transportation community. Any post-test review should take into account the fact that this partnership was one of several operational tests that were breaking new ground in ITS projects, specifically with regards to making traffic information available to the public.

In summing up the results from the five individual Test Reports, three main issues arose that merit further examination:

- Deployment/Funding
- Modeling/System Effectiveness
- User Responses/System Technical Capabilities.

4.2 DEPLOYMENT/FUNDING

Genesis operations ceased immediately upon the conclusion of Phase 1, which was the only phase ultimately funded. Lack of funding for Phases 2 and 3 were cited as an institutional issue: nevertheless, raising the issue of funding termination by itself did not fully answer the question concerning deployment potential.

4.2.1 Response to Deployment/Funding Issues

Advanced phase funding for Genesis was terminated due to FHWA concerns that the system could not collect travel time data on arterial roadways, and due to competing program interests for funding from FHWA to Mn/DOT. The programmatic shift in Guidestar occurred when it appeared that FHWA approval for latter test phases would not be forthcoming.

This test was not reflective of what could be expected under an actual business type of arrangement. Mn/DOT was working with a single pager supplier. The Mn/DOT equipment communicated with the pager company over a single modem which directed the data to specific mail slots. The way the project was structured, the partners could not have participated as they did without the FHWA/Mn/DOT funding arrangement. There was no provision to support further public/private partner involvement in the project as structured after the original funding was depleted.

4.3 MODELING/SYSTEM TEST EFFECTIVENESS

The findings from the System Effectiveness Test field trials indicated that PCD users did not save a significant amount of travel time from using the PCD device. Figure 3-4 (from the modeling test) demonstrated that PCD users were saving up to 15 percent of travel time, particularly during 100 percent travel demand conditions. These are contrasting conclusions, and the 15 percent savings from the modeling test is noticeably different from the System Effectiveness Test.

4.51 Response to Modeling/system Effectiveness Test Issues

Examination of the model caveats offers perhaps the best explanation for this discrepancy. In the model, Genesis is the only source of real time traffic information for any of the modeled vehicles: therefore, non-PCD vehicles were not receiving real-time information at all. Furthermore, non-PCD users were not able to 'optimize" themselves based on the same types of information available to most vehicles in reality, such as radio reports, experience on the roadways, etc.

The model would be more reflective of real-world conditions if a certain percentage of non-PCD equipped vehicles also altered behavior in an attempt to optimize. This would increase the traffic volume on alternate routes chosen by PCD-equipped vehicles. thus reducing speeds and narrowing the time savings, which would presumably bring the results closer to the findings in the System Effectiveness Test. It is understood that complexity and cost are obstacles to this approach.

4.4 USER RESPONSES/SYSTEM TECHNICALCAPABILITIES

In the User Perception Test Report, there were numerous suggestions regarding

ways to improve the service (i.e., route-specific information, customized route information, more detailed information, etc.). This raised two improvement-related questions:

- Was it possible or feasible to fit these kinds of improvements into a pager?
- Would the user-identified improvements necessitate migrating to a physically larger device?

Also in the User Perception Test Report, it was stated that many "existing" Motorola Pager users did not receive ATIS information, and that for some reason. their pagers did not receive the initial "start-up" message. There is no mention in the report as to whether or not this situation was remedied. The following questions relating to user perception were:

- Did these participants ever receive ATIS information?
- Did they participate in the surveys?
- Were they getting ATIS information before providing feedback?

4.4.1 Responses to user Responses/ System Technical Capabiities Issues

According to the Project Manager and the Independent Evaluator, many of the improvements cited by the test participants should be conditioned by two considerations:

1. Information that can be provided by Mn/DOT
2. Information that can be provided by a paging system.

User-identified improvements regarding traffic information, and particularly, estimates of delay, incident and clearance and alternate route information require data not currently available to Mn/DOT. The manner in which the Metro Division gauged traffic flow on the freeways did not directly translate into numeric speeds.

There is agreement that the pagers could have provided an improved message, given more time for user feedback and technical refinement. particularly with regards to message legibility and consistency: however, it is not possible to predict exactly to what level the pagers could be improved from what was demonstrated during the test to make the system more attractive to users. Nevertheless, it would not be necessary to migrate to a larger device, such as a PDA in order to incorporate the improvements as they are currently understood.

The reaction to the Apple Newton pagers should not be reflective of a reaction to the idea of PDAs as traffic information providers in general. According to the Project Manager, the test software in the device did not work properly, and rendered the device almost useless for traffic information or any other function. The Newton PDA was merely mirroring the functionality of the pager, and not making use of its other capabilities. Data regarding the Newton PDA as a traffic information provider should be heavily discounted for these mitigating reasons, and overall conclusions avoided.

The potential issue with regards to "existing users" and input from the surveys was marginalized by the Independent Evaluator. During follow-up phone surveys, it was discovered that some participants who already used pagers were not receiving traffic information. The Independent Evaluator notified Mn/DOT and MinnComm of the situation, but in some cases, some pagers never did become operational for the purposes of the test. Actual numbers or estimates of this condition are not available. According to the Independent Evaluator, most of those existing users who did not receive traffic information did not provide written survey responses. This was deduced from the fact that most of those people who did return surveys indicated that they were getting traffic information. Thus, the Independent Evaluator believes that the results of the inputs from the existing users were reflective of those who were, in fact. receiving traffic information.

SECTION 5. PERSPECTIVES, LESSONS LEARNED, AND FUTURE APPLICATIONS

5.1 INTRODUCTION

The following partner perspectives and lessons learned were provided to SAIC and reported in the Institutional Issues Test Report (April, 1997).

In order to provide a richer context of the lessons learned provided to the Independent Evaluator by the project participants, it is appropriate to first highlight the various reasons for partner participation in the project from the beginning. The idea of presenting original reasons for participating with after-the-fact perceptions and observations is an excellent way to transmit lessons learned not only from the perspective of a single project testing a personalized ATIS device, but also for ITS operational tests and deployment projects in general. The feedback ii-om the partners with regards to their perspectives and lessons learned was taken in late 1995 and early 1996 as the project was beginning to wind down.

5.2 PROJECT PARTICIPATION PERSPECTIVES

The Independent Evaluator asked all participants to provide their organization's goals for participating in the Genesis FOT. Table 5-1 is a summary of their responses.

Table 51. Genesis Partner Reasons for Participation

Private Partners	Public Partners
Develop market-driven solution for traffic problems in the Twin Cities	Provide traffic information so people can make better decisions
Build and grow ITS business	Opportunity to integrate different ATIS programs
Develop a replicable ITS technology	Provide timely traffic information to the general public
Establish or strengthen relationship with Guidestar partners	Offer options to drivers
Exposure in ITS area	Improve traffic flow
See traffic information become available to general public	Test ATIS concept
Develop incident data-collection subsystem and data interfaces to enhance the technology	Interested in two-way communication technology
	Provide an opportunity to measure travel times-never done before
	Test different delivery methods
	Provide a significant ATIS for users
	Equipment will become core of future incident-dissemination system
	Test the value of using PCDs for providing traffic information
	Learn about technology issues in the ITS area

Table 5-l summarizes a set of reasons that would typically be listed by participants such as those that were involved with the Genesis FOT. The project was unique, not only to the Twin Cities area but to the nation in general. The responses provided indicate a genuine interest from the Mn/DOT Guidestar program, whose charter directs it to explore new technologies for providing better transportation service to citizens of Minnesota. as well as from some forward-minded commercial information providers.

5.3 BENEFITS AND RISKS

The Independent Evaluator also asked the private participants to provide their perspective with regards to what they saw as the potential benefits and risks of the project. These results are summarized in Table 5-2.

Table 5-2. Genesis Participant Perceived Benefits and Risks

Private Participants Perceived Benefits	Private Participants Perceived Risks
Exposure to ITS technologies	Technical risks
Reference-we can say we've done this	Requirements changes from Mn/DOT
Experience working with state contracts	Performance challenge3
Technology integration	User acceptance-not sure about willingness to pay
Chance to put a useful product in front of users	Program failure
Establish relationship with Mn/DOT	Negative image if project falls
Develop ITS workbase	Being a sub-contractor
Establish relationships with Guidestar partners	Requirements/ enhancement risk
Increased pager sales/rental	cost overrun
Exposure	
Learn about technology	
Consolidate database technology	
Work with Mn/DOT on ITS project	
Project exposed to larger audience	
Experience	

Public Participants Perceived Benefits	Public Participants Perceived Risks
Experience working with other operational tests during integration	Contractor problems with project knowledge and system architecture
Fusing data and data distribution	Too much done through contractor and not in-house
Good project for learning DBMS issues	Additional time required for integration and testing
Work with TMC	Not having information due to technical problems
Good user product	Public concern over cost
Experience dealing with private sector	Throw-away technology
Software development/ specification experience	System won't work
Real ITS project with success potential	People won't use it
Learn about technology	Risk relationship with TMC if system doesn't work well (e.g.. DCS)
	No processes for implementation
	Opportunity to develop partnerships

At some point in their involvement, it was apparent to those in the commercial sector that they weren't quite sure whether the public would pay for the product as it was seen to be, and #at there were some problems dealing with changing requirements from the public agency.

From the Guidestar perspective, it appears that the systems integration and organizational challenges became much more visible as the project progressed. Mn/DOT was also learning lessons about dealing with contractors to develop technology systems that were not based on known, proven designs.

5.4 GENESIS LESSONS LEARNED

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. Table 5-3 provides a summary of lessons learned as provided by the partners to the Independent Evaluator.

Table 5-3. Genesis Partner-Provided Lessons Learned

Issues	Specific Remarks
Funding limitations can negatively impact the scope and level of functionality of an operational test	• Adequate feasibility scoping of ITS projects needed • Need to continually "sell" an ITS project until all funding is received • Need to get as much funding for a project in advance as possible • Need to educate more people on the overall development process for a project
Operations personnel within Mn/DOT view ITS activities as add-on functions	• Commitment, or buy-in for the project should have been obtained from the TMC management and operations personnel from the start * Better planning, especially for overall systems architecture and integration testing (the latter of which occurs on-site) should have been conducted in advance of the pmject • TMC operations personnel should have been consulted throughout the systems development process for their inputs rather than when problems (e.g., excessive time required for integration testing) occurred
Metro and Guidestar Divisions of Mn/DOT need to work more effectively together	• Shared vision of project needed • Better communications channels needed - Who determines extent of problem? - Who calls whom when a pmblem occurs? - Who makes the final decision regarding systems integration problems7 • Schedule coordination needed • Shared commitment needed
Federal funds for ITS pmjects are not released as quickly as possible	• State agencies can't assume FHWA funding will always be there, and, as a result, state directors of ITS pmjects should probably seek increased monetary contributions from the private partners • Expectations regarding the results of ITS pmjects should probably be reduced; development schedules should be more realistic, and more careful review of the pmject is probably needed
Funds have not been committed for implementation of products and services after the test is complete	• Private sector should be expected to pick up more of the cost of building traveler information systems • Mn/DOT should hire one company to do the overall system architecture instead of developing multiple projects independently. with multiple companies.
Partners may forget to make customer satisfaction a high priority	• Operations personnel, especially those expected to use and maintain an ITS system. should be involved from the start regarding usability • ITS software specifications should include quality statements (e.g.. availability requirements, query response times) to avoid a broad class of usability problems (e.g.. downed systems. slow query response times) that can hamper operations.
Feasibility of PDA operation should have been determined in advance	• Feasibility of combining new technology needs to be determined in advance of a pmject (e.g.. PDA and pager card compatibility). • Analyses which more clearly specified operational requirements should have been conducted before the system requirements were written.

Issue	Specific Remarks
Integration of related projects not a high priority	• Integration-testing schedules for different ITS systems should be coordinated • Integratton testing procedures should [redacted] impact on more mature systems • Live-trial integration testing procedures should be written to facilitate field personnel effectiveness • Development contractor needs to thomugbly test all integration test procedures before they are delivered
Better technical support is needed from development contractor	• Lines of communication with who's best to solve particular types of problems are needed • All-hours technical support "hot line" is needed • Technical support requirements (e.g., after-hours support) needs to be better specified contracts • Need to better understand each partners organizational culture so that the process of getting to the proper source of information is recognized
Development process not clearly specified	• Projects development process should be documented and understood by all participants before development is initiated • One contractor should be given the job of overseeing complete ITS system design and development rather than having one part to build. • Perhaps all operational tests should be viewed as research and development efforts and funded accordingly (i.e. money should be set aside for systems changes/upgrades that are discovered during system development.

5.5 FUTURE APPLICATIONS FOR GENESIS PCD TECHNOLOGY

The following are suggestions from the partners regarding what they thought were future applications for Genesis PCD technology:

- PCD acceptance critical-FHWA will get cold feet otherwise
- Some type of device, developed in the consumer market area, needs to be developed-should not be market driven by ITS, however
- Wonderful idea. but not sure what people are going to do with it-pagers will be here for awhile, however
- Alternative nodes (e.g.. Internet) for distributing traffic information are necessary
- Phase 2 and 3 applications (e.g., driver profile, two-way communications) were good ideas, but they appeared to get ahead of technology
- Mn/DOT needs to make traffic information available on a wider scale-private sector will then develop/determine delivery system
- Sees hope for in-vehicle and in-home applications
- Genesis needs to be expanded by gaining more service providers
- Transit information needs to be added
- Graphic, map-based interface would be an improvement
- Two-way capabilities would be nice, but may be too expensive
- PCD acceptability by public needs to be improved
- Latter phases of Genesis would be good-depends on PCD technology improvements
- Real time. comparative traffic information is needed
- Different ways to disseminate traffic information are needed
- Automated route planning is needed
- PDA usage needs to be improved, perhaps by adding route planning capabilities
- Route-planning capability based on travel time information is needed
- Fax and telephone servers for distributing information are needed
- Filtering information by route should be attempted.

5.6 CONCLUSIONS

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 aspects of the test were planned.

- The funding for all the planned phases was not locked in
- The technology was not proven

- ITS project management was in itself very new
- The project did not originate with the host organizational entity.

Thus, the lessons learned by the partners are a direct reflection of these characteristics. Nevertheless. the FOT was able to proceed successfully and provide the ITS community with a significant amount of data and information on ATIS operation and impacts.

SECTION 6. FINAL CONCLUSIONS

6.1 OVERVIEW

Booz-Allen & Hamilton Inc. has completed a thorough review of the Genesis Evaluation Plans, the original sets of survey data, focus group feedback, and all five of the Individual Test Reports. In addition to our own reviews, we have also received feedback from the Project Manager and the Independent Evaluator.

6.2 FINAL CONCLUSIONS

Based on the review of the history and documents of this test, and placing the events of this test and the results against the backdrop of our support for ITS FOTs nation-wide, we offer the following final conclusions and recommendations:

- Conclusion: The Genesis FOT was a successful demonstration of the benefits that can be realized through travel time savings and 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, and if there is a significant market penetration rate of ATIS-type systems, the traffic system as a whole may improve. The data clearly show behavior trends that center around the desire to avoid congestion.

- **Conclusion:** 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.

- **Conclusion: The** Genesis POT 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.

- **Conclusion: The** Genesis FOT successfully demonstrated the potential for ATIS information via PCDs to be 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.

- **Conclusion:** 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.