User Perception Test

Prepared for:
Minnesota Guidestar Program
Minnesota Department of Transportation

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1. Executive Summary

Genesis was an Advanced Traveler Information System (ATIS) that used personal paging devices to distribute timely travel information intended to be of assistance to Minnesota travelers.

The primary objectives of the Genesis project were to:

- Influence individual travel decisions
- Determine the technical feasibility of personal paging to deliver traffic information
- Assist in the development of the Twin Cities integrated transportation system.

The Genesis Operational Test was a six month test designed to deploy, test, and evaluate the Genesis system. Two personal communications devices were tested: the Motorola Advisor alphanumeric pager and the Apple Newton 110 with Motorola Newscard pager card. There were three types of messages:

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

Purpose of Test

The purpose of the Genesis User Perception Test was to evaluate Genesis users’ perceptions of the Genesis system as measured by responses to questionnaires and focus groups. Three classes of users were recruited:

- Previous Users were of interest because they represented the population that was already using alphanumeric pagers and for whom traffic information would represent an additional pager service.
- New Users were generally not familiar with the operation of alphanumeric pagers prior to their introduction to Genesis.
- Personal Digital Assistant (PDA) Users received Genesis information on Apple Newton Personal Digital Assistants that were equipped with an alphanumeric pager card.
Methods

Users were mailed questionnaires towards the end of their six month participation in the Genesis operational field test. The questionnaires contained items that addressed objectives set out in the evaluation test plans and detailed in Table 3 on page 17 of this report. The focus groups were conducted with groups of seven to ten participants. Two focus groups were held with members of each of the three user groups: Previous Users, New Users, and PDA Users. The focus group and questionnaire methods of assessing user perceptions were complimentary. Whereas the questionnaires were useful for obtaining quantitative assessments of perceptions from large numbers of participants, the focus groups were useful for obtaining more detailed qualitative impressions from a smaller subset of users who were encouraged to speak openly and share their perceptions with other users.

Questionnaires were returned by 175 of the 448 participants with the highest return rates among New Users (51 percent) and PDA users (47 percent). Previous Users had a low return rate (15%) that may have reflected the less positive perceptions among this group.

Overall, Genesis users were highly educated, middle income persons, who compile high annual mileage. Participants’ median reported mileage was 25,000.

Results

User Satisfaction. Users tended to view the messages they received from Genesis as accurate, useful, and easy to understand. For the most part, users also reported messages to be timely. Whereas ratings of usefulness, understandability, and accuracy were generally positive, they were not overwhelming so. Planned event messages, especially construction messages, were called out by users as particularly useful, timely, and accurate. Congestion messages were often mentioned as not useful. Users were not certain what the distinction between slow, stop and go, and heavy traffic were. In focus groups, users indicated that they were not interested in slow traffic messages if the traffic was not slower than usual, and said that they would prefer travel time (in minutes) or travel speed (in miles per hour) messages to less precise adverbs.
Previous users were least positive about congestion messages, and expressed more skepticism regarding the timeliness of incident messages. Previous users were recruited through employers who supplied their pagers. These users were sensitive to the perceived interference of traffic information messages with the use of the pagers for business and personal pages. Thus it appears that ratings of timeliness and usefulness were influenced negatively, among the Previous User group, by frustration with the perceived interference between traffic and other messages.

Pager users were generally satisfied with the Motorola advisor. Some suggested a larger display area would be useful. With a few exceptions, users did not report difficulty receiving messages. Members of the Previous User group did not like the feature that prevented them from viewing messages while new pages were being received. This feature had a negative influence on their perception of Genesis messages, as volleys of traffic information messages could tie up the device for approximately 20 seconds.

PDA users were not satisfied with the MessagePad and Messagecard combination. The process of downloading messages was viewed as inconvenient. Some users who left their Messagecard on at all times, developed a practice of downloading messages first thing in the morning — a process that could take up to 25 minutes — so that they could view the latest traffic information before they left for work. Other users commented that the PDA was too bulky and too valuable to be carried everywhere.

**Suggested Improvements.** Users suggested several improvements in the Genesis service. Most seemed to consider the operational test as a suggestion of what may be possible, rather than a demonstration of a finished product. 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. Among pager users, most thought that the area of coverage, and the number of roads within the coverage area should be increased. To limit the number of messages not relevant to their travel, many users said they wanted messages better tailored to their travel by allowing them to give more specific road selections.
PDA users want graphical displays of traffic information and methods for requesting information specific to their routes of travel.

**Perceived Benefits.** Users perceived Genesis helped them to avoid congestion by providing more information when they were planning their routes. Reduction in travel time was not viewed as a major benefit. Respondents did not apply the information they received to decisions regarding transit and carpool options.

Focus group participants tended to stress the potential for benefits, rather than benefits received during the operational test. In particular, focus group participants stressed that the timeliness of incident messages would need to improve before they could expect actual benefits.

**Willingness to Pay.** In focus groups, estimates of the value of Genesis service were mostly between $5 and $10 per month. PDA users showed the most variability in willingness to pay with several saying they would pay nothing, whereas others suggested $30 to $100 dollars a month would be reasonable given that improvements were made. In the questionnaire, willingness to pay was addressed by asking participants to compare the value of other services to that of Genesis. In this comparison, Genesis was viewed as more valuable than a premium cable television station subscription, a one month daily newspaper subscription, an issue of a national magazine, or four hours of parking downtown. Traffic information was rated much more valuable than sports score and stock quote messages on the pager — two services that are already provided as part of the basic paging service. It should be noted that value and price, though often related, are not interchangeable. Some products, such as traffic information on the radio, and network television news are free to consumer. Consumers may still perceive a value to these nominally free services, and the questionnaire items asking users to rank the value on Genesis and other products, was an attempt to get at the intrinsic value, not expected price, of the service.

**Perceptions of Safety.** Approximately half the pager users, and nearly all the PDA users indicated that they don’t think it is safe to consult their respective devices while driving. None-the-less, many users, almost all of them pager users, at least occasionally consult
their device while driving. There is no evidence that Genesis participants created a hazard when they checked their pagers. However, given that users will occasionally wish to obtain traffic information while on the move, efforts to make the device driver friendly might have a safety payoff and increase consumer acceptance.

**Conclusions**

The Genesis operational test results suggest that there is a demand for traffic information that may be met by transmission to personal communications devices such as pagers. Important lessons were learned regarding the nature of the information users desire, especially that approximate travel times are preferred to reports that traffic is slow or congested. Users reported that the pagers were a convenient way to receive traffic messages. Participants indicated that they would be willing to pay $5 to $10 per month for a Genesis-like service that distributes timely, accurate, traffic information for relevant routes. Furthermore, users rated traffic information on a pager to be similar in value to daily newspaper, radio traffic reports, and online services. Furthermore, when comparing the Genesis service to other information services, users estimated Genesis to have a value comparable to service that cost up to $20 per month.

Genesis 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.
2. Introduction

Intelligent Transportation Systems (ITS) is part of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 that formed the basis for the Department of Transportation (DOT) initiative to solicit proposals for the operational field tests of ITS products and services. The goals of the DOT ITS Program are:

1. To improve the safety of surface transportation.
2. To increase the capacity and operational efficiency of the surface transportation system.
3. To enhance personal mobility and the convenience and comfort of the surface transportation system.
4. To reduce the environmental and energy impacts of surface transportation.
5. To enhance the present and future productivity of individuals, organizations, and the economy as a whole.
6. To create an environment in which the development and deployment of ITS can flourish.

Operational tests present the opportunities to develop, deploy, and evaluate a specific implementation of ITS. Operational tests also represent a significant step in accelerating the deployment of ITS in North America. They generally entail the support and involvement of Federal, State, and Local Governments in partnership with industry and academia. Resources from public and private organizations are brought to bear to conceive, design, develop, and deploy an ITS that meets the DOT goals.

The conduct of an operational test results in early feedback from the public regarding the viability and perceived usefulness of a specific ITS implementation. Data are also provided to determine the potential benefits associated with full-scale deployment of ITS technologies. Also, lessons learned are derived with respect to the institutional and legal barriers that might affect future operational tests or full-scale deployments.
2.1 Project Genesis

Genesis was an Advanced Traveler Information System (ATIS) that used personal paging devices to distribute timely travel information intended to be of assistance to Minnesota travelers. Genesis was one of the principle elements of the Minnesota Guidestar program’s integrated transportation system. Genesis provided the Minneapolis/St. Paul area travelers with current traffic incident data.

The primary objectives of the Genesis project were to:

• Influence individual travel decisions
• Determine the technical feasibility of personal paging to deliver traffic information
• Assist in the development of the Twin Cities integrated transportation system.

Secondary objectives of the Genesis project were to:

• Expand traffic monitoring capabilities
• Integrate traffic and transit information databases
• Determine appropriate information for dissemination and advice
• Manage the expanded traffic operations database.

2.2 Background

The following sections provide a brief overview of the Genesis System, the Genesis Operational Test, and the operational test evaluation that included this User Perception Test.

2.2.1 Genesis System Description

The Genesis System was an ATIS. The system provided traffic information to travelers using wireless radio to transmit messages to personal communications devices. Two personal communications devices were tested: the Motorola Advisor alphanumeric pager and the Apple Newton 110 with Motorola Newscard pager card.

Genesis was sponsored by the Minnesota Department of Transportation (Mn/DOT) as part of the broader Guidestar program. Guidestar is responsible for implementing Minnesota’s Intelligent Transportation Systems (ITS) program. The goals of the Guidestar ITS program are to:
• Enhance mobility and reduce congestion
• Improve safety
• Reduce environmental impacts
• Promote new institutional relationships
• Develop public-private partnerships
• Promote a key role for academia
• Promote and strengthen ITS research and education
• Develop innovative applications of academic research
• Promote public acceptance
• Maintain ITS leadership.

The Genesis system concept, depicted in Figure 1, was composed of four subsystems:

• Data Collection Subsystem (DCS)
• Traveler Information Processing Subsystem (TIPS)
• Communications Subsystem (CS)
• Personal Communication Device (PCD) Subsystem.

DCS. The DCS consisted of two workstations located in Mn/DOT’s Traffic Management Center (TMC). Operators used the DCS to enter traffic incident and event messages into the Genesis system.

There were three types of messages:

• Congestion (i.e., slow, heavy, stop-and-go)
• Incident (i.e., accidents, disabled vehicles, lane closure)
• Planned Event (e.g., stadium events, construction).
The messages conformed to International Traveler Information Interchange Standards. These standards specify an *event* description, a *location* identification, the traffic *backup extent*, and an *expected duration* estimation. Genesis messages conformed to this standard, except that it did not provide a duration. Typical messages broadcast during September 1995 are shown in Table 1.

**Table 1. Typical Genesis Traffic Information Messages.**

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>09/01/95</td>
<td>12:48</td>
<td>S:I-35W N roadway reduced to one lane. Slow traffic From:CR 42 To:HWY 13</td>
</tr>
<tr>
<td>09/01/95</td>
<td>06:17</td>
<td>S:I-35W S disabled vehicle From:I-94 (W JCT) To:31ST ST</td>
</tr>
<tr>
<td>09/01/95</td>
<td>17:43</td>
<td>S:I-35W S road construction. left lane closed From:46TH ST To:DIAMOND LAKE RD</td>
</tr>
<tr>
<td>09/01/95</td>
<td>06:32</td>
<td>S stop and go traffic From:CARLSON PKWY To:HWY 7</td>
</tr>
<tr>
<td>09/05/95</td>
<td>16:46</td>
<td>N:I-35E N heavy traffic From: PENNSYLVANIA AVE To:LARPENTEUR AVE</td>
</tr>
<tr>
<td>09/01/95</td>
<td>08:01</td>
<td>N:I-35W S accident From:UNIVERSITY AVE To:HWY 55</td>
</tr>
</tbody>
</table>

The TMC was Mn/DOT’s Minneapolis-based, Traffic Management Center. It monitored traffic primarily through video display from closed-circuit cameras along controlled-access highways in the Twin Cities area. In addition, it collected loop detector information and controlled ramp meters. Besides providing traffic information through Genesis,
the TMC disseminated traffic information to Minneapolis/St. Paul travelers via radio broadcasts and changeable message signs. Radio broadcasts were transmitted over 88.5 FM (KBEM).

**TIPS.** 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 CS for broadcast to the user devices. Figure 2 depicts the boundaries of the two coverage areas. Traffic incident information was provided for limited access roadways within the coverage areas. TIPS also stored Genesis messages in a relational database.

**Figure 2. Genesis Coverage Area.**

**CS.** The CS received messages from TIPS and transmitted them via telephone modem to a local communications provider that broadcast the messages.

**Pager.** The Motorola Advisor pager, pictured in Figure 3 has a liquid-crystal display capable of display 20 alphanumeric characters on each of 4 lines. In addition to an on/off switch, the pagers had four cursor buttons, arranged in a diamond shape, for moving a cursor on the display, a button to read selected messages, and a button to access other
pager functions. The Advisor measures 3.38 by 2.32 by 0.78 inches, and weighs 4.11 ounces.

The main menu screen of the pagers 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 only displayed when messages were present. Triangles on the first line represented personal pages. Triangles on the second line represented group page messages. Non-Genesis group page messages included services such as news, weather, sports, and stock quotes. Up to four triangles could be displayed for Genesis traffic information messages; two for the North area and two for the South.

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 slot. Thus when a series of traffic messages were sent, users might have to wait 20 seconds or more before they were able to review or access messages.

**PDA.** The Apple Newton MessagePad 110, pictured in Figure 4, is 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 320 pixel vertically and 240 pixels horizontally. The user controls the Newton using a stylus to select icons on the screen. The MessagePad can recognize both cursive or printed handwriting, and can accept hand drawn graphics. The MessagePad 110 is 8 by 4 by 1.25 inches (height, width, depth), and weighs 1.28 pounds.
Equipped with the Motorola Newscard, pictured in Figure 5, the MessagePad can display alphanumeric pages. The Newscard uses a PC card interface to connect to the MessagePad. The Newscard base measures 2.1 by 3.4 by .196 inches (height, width, depth). The extension measures by 2.1 by 1.1 by .6 inches. Weight with battery is 2.2 ounces. When the card was installed, only the extension, shown towards the top of Figure 5, protrudes from the MessagePad.

When turned on, the Newscard stored all messages internally. To review messages the user had to download the messages from the Newscard to the PDA using a MessagePad.
application provided by Loral Federal Systems. The application provided three mail slots: one each for North and South area traffic information, and one for personal pages. The newscard could hold hundreds of messages. Generally 8 traffic messages could be viewed on the Newton screen at once, with the most current message displayed at the bottom of the screen. Downloading messages from the News card to the Newton caused older messages already in the Newton to be deleted, although there was a function that allowed users to save messages they did not want deleted. When the News card was full, as would be the case if a long time had elapsed since the previous download, a download of messages could take up to 25 minutes. The download could be lengthy because of the number of message the News card could hold, and because the Newton application that downloaded the messages categorized each message and determined which messages updated which other messages.

A number of challenges were faced in deployment of the PDAs. These challenges resulted in deployment late in the operational test, and caused the developers to consider canceling altogether the PDA field test. Hardware incompatibilities and software challenges to overcome differences in the way the pagers and News card/PDA combination handle messages resulted in design compromises that had been not foreseen. The potential for lengthy downloads, and display of most recent messages last were among the less that desirable compromises that were made to meet field test schedule.

After information was downloaded three rectangular buttons were displayed: N, S and P for North traffic, South traffic, and Personal pages. By selecting any of the three buttons, the user could scroll through messages one at a time.

### 2.2.2 Genesis Operational Test

The Genesis Operational Test was a six month test designed to deploy, test, and evaluate the Genesis system.

### 2.2.3 Genesis Evaluation

Genesis was an operational test of new ITS technologies. As a federally supported program, and in the interest of providing information to the transportation community, the Genesis project included a significant amount of evaluation. By evaluating the Opera-
tional Test, Minnesota Guidestar sought to determine the benefits of the program and the feasibility of continuing and expanding the project. It was also anticipated that evaluation results might be beneficial to other agencies that are contemplating ATIS programs.

The Genesis evaluation consisted of five individual tests. Each of the tests was to evaluate one or more of the objectives. The Genesis evaluation tests, summarized in Table 2, were organized according to the nature of the data used to evaluate objectives.

Table 2. The Five Genesis Pilot Evaluation Tests.

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<tr>
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<th>Goal Summary</th>
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<td>Document the Genesis partnership arrangement.</td>
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<td>Modeling</td>
<td>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.</td>
</tr>
<tr>
<td>System Effectiveness</td>
<td>Evaluate Genesis pager benefits to users.</td>
</tr>
<tr>
<td>User Perception</td>
<td>Evaluate the Genesis system from user responses to questionnaires.</td>
</tr>
<tr>
<td>Human Factors</td>
<td>Evaluate (1) the effects of Genesis pagers on driving safety, and (2) the Genesis user interface.</td>
</tr>
</tbody>
</table>

2.3 Purpose of the User Perception Test

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

2.4 Objectives

The questionnaires and focus groups were used to assess the effectiveness of the Genesis system in meeting its objectives. The objectives of the test were to:

- Determine accuracy of messages sent to 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 user
• Document potential Genesis benefits to user
• Document Genesis benefits to society
• Document potential 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 user perception of PCD reliability
• Assess user perception of traveler safety.

Table 3 summarizes the objectives and approach of the User Perception Test.
## Table 3. Objectives and Methods of Addressing Goals for the Pilot User Perception Test.

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<th>Objective</th>
<th>Hypothesis</th>
<th>Measure of Effectiveness</th>
<th>Measure(s) of Performance</th>
<th>Data Source</th>
<th>Method of Analysis</th>
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<td>Determine accuracy of messages sent to Genesis PCD</td>
<td>Genesis PCDs were accurate</td>
<td>User Judgment</td>
<td>Likert Scale ratings and user comments</td>
<td>• Questionnaire</td>
<td>Descriptive Statistics</td>
</tr>
<tr>
<td>Assess usefulness of incident detection and reporting</td>
<td>Users found the traffic information was useful</td>
<td>Perceived frequency of user errors in interpretation</td>
<td>Likert Scale ratings and user comments</td>
<td>• Questionnaire</td>
<td>Descriptive Statistics</td>
</tr>
<tr>
<td>Assess understandability of messages received</td>
<td>Users found the traffic information was understandable</td>
<td>Perceived failure rate</td>
<td>Likert Scale ratings and user comments</td>
<td>• Questionnaire</td>
<td>Descriptive Statistics</td>
</tr>
<tr>
<td>Assess Genesis PCD reliability</td>
<td>Genesis PCDs were reliable</td>
<td>Perceived failure rate</td>
<td>Likert Scale ratings and user comments</td>
<td>• Questionnaire</td>
<td>Descriptive Statistics</td>
</tr>
<tr>
<td>Assess Genesis PCD signal availability</td>
<td>Genesis PCD signals were available</td>
<td>Perceived failure rate</td>
<td>Likert Scale ratings and user comments</td>
<td>• Questionnaire</td>
<td>Descriptive Statistics</td>
</tr>
<tr>
<td>Assess user impressions of message format</td>
<td>Message presentation format was acceptable</td>
<td>User impression of messages</td>
<td>Likert Scale ratings and user comments</td>
<td>• Questionnaire</td>
<td>Descriptive Statistics</td>
</tr>
<tr>
<td>Assess Genesis PCD ease of use</td>
<td>Genesis PCDs were easy to use</td>
<td>Ratings of usability</td>
<td>Likert Scale ratings and user comments</td>
<td>• Questionnaire</td>
<td>Descriptive Statistics</td>
</tr>
<tr>
<td>Document improvements recommended by users</td>
<td>Users recommended system improvements</td>
<td>User Recommendations</td>
<td>User recommendations</td>
<td>• Questionnaire</td>
<td>Description</td>
</tr>
<tr>
<td>Document benefits to user</td>
<td>Users perceived benefits to using Genesis system</td>
<td>User Comments</td>
<td>Likert Scale ratings and user comments</td>
<td>• Questionnaire</td>
<td>Descriptive Statistics</td>
</tr>
<tr>
<td>Document potential Genesis benefits to user</td>
<td>Users perceived future benefits with deployment of a Genesis system</td>
<td>User Comments</td>
<td>Likert Scale ratings and user comments</td>
<td>• Questionnaire</td>
<td>Descriptive Statistics</td>
</tr>
<tr>
<td>Document Genesis benefits to society</td>
<td>Users perceived societal benefits to use of Genesis</td>
<td>User Comments</td>
<td>Likert Scale ratings and user comments</td>
<td>• Questionnaire</td>
<td>Descriptive Statistics</td>
</tr>
<tr>
<td>Assess willingness to pay for Genesis PCD</td>
<td>Users were willing-to-pay for Genesis</td>
<td>Willingness-to-pay</td>
<td>Estimated dollar value for personal purchase/anticipated price</td>
<td>• Questionnaire</td>
<td>Inferential statistics, Statistical model</td>
</tr>
<tr>
<td>Assess Genesis PCD usefulness</td>
<td>Users believe Genesis PCDs are useful</td>
<td>Subjective Utility</td>
<td>—Usefulness rating for trip planning —Usefulness rating for saving time —Usefulness rating for stress reduction</td>
<td>• Questionnaire</td>
<td>Inferential statistics, Statistical model</td>
</tr>
<tr>
<td>Assess usefulness of real-time data in route planning</td>
<td>Real time planning alters travel behavior</td>
<td>Mode selection Route selection Time of departure decisions</td>
<td>Frequency of travel behavior changes</td>
<td>• Questionnaire</td>
<td>Descriptive Statistics</td>
</tr>
<tr>
<td>Assess user perception of information reliability</td>
<td>Users perceived Genesis information as timely and accurate</td>
<td>Information timeliness and accuracy</td>
<td>Likert Scale ratings and user comments</td>
<td>• Questionnaire</td>
<td>Descriptive Statistics</td>
</tr>
<tr>
<td>Assess user perception of communications reliability</td>
<td>Users perceived the communications to be reliable</td>
<td>Perception of data transfer, reception, and reliability</td>
<td>Likert Scale ratings and user comments</td>
<td>• Questionnaire</td>
<td>Descriptive Statistics</td>
</tr>
<tr>
<td>Assess user perception of PCD reliability</td>
<td>Users perceived PCD to be reliable</td>
<td>Perceived failure rate</td>
<td>Likert Scale ratings and user comments</td>
<td>• Questionnaire</td>
<td>Descriptive Statistics</td>
</tr>
<tr>
<td>Assess user perception of traveler safety</td>
<td>Users perceived that Genesis PCD did not reduce safety</td>
<td>Perception of Genesis PCD use safety</td>
<td>Likert Scale ratings and user comments</td>
<td>• Questionnaire</td>
<td>Descriptive Statistics</td>
</tr>
</tbody>
</table>
3. Method

3.1 Duration of Test

The operational phase of the Genesis operational test ran from 24 July 1995 through 26 January 1996. Questionnaires were distributed to pager users during the second week of December 1995. Apple Newton user questionnaires were mailed the fourth week in January 1996. Focus groups were conducted in December 1995 and January 1996.

3.2 Test Conditions

Three classes of users were recruited:

- **Previous Users.** These individuals were of interest because they represented the population that was already using alphanumeric pagers.

- **New Users.** These individuals were generally not familiar with the operation of alphanumeric pagers prior to their introduction to Genesis, although a few had been exposed to numeric pagers (i.e., pagers that display only phone numbers to be called).

- **PDA Users.** These individuals were selected randomly from among the same population of volunteers as the New Users category. Whereas new and Previous users received Genesis information on Motorola Advisor alphanumeric pagers, PDA users were provided Apple Newton Personal Digital Assistants that were equipped with an alphanumeric pager cards so that they could receive Genesis information.

3.3 Materials and Protocols

The User Perception Test employed a survey, a questionnaire, and focus groups.

The following presents a brief description of the data collection instruments and the rationale for their use.

3.3.1 User Profile Survey

User profiles were collected from participants at the time they expressed interest in participating in the operational test. This information was collected via telephone, fax, and the US Mail. The information was used to screen volunteers for participation in the operational test. The following information was obtained through the survey:
• Date of birth
• Gender
• Level of education
• Previous computer experience
• Family income
• User type (i.e., single-occupancy-vehicle commuter, high-occupancy-vehicle
  commuter, business user)
• Zone (i.e., whether they desire traffic information for the North, South or both
  zones of the Genesis coverage area as depicted in Figure 2)
• Travel time (peak or between peaks)
• Transit use (i.e., frequent, occasional, rarely, never).

3.3.2 Questionnaires

Questionnaire items were prepared for each of the test objectives. The majority of the
questions were presented as Likert scale items. That is, an affirmatively worded statement
such as “Genesis traffic incident information messages were timely” was presented with a
seven point scale with anchors provided for the ends of the scale. In the case of the above
question the anchor for one was “strongly disagree” and the anchor for seven was
“strongly agree”. Respondents indicated their rating by blackening an open circle under
their rating choice. The response forms were machine processed. An example of a typical
questionnaire item is presented in Figure 6.

![Figure 6. Sample Questionnaire Item.](image-url)
3.3.3 Focus Groups

Focus group meetings have proven to be a valuable tool for gathering market/product research data. The strength of focus group meetings in market/product research is based on three factors:

1. Grouping participants with common experiences in distinct focus group meetings.

2. The participants’ understanding that there are no right or wrong answers and that it is only honest opinions (both positive and negative) about the product that are important to the testers.

3. The focus group meeting design and process are scientific and replicable.

3.4 Procedures

3.4.1 User Profile and Questionnaires

User profile and machine-readable questionnaire data were merged into a relational database so that demographic information from the profiles could be linked to user responses to questionnaire items.

Written comments in the questionnaire were subjected to a content analysis. For the content analysis, an analyst reviewed the comments then classified them into categories that would facilitate a concise and comprehensive summarization.

3.4.2 Focus Groups

The Objective, Reflective, Interpretive, and Decisional (ORID) design method was used to conduct the Project Genesis focus group meetings. This design was chosen because of its structure, which leads participants to discuss products from four critical reference points:

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

Specific focus group topics and issues that were addressed under each of these reference points were developed based on the following:
• Genesis goals
• Characteristics and features of the Genesis architecture and service delivery processes
• Characteristics and features of the two PCDs
• Information received from test participants during telephone interviews/surveys conducted during the System Effectiveness Test.

Table 4 presents the design of the Project Genesis focus group meetings.

3.5 Test Schedule

Six focus group sessions were held, two with each of the three user groups. The focus group schedule was:


3.6 Research Design

Results are reported for New Users, Previous Users, and PDA Users. A total of 492 individuals were recruited to participate as end users of Genesis devices. Of these, 239 were New Users, 210 were Previous Users, and 43 were PDA Users.

Questionnaires were mailed to all participants who were still active users of Genesis.
Table 4. Focus Group Meeting Design.

**Context:** Through Project Genesis, operational test participants have been provided on-time, traffic information to enable them to choose routes that are less congested, ultimately improving traffic flow in and around the Twin Cities. The User Perception Test element of the operational test has been designed to check perceptions about the traffic information service and the devices (pager or PDA) that have been used by the test participants.

**Rational Objective:** The purpose of the focus group meeting is to surface thoughts and feelings about the traffic information and to dialogue about its usefulness and value.

**Experiential Objective:** Participants should feel comfortable about participating in an open, honest exchange of ideas and perceptions.

<table>
<thead>
<tr>
<th>OPENING</th>
<th>OBJECTIVE (Get Facts)</th>
<th>REFLECTIVE (Emotions, Associations, and Feelings)</th>
<th>INTERPRETIVE (Values and Meaning)</th>
<th>DECISIONAL (Future Resolve)</th>
<th>CLOSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Welcome</td>
<td>• What is your name, occupation?</td>
<td>• What was your general reaction to the traffic information service? How did you feel about it?</td>
<td>• What is the real value of this service for you and others?</td>
<td>• What other messages or information would you add?</td>
<td>• Note contributions of participants - why their participation was valuable and how the information will be used.</td>
</tr>
<tr>
<td>• Meeting objectives</td>
<td>• Describe your objective for wanting to use the service. What were your expectations?</td>
<td>• When was the service the most useful or helpful? When was it the least useful or helpful?</td>
<td>• What would you change about the service and why?</td>
<td>• How much would you be willing to pay each month for the service as it is?</td>
<td>• Thank participants.</td>
</tr>
<tr>
<td>• Logistics:</td>
<td>• How many times did you use your pager each week/each day?</td>
<td>• Were the messages timely, accurate, understandable?</td>
<td>• What would you change about the pager (PDA) and why?</td>
<td>• How much would you be willing to pay if the suggested changes were made?</td>
<td>• Discuss payment process.</td>
</tr>
<tr>
<td>— Role of moderator</td>
<td>• How did you use the service? What time of day? For what purpose?</td>
<td>• How easy was the pager (PDA) to use?</td>
<td>To what extent should public resources be used to support and distribute traffic information?</td>
<td>• Adjourn.</td>
<td></td>
</tr>
<tr>
<td>— Role of observers</td>
<td>• Did the service meet your expectations?</td>
<td>• What specifically did you like about the service? What didn’t you like?</td>
<td>• What would be the impact if pagers (PDAs) were widely available?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Registration, name tags, refreshments, tape recorder, presentation boards, handouts

Pay participants

| 20 minutes | 25 minutes | 25 minutes | 20 minutes | 20 minutes | 5 minutes |
4. Results

The results of the User Perception Test are organized according to the objectives listed in the Method section. Within sections describing results relative to each objective, questionnaire and focus group results are reported separately. Before reviewing questionnaire and focus group results, the demographics of the questionnaire and focus group respondents are summarized.

4.1 Focus Group Participants

4.1.1 New Users

Seven individuals participated in the December 6 meeting, and nine participated in the January 3 meeting. All seven participants in the first meeting were professionals. Five were white collar office workers performing a service. One was a flight nurse. Eight of the nine participants in the second meeting were professional white-collar office-workers. One was a salesperson who spends a lot of time traveling in his car during work hours. The ninth was a salesperson for a security firm.

When asked why they participated in Genesis, avoiding traffic congestion during the peak travel periods was the most frequently cited reason given by attendees at both meetings. One individual in the second group wanted to avoid off-peak congestion. Experimenting with a new technology was mentioned by two people in the second group.

When asked how often they used Genesis, daily use, once on the way to work in the morning and once on the way home in the afternoon, was the most common response. One person in the first meeting, and one in the second, estimated that they consulted the Genesis information at least five times per day.

4.1.2 Previous Users

Seven individuals participated in each of the two Previous Pager User focus group meetings. Five of the seven members of the first focus group drive frequently during their work day. Two members of the second group drive during most of their work day. Most of those who said they drive during their work day are technicians or service providers who either
respond to calls from a central office or are dispatched from their office. Thus, seven of the Previous Users reported that they drive frequently during the off-peak traffic portion of the day, and seven reported that they work in an office and commute to and from work during the peak traffic periods.

As with the New Users, Previous Users most often cited avoiding congestion as the motivation for participating in the operational test. Saving travel time, being on the cutting edge of technology, and participating in a test of the system were also cited as motivations for participation.

4.1.3 PDA Users

Nine participants attended the first PDA User focus group meeting and seven participants attended the second meeting. Of the 16 PDA Users, 5 had used a PDA prior to participating in the operational test. Among participants in the first focus group were two engineering consultants, a health care provider, an education specialist, a research administrator, a storage technology service representative, and two office workers. Attendees at the second meeting two engineers, two consultants, an entertainer, a sales representative, and a law student.

At least one participant in each group cited the need to have something better than the radio for receiving traffic information as a reason for participating in the operational test. Others commented that on-time, on demand information was needed so that they could make informed decisions. Most participants focused on the need for information during the peak travel periods, but some also expressed a need for traffic information during the off peak periods.

Among first focus group participants, estimates of how often they used their PDA’s for traffic information ranged between twice a day (once in the AM and once in the PM) to constantly throughout the day. One person said it was used once a day initially, but, because the PDA was so difficult to operate, she stopped using it completely. The person who used the device several times throughout the day complained that it took a lot of time to dump previous messages so that current messages could be received.
Among participants of the second focus group, one person indicated that he checked his PDA every time it beeped, about 30 times a day. Another person said he used it about 12 times a day in the beginning but, because of operational difficulties, his usage eventually dropped to zero. Others in the second group said they checked their PDA for traffic information once or twice a day. Because of issues surrounding the receipt of devices and cards that worked properly, participants in the second group expressed little confidence in the service and only used their PDAs on an infrequent basis.

4.2 Questionnaire Respondents

Questionnaires were returned by 175 participants. Table 5 shows the distribution of respondents as a function of user type. The low return rate for Previous Users is thought to be the result of several factors, the most important of which was that the traffic information function was never activated for many of the individuals who were already using alphanumeric pagers when they volunteered to participate. The failure of Previous Users to receive messages apparently resulted because their pagers were turned off when the signal was broadcast to initiate Genesis services. This initiation was a one time event that set up the pagers to receive traffic information in the four slots reserved for it. Another possible reason for a low return rate was that Previous Users were less satisfied by the Genesis service (as suggested by the focus group findings) and therefore were less motivated to respond to the questionnaires.

<table>
<thead>
<tr>
<th>User Type</th>
<th>Number of Respondents</th>
<th>Return Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous Pager</td>
<td>32</td>
<td>15%</td>
</tr>
<tr>
<td>New Pager</td>
<td>123</td>
<td>51%</td>
</tr>
<tr>
<td>PDA</td>
<td>20</td>
<td>47%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>175</strong></td>
<td><strong>36%</strong></td>
</tr>
</tbody>
</table>
Table 6 provides a summary of the gender and relative age of those individuals who returned questionnaires.

Table 6. Age and Gender of Questionnaire Respondents.

<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Younger (≤ 36)</td>
<td>26</td>
<td>45</td>
<td>71</td>
</tr>
<tr>
<td>Older (&gt; 36)</td>
<td>16</td>
<td>78</td>
<td>94</td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
<td>123</td>
<td>165</td>
</tr>
</tbody>
</table>

Not all participants responded to all questions, so the sample size for various questionnaire findings varies. For all the demographic variables examined, there were no trends to suggest that the demographics of the various user types (i.e., Existing, New, and PDA users) differed. Therefore the summary of users’ self-descriptions are given for the participants as a whole.

Figure 7 shows that the majority of respondents reported family incomes above $40,000 per year.

![Figure 7. Stated Annual Family Income of Questionnaire Respondents.](image-url)
Figure 8 illustrates that, as the whole, the respondents indicated a high degree of education. Figure 9 shows that, as a group, the respondents said they were highly familiar with high technology consumer devices.

**Figure 8.** Stated Educational Level of Questionnaire Respondents.

**Figure 9.** Participants Self-Described Level of Experience with Computers and Other High Technology Devices.
Figure 10 shows that the respondents drive substantially more than average, with the reported median annual mileage falling at approximately 25,000 miles. There were no apparent or statistically reliable differences in annual mileage among the three user types.

![Annual Mileage Graph](image)

**Figure 10. Estimated Annual Mileage Reported by Questionnaire Respondents.**

In the sections that follow, the results of the User Perception Test are organized according to the objectives listed in the Method section. Within sections describing results relative to each objective, questionnaire and focus group results are reported separately.

### 4.3 Accuracy of Messages Sent to Genesis PCD

**Questionnaire items.** The questionnaire asked respondents to rate the accuracy of traffic incident, traffic congestion, and planned event messages. Responses are illustrated in Figure 11, Figure 12, and Figure 13. There were no differences in accuracy ratings between the three user groups. There were statistically reliable differences in ratings of the three message types, $F(2, 140) = 25.5, p < 0.001$. The Planned Event message accuracy ratings were significantly higher than traffic incident ratings, which were, in turn, rated significantly higher than congestion messages (all $p < 0.05$).
Respondents indicated that receiving accurate traffic information was important. There were no differences in ratings of the importance of message accuracy relative to the three message types. Therefore, Figure 14 shows the distribution of importance ratings averaged over incident, congestion, and planned event information.

Whereas the respondents appear to have rated the overall accuracy of messages favorably, their responses to another question indicate that they also perceived room for improvement in message accuracy. When asked to rate areas in which they would like to see improvements in the Genesis traffic information system, of 176 respondents, 71 percent agreed or strongly agreed that they would like to see improvements in message accuracy, whereas only 12 percent disagreed or strongly disagreed.

![Figure 11. Ratings of the Assertion that Traffic Incident Messages were Accurate (Mean = 5.2, n = 154).](image-url)
Figure 12. Ratings of the Assertion that Traffic Congestion Messages were Accurate (Mean = 4.8, n = 153).

Figure 13. Ratings of the Assertion that Planned Event Information was Accurate (Mean = 6.2, n = 168).
Questionnaire comments. Four of the 176 questionnaire respondents commented on the accuracy of messages. Three reported that the congestion messages (i.e., slow traffic, heavy traffic, stop and go traffic) were inaccurate. One mentioned a specific incident which was incorrectly reported.

Focus group. No specific examples of inaccurate messages were reported in the focus group results. Rather, when asked about the accuracy of messages, participants tended to mention perceived inaccuracy due to a lack of precision in the messages. That is, congestion messages were perceived as inaccurate because they did not provide the desired level of precision. Participants said they wanted to know how fast traffic was moving in miles per hour or in travel time. Some desired to know which lanes were moving slowest or fastest. For incidents, participants wanted to know when the incident occurred and when it was expected to be cleared. Incident messages were viewed as imprecise, and therefore inaccurate, because participants were not sure whether the incident applied to the time that they would be traveling.

4.4 Usefulness of Messages

Questionnaire Items. Overall, users rated the traffic information provided by Genesis as useful. On a seven point scale where one represented strongly disagree and seven represented strongly agree, the mean rating for the assertion that the messages were useful was
5.0. There was a statistically significant difference in ratings as a function of message type, $F(2, 280) = 12.71, p < 0.001$. Agreement was highest for planned event messages, mean = 5.5, with no difference in mean rating for incident and congestion messages, mean = 4.7. There were no differences in ratings as a function of user type.

Besides rating the usefulness of the three types of messages, respondents also rated the usefulness of the individual messages that made up those classes. The mean ratings of the messages are shown in Figure 15. The error bars in the figure represent 2 standard errors. Non-overlapping error bars would represent statistically reliable differences between means. Although the overall test of significance indicated there were differences in message ratings, $F(6, 888) = 6.94, p < 0.001$, the differences between individual pairs of means are not statistically reliable. Overall, the results reflect higher ratings for planned events and accident messages, and lower ratings for disabled vehicle and traffic congestion messages.

**Figure 15. Ratings of Agreement with the Assertions that each of Seven Traffic Messages were Useful.**

**Questionnaire Comments.** Comments that accompanied the questionnaire ratings tended to mention factors that would make the information more useful, or factors that prevented the messages from being useful. The most frequent comment was that the messages were
too late to be useful — eight respondents said this. Nine respondents suggested that the messages would be more useful if they included more details such as expected length of delays, which side of an interchange an incident was on, the time that accidents occurred, and what alternative routes would be best.

**Focus Group Findings.** A recurring theme in the focus groups for all three user types was that construction messages were very useful. The slow traffic messages were generally regarded as least useful, especially during peak travel periods when the participants expect traffic to be slow. PDA users tended to report the devices as useful only during peak travel periods, if they found the devices useful for traffic information at all. The PDAs were regarded as less useful because of the perceived difficulty in downloading messages from the pager card to the Apple Newton.

### 4.5 Understandability of Messages

**Questionnaire Items.** Figure 16 shows mean ratings for agreement with the assertions that each of the three message types were “easy to understand”. Error bars in the figure represent two standard errors of the mean. There were significant differences in ratings as a function of message type, $F (2, 282) = 8.51, p < 0.001$. Planned event messages were rated easiest to understand, and congestion messages were rated least easy to understand relative to the other message types. Given that all the mean ratings were greater than 4, which would be a neutral rating, the overall consensus was that all message types were understandable.
Figure 16. Mean Agreement Ratings for the Assertion that Messages Were “Easy to Understand” (n = 144).

Figure 17 shows respondents ratings of the common elements of messages. The most striking finding is that the average rating of understandability of the extent of congestion and delays is not significantly different from neutral, and is significantly less than the rating for other elements. Respondents, on average, neither agreed nor disagreed with the assertion that the extent of congestion and delays was “easy to understand”.
Figure 17. Mean Agreement with the Assertion That Message Elements were “Easy to Understand” (n = 145).

Questionnaire Comments. Many comments were associated with the desire for more detailed information that would make the traffic information easier to understand or use. Eleven people commented that they needed more details, but did not provide specific examples. Six respondents suggested that “slow” traffic be defined in terms of an average speed. Six respondents suggested four message areas (NE, NW, SE, SW) rather than just the two (N and S). Three people reported that they found the military time to be confusing.

Focus Group Findings. A few individuals in the New Users group expressed difficulties in understanding some messages. Previous Users and PDA Users did not comment directly on understandability, but rather, commented on the desire for additional details. One New User was confused by the “to” and “from” designations. Other New Users expressed difficulty understanding abbreviations such as “E-JCT” and “TH”.

4.6 PCD Reliability

Questionnaire Items. Pager users were asked to respond to the assertion “My pager is reliable for all uses, not just Genesis.” The purpose of this question was to assess users’ perception of the reliability of the pagers. The intent of the question was to assess the possibility that impressions of Genesis traffic information might have been adversely affected by perceived problems with the pagers. PDA users were not asked an analogous question.

New Users and Previous Users provided identical mean ratings of pager reliability; on a scale from 1 to 7 where 1 represented reliable “none of the time” and 7 represented reliable “all of the time”, the mean rating was 4.6. Although this mean rating is significantly greater than the neutral point, 4.0, this finding might suggest that the perception of pager reliability was not strongly positive. However, comments associated with this questionnaire item suggest that, in responding to this item, respondents focused on elements of Genesis rather than the reliability of the pagers.

Questionnaire Comments. Eighteen pager users offered comments to the reliability question. Of these comments, none were clearly rated to the reliability of the pager. Three comments were general in nature (e.g., “very reliable”). Six comments related either to the timeliness of traffic information, or of failures to report significant traffic incidents. The remainder of the comments expressed a desire for a wider coverage area, or additional types of information.

Focus Group Findings. The focus groups did not address reliability of the pagers. However, in both Previous User groups, at least one participant complained that the broadcast of Genesis information interfered with the reception of personal and business pages. When the pagers received new messages, an envelope icon was displayed and messages could not be accessed or viewed. A message might take only a few seconds to be received. However, traffic messages were often sent out in series, which could result in a long delay when messages could not be accessed. It was this long delay that some previous users complained about. The delay was most noticeable, by some accounts, when trying to check messages while driving.
4.7 Assess Genesis PCD Signal Availability

Questionnaire Items. Another question asked users whether there were locations within the Genesis coverage area where they were unable to receive messages. New- and Existing-Pager Users responded similarly, only 15 percent indicated that they were aware of areas where they could not receive pages.

Questionnaire Comments. Three users provided addresses for buildings where they could not receive pages.

Focus Group Findings. Signal availability was not discussed in the focus group meetings.

4.8 Assess User Impressions of Message Format

Questionnaire Items. Respondents were asked to rate satisfaction with the overall message format, the order of message elements, and the format of each of six message elements. Figure 18 shows the six elements with examples of each as they were shown in the questionnaire. For all eight format related questions, responses were provided on a seven point scale where 1 represented “Not at all Satisfied” and 7 represented “Very Satisfied”.

<table>
<thead>
<tr>
<th>Area</th>
<th>Roadway affected</th>
<th>Explanation</th>
<th>Location/Extent</th>
<th>Date (planned events only)</th>
<th>Time (planned events only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S: or N:</td>
<td>TH100 S</td>
<td>road construction. right lane</td>
<td>From:42ND AVE N To:36 AVE</td>
<td>(06/30-07/30)</td>
<td>(09:30-17:00)</td>
</tr>
</tbody>
</table>

Figure 18. Example of Message Elements as Shown in Questionnaire.

There were no significant differences in ratings as a function of user group. There were, however, significant differences in ratings for different elements of the format, $F(7, 149) = 9.30, p < 0.001$. The ratings are shown in Figure 19 with error bars representing to standard errors of the mean. It can be seen that the rating for display of area (North or South portion of Genesis coverage area) had a mean rating not significantly different from neutral — neither satisfied nor dissatisfied. All the other message elements received positive average ratings.
Figure 19. Ratings of Satisfaction with Message Format.

Questionnaire Comments. Six respondents commented that they would have preferred that the area be divided into quadrants rather than halves. Three respondents said that they found the military time format difficult to understand. Two people commented that the messages were difficult to read or interpret quickly. Four people appeared to be confused by the question that was being asked.

Focus Group Findings. Several PDA users suggested that colored maps would be more appropriate for displaying congestion and incidents. New- and Previous Users mentioned that they did not like to have to scroll to read messages, or to check in more than one slot for traffic messages. One New Pager User suggested that messages be labeled by type: congestion, incident, and planned event. Another New Pager User suggested that the location and extent of incidents and congestion be indicated with reference to commonly known locations rather than to cross streets that may not be as recognizable.
4.9 Assess Genesis PCD Ease of Use

**Questionnaire Items.** The questionnaire did not address ease of use per se. Ease of use was at least partially addressed by the understandability and message format items discussed above.

**Focus Group Findings.** Focus group comments that reflected ease of use included the following:

- Pager users suggested that a larger display would be easier to read, especially when driving, and would require less scrolling.

- PDA users were irked by the lack of a quick and easy way to delete messages. It was suggested that the ability to delete individual messages would be useful, and that clearing all messages should be quick and easy — one user estimated that it took 25 minutes to clear messages.

- Pager users appreciated the size of the device — it was easy to carry in a pocket or purse. PDA users, on the other hand, expressed dismay at the bulk of their device.

- Previous Users felt that frequent traffic information made it difficult for them to use the pager for its primary purpose, to receive messages from their office.

- Various suggestions were offered to make the pager easier to use while driving: larger characters, vehicle mounting, voice enunciation of messages. There appears to be a demand for a device that is easy to use while en route.

- Although the PDA was intended as a small portable device that could be carried with the user throughout the day, some PDA Users felt that the device was too valuable to carry with them. These users felt the risk of loss or breakage was too great.

- The PDA also garnered other ease-of-use complaints. The lack of a back light made it difficult to use at night. The stylus was regarded as awkward to use.
4.10 Document Improvements Recommended by Users

Questionnaire Items. Respondents were asked to indicate areas where they would like to see improvements in the Genesis system. Nine possible areas of improvement were listed in the questionnaire under the assertion: “I would like to see the following improvements in the Genesis traffic information system.” The areas are listed along with mean responses, where 1 represented “strongly disagree” and 7 represented “strongly agree.” Error bars in the figure represent two standard errors and provide 95 percent confidence limits for the means. There were no significant differences in ratings among the three user groups.

Whereas in other sections of the questionnaire, respondents may have given positive ratings based on their understanding of how Genesis was intended to perform, in indicating desires for improvements the users may have been frank in reflecting on the system as fielded in the operational test. It can clearly be seen in Figure 20, respondents did not agree that “Genesis is great as is.” They strongly agreed that additional description of the severity of delays is desired. They generally agreed with the desire for better accuracy and timeliness of messages. All users, but particularly PDA users (Mean = 6.5) would like the information tailored to the roads they drive and, by inference, for the times that they drive. Respondents agreed that a wider coverage area, and coverage for more road types is desirable.

Questionnaire Comments. Comments that accompanied the ratings of desired improvements, largely reinforced the rating outcomes. Eleven respondents commented that they would like more personalized messages — messages that relate only to routes they travel. Seven respondents expressed the desire for coverage over a wider area, and, or, coverage for alternative routes within the coverage area. A desire for improved timeliness was cited in only one user comment.
Figure 20. Ratings of Agreement with the Assertion that “I would like to see the following improvements in the Genesis traffic information system.”

Focus Group Findings. Several focus group discussion topics were somewhat related to desired improvements in the system:

- Did the service meet you expectations?
- What specifically did you like about the service?
- What didn’t you like?
- What other messages or information would you add?
- What would you change about the service and why?

Responses to the first three topics may suggest how users feel the system should work.

Responses to the latter two topics focus directly on desired improvements.
**Did the service meet you expectations?** Previous Users and PDA Users said they were disappointed by Genesis. One of the two New Pager User Groups generally agreed that the system met their expectations, but the other New User group was disappointed because they found retrieving traffic information laborious, and the messages lacking in detail. The disappointment among Previous Users centered on conflicts between traffic messages and messages from the office. Previous Users did not like having to scroll between personal pages and traffic information, and did not appreciate interruptions in business applications caused by receipt of traffic information.

**What specifically did you like about the service?** As might be expected among a population of users that requested to participate in an ATIS operational test, all the focus groups indicated that they liked the concept of receiving traffic messages on a pager or PDA. Several participants indicated that, at least on some occasions, Genesis helped them avoid congestion.

**What didn’t you like?** Participants in the focus groups indicated that they did not like receiving messages about traffic that was not related to their travel plans. They did not like have to scroll through many messages to find messages of interest. Whereas participants wanted fewer messages irrelevant to their trips, they none-the-less wanted information on a wider area, and coverage for more roads within the current coverage area.

**What other messages or information would you add?** Participants in most of the focus groups asked for more detail on congestion. Suggestions for additional information included: identification of which lanes were moving fastest, which lanes were open, and when incidents and congestion were expected to clear. Some participants said they wanted travel times or speeds — they did not understand what “slow traffic” implied.

**What would you change about the service and why?** Previous Users in both focus group sessions would like to see the system changed such that traffic information receipt would have no effect on personal or business related pages. PDA users suggestions included graphical map displays and two-way communication so that information could be tailored to intended trips. New Users also indicated that they desired information tailored to their travel plans.
4.11 Document Actual Benefits to User

Questionnaire Items. Under the heading of “Benefits”, respondents were asked to rate their agreement with the assertion that Genesis helped them to obtain the benefits listed in Figure 21. New, Previous, and PDA users responded similarly to all items. It can be seen that, on average, respondents agreed that Genesis helped them to avoid congestion and to plan better routes. Respondents were neutral as to whether they were able to save time, however. On average, respondents disagreed with the assertions that Genesis helped them to arrive on time, better utilize their time, decide when to start trips, reduce stress, or save fuel. Perhaps because the Genesis user population tended to consist of single-occupancy-vehicle commuters, respondents strongly disagreed with the assertion that Genesis help them decide when to take the bus, carpool, or use high-occupancy-vehicle (HOV) lanes. Two of the assertions that were labeled “For Business Users” (“Make more business contacts” and “Make for Sales”) were responded to by approximately 70 persons, whereas the approximately 170 users responded to the remaining items shown in Figure 21. The latter two assertions received general disagreement, as did the assertion that Genesis helped get more work done.

Thus, Genesis users tended to perceive a benefit, perhaps marginal, in the form of improved ability to plan routes that avoided congestion, but did not perceive any secondary benefits such as travel time savings, or even reduced stress. This finding raises the question of what benefit is perceived from the ability to avoid congestion.
Figure 21. Ratings to the Assertion that Genesis Helped the User To Obtain the Listed Benefit.

**Questionnaire Comments.** Four respondents commented that the traffic information would have been useful had it been more timely. Two people commented that although the information didn’t save them time, it did relieve their stress by letting them know
what to expect and increasing their feeling of control. Two people commented that it did help them to arrive on time. One person said that he benefited just by a change in travel habit — considering his route choices before beginning his commute. Thus, one possible explanation of why the questionnaire rating results seem to indicate a perceived congestion avoidance benefit without any secondary benefits, is that users disagreed on the nature of the secondary benefits.

**Focus Group Findings.** In one of the New User groups, participants did imply that knowing about congestion, and how to avoid it, was a benefit. However this view did not come out in the other New User group, nor in any other focus group session. Several of the focus groups indicated that the Genesis service had no value to them. Other perceived possible travel time savings benefits if the service were improved.

### 4.12 Potential Genesis Benefits to User

**Questionnaire Items.** There were no questions that requested ratings regarding potential benefits.

**Questionnaire Comments.** An item in the questionnaire asked users to describe in their own words what additional benefits they would expect if Genesis were improved. Thirteen respondents indicated that they looked forward to personalized information — typically information only for routes they request. Others hoped that sports, or one of the non-traffic categories of information could be avoided. Nine respondents indicated that coverage over a wider area, or for more roads, would increase the benefit they derive from Genesis.

**Focus Group Findings.** PDA users generally indicated that they did not think the PDA technology was appropriate for distributing traffic information. Therefore, benefits to be derived from improvements to the system were not considered. This contrasted with responses from the pager focus groups, where information such as maps and route specific information — both more easily implemented on a device with PDA-like capabilities — were suggested as improvements.
4.13 *Genesis Benefits to Society*

**Questionnaire Items.** In the questionnaire, users were asked, “Do you think other drivers benefit when you use Genesis?” Of 164 respondents, 84 said “no” and 80 said “yes”. There were no significant differences among the three user groups in response to this question.

**Questionnaire Comments.** Respondents who provided comments to this question were the ones that answered “yes”; 22 respondents indicated that they believed that if enough people were using Genesis, non-Genesis users would benefit by reduced congestion around incidents as Genesis users avoided those incidents. Another five people commented that others might benefit if Genesis information were more timely.

**Focus Group Findings.** Whereas those who provided questionnaire comments took the optimistic viewpoint that the public would benefit from a Genesis-like system by reduced congestion around incidents, the focus group discussion was decidedly pessimistic. Those focus group participants who could conceive of Genesis having any effects, suggested that widespread use of Genesis would result in congested alternative routes. Members of one focus group session suggested that the negative effect of traffic information on alternative routes would only be realized during peak traffic periods.

4.14 *Assess Willingness to Pay for Genesis PCD*

**Questionnaire Items.** In the questionnaire, respondents were asked to consider the value of 15 information related items. Among these items was Genesis traffic information. The fifteen items were:

- 4 hours parking in downtown Minneapolis
- Alphanumeric paging service
- Cellular telephone service (30 minutes of calls)
- Daily newspaper (1 month subscription)
- Genesis traffic information
- Online Service (e.g. CompuServe, America Online)
- Premium Cable Television Channel
- Single issue of a national magazine
• Sports scores on a pager
• Stock quotes on a pager
• Telephone voice mail (or answering machine)
• Traffic information on the radio
• Weather information by telephone
• Weather information on a pager
• Wireless electronic mail on a notebook computer.

The items were presented in pairs, and respondents were asked to select the most valuable item in each pair. Except when stated otherwise, they were to assume services were for one month, and all quantities were one. Each respondent was asked to compare 15 pairs of items, across all participants, 103 of 105 possible pairings of the items were presented, with each item appearing as the first or second member of a pair equally often. The responses were converted into a dominance matrix that represents each item in a row and a column, with the cells in the matrix representing the proportion of times the row item was selected over the column item. Thurstone’s scaling procedure was then applied.[1,2,3] This procedure requires the assumption that the paired comparisons were based on judgments against a single criterion dimension (value). Furthermore, the procedure requires the assumption that, in sampling, the probability of an item being selected over another will fluctuate over time, but that over many samples, a mean probability of selection of an item over another will arise, and the variability of about that mean will distribute normally.

The results of the scaling procedure are shown on the left side Figure 22 where the items are placed on a scale from 0 to 100, with items placed along the scale according to the respondents’ collective value choices. On the right side of the figure items are scaled against estimated market prices for the items in the Minneapolis/St. Paul area. The estimated prices are not based on questionnaire data, but rather on estimates provided by the author. As can be seen, the most expensive items appear at the top of the value scale, and, as expected, items provided free to pager users appear at the bottom of the scale. The finding that items on the scale are roughly ordered according to values one might expect users to place on them, suggests that the scaling procedure was successful. Note that
some items, such as traffic information on the radio, have a much greater value to the respondents than their estimated market price. This is in line with the request that respondents rate the value, not the cost, of the items. Genesis traffic information was valued about equally with a daily newspaper and traffic information on the radio. Based on this perceived value, it appears that participants might be willing to pay as much as $20 a month for a Genesis-like system. Because respondents rated relative value, and not willingness-to-pay, care should be taken interpreting this result. For instance, traffic information on the radio, which is distributed at no direct cost to the consumer, was valued approximately equal to Genesis information. Given that consumers now receive the radio information free, it is likely that they would show some resistance to paying $20 per month for it, even if they perceive that to be its true value.

**Questionnaire Comments.** Four users commented that the scaling questions did not make sense to them. None-the-less, 171 of the 175 questionnaire respondents provided inputs to the paired comparisons of value.

**Focus Group Findings.** Focus group participants were asked how much they would be willing to pay for the Genesis services both as they experienced it, and if the improvements they requested were made. Previous Users expressed very little willingness to pay for Genesis. One of the two Previous Pager User groups indicated they would be willing to pay between $2 and $5 per month if improvements were made to the service. The other Previous Pager User group said they were unwilling to pay regardless of whether improvements were made.

New Users provided value estimates of between $1 and $20 dollars per month over and above what they would pay for the paging service itself. The consensus estimate of the New Users was $5 per month and this estimate was not dependent on, or influenced by, whether the system were improved.

PDA users provided estimates that ranged from nothing to $30 per month. In general, group participants expressed a willingness to pay $3 to $5 per month for traffic information, and perhaps an additional $5 per month for hardware to receive that information.
4.15 Assess Genesis PCD Usefulness

**Questionnaire Items.** The questionnaire did not address the usefulness of the pager or PDA.
Questionnaire Comments. Comments from Previous Users indicated that pagers are critical to their jobs, regardless of whether they receive traffic information pages.

Focus Group Findings. Pager users, both New and Previous, found the pagers useful. They particularly liked the small size which made it easy to carry. One of the Previous Users groups commented that the batteries tended to run down quickly when the pager was left on for long periods of time. PDA users were not very positive about the device they used. Several people commented that it was too big to carry around in a pocket. Others felt the small screen size and lack of a backlight were a drawback. Given its size, PDA users thought it should have more capabilities, such as Global Positioning System (GPS) driven navigation maps and voice enunciation of messages.

4.16 Assess Usefulness of Real-Time Data in Route Planning

Questionnaire Items. As indicated in Figure 21, Genesis participants’ average response was mildly positive in agreeing that Genesis traffic information help them plan better routes.

Questionnaire Comments. In general, comments indicated that timely and accurate real-time information would be useful. Respondents were less strong in agreeing that the information they received during the field operational test was useful.

Focus Group Findings. The focus groups did not directly discuss the usefulness of real-time data for route planning. However, all three user groups were positive about the concept of receiving real-time information. The utility of the data distributed during the operational test was not uniformly viewed as positive, although there were reports of positive experiences.

4.17 Assess User Perception of Information Reliability

Questionnaire Items. The questionnaire covered two aspects of Genesis traffic information reliability: accuracy and timeliness. The findings with respect to accuracy are discussed in 4.3. Respondents were also asked to rate the timeliness of incident, congestion, and planned event information. Figure 23 shows the mean timeliness ratings, with error bars representing two standard errors of the mean. Two interesting effects were found.
First, there was a significant effect for type of message, $F(2, 133) = 7.95, p < .001$, that resulted from planned event messages being rated more timely than incident or congestion messages. Second, there was a significant interaction of message type and user type, $F(4, 266) = 3.00, p < 0.05$, that resulted largely because Previous Users rated incident messages less timely than did the other two user groups. Planned event messages were sent well in advance of the actual event, which could account for the perceived timeliness of these messages. The lower timeliness ratings for incident messages by Previous Users is less easily explained, but Previous Users expressed greater annoyance with Genesis messages interfering with other messages, so the lower rating may reflect an increased annoyance sensitivity when messages were received that were perceived as untimely. Except for the rating of incident messages given by Previous Users, all of the mean timeliness ratings were significantly greater than the neutral rating (4.0) and therefore, overall, there was mild agreement with the assertion that messages were timely.

1 Both $F$ tests reported in this paragraph were based on the multivariate approach to repeated measures and the Wilks’ Lambda statistic.
Questionnaire Comments. Eight respondents commented that incident messages were delivered too late to be useful. Six people had the same comment regarding congestion messages. There were no positive comments with regard to the timeliness of messages.

Focus Group Findings. Comments in all four pager user focus groups indicated participants did not feel the messages were timely. One of the PDA focus groups indicated those participants felt the messages were timely, but these users found accessing PDA messages so difficult that they may not have had much opportunity to evaluate timeliness.

4.18 Assess User Perception of Communications Reliability

No additional information on perceptions of communications reliability are available beyond that used to discuss signal availability in section 4.7.

4.19 Assess User Perception of Traveler Safety

Questionnaire Items. Two items in the questionnaire addressed the safety issue. One item asked how often respondents consulted the pager while in their vehicles. This item asked users to rate frequency of use (1) before departing, (2) while moving, and (3) while stopped. The rating was on a scale from 1 to 7 where 1 was labeled “never”, and 7 was labelled “every trip”. The second safety related item requested a yes or no response to:

“Do you feel it is safe to check your pager while the vehicle is moving?”

Figure 24 summarizes the findings with respect to when respondents indicated they check their pagers. Whereas there is no overall difference between user groups (\(p > 0.09\) by multivariate \(F\)), there was a significant interaction between user groups and part of trip, \(F(4, 334) = 3.43, p < 0.01\), and a main effect for part of trip, \(F(2, 166) = 24.39, p < 0.001\). The main effect is primarily reflects respondents’ low ratings for frequency of consulting the pager while the car is moving. That is, drivers indicated that they seldom looked at the pager while moving. The interaction resulted because PDA users were not only unlikely to check their device when their car is in motion, but also unlikely to check it when they are stopped.

As shown in Figure 25, almost half of the pager users indicated that they felt it is safe to consult pager messages while their vehicle is moving. Most PDA users felt that consult-
ing their device while driving is unsafe. The difference in opinion between pager and PDA users as to the safety of checking the devices is statistically reliable, $X^2 (2) = 6.78$, $p < 0.05$.

**Figure 24. Mean Rating for Frequency of Use of the Pagers as a Function of Part of Trip and User Group.**

**Questionnaire Comments.** Thirteen respondents included comments with their response to the questionnaire item regarding how often they check their pager while in their vehicle. Six of these comments suggested that it is dangerous to consult the pager while driving. The other seven respondents indicated that they check the pager while driving and did not indicate that they felt this was dangerous.

**Focus Group Findings.** The focus groups did not address the safety question directly. Some Previous Users indicated that they checked their pager while driving. Only one PDA user indicated he used the PDA while driving and demonstrated a one-handed method for accessing messages. Several PDA and pager users indicated that they would find the devices more useful for traffic information if they could be designed to mount in the vehicle with the display designed to be easily read at a distance.
Figure 25. Percent of Users Who Indicated They Believe it is Unsafe to Consult Their Pager or PDA While Driving.
5. Summary and Discussion

Four hundred and ninety-two users were recruited to participate in the Genesis Operational Field Test and evaluation. Of these, 175 returned completed questionnaires, and 46 participated in focus group discussions. The focus group and questionnaire findings were largely complementary — there were no obvious discrepancies between the findings from these two data sources.

The majority of respondents (123) were from the New User group; individuals who had not previously used an alphanumeric pager. Although there were a relatively large number of participants (210) in the Previous User group, a group of individuals who were using alphanumeric pagers prior to the start of the operational test, many of these users did not return questionnaires. The low questionnaire return rate among this 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. This initiation was a one time event that set up the pagers to receive traffic information in the four slots reserved for it.

Approximately ¾ of the questionnaire respondents were male, and slightly less than half (44 percent) were 36 years of age or younger. More than ¾ the respondents reported holding a bachelors degree or higher, and most indicated they were familiar with high technology items such as computers. The most striking finding among questionnaire respondents was their reported annual driving mileage; the median annual mileage was approximately 25,000 miles.

5.1 User Satisfaction

Users tended to view the messages they received from Genesis as accurate, useful, and easy to understand. For the most part, users also reported messages to be timely. Whereas ratings of accuracy, usefulness, understandability, and accuracy where generally positive, they were not overwhelming so. Planned event messages, especially construction messages, were called out by users as particularly useful, timely, and accurate.
Genesis users’ perceptions of congestion messages may be important for traffic managers who want to influence traveler decision making. Congestion messages were often mentioned as not useful because users were not certain whether there was a meaningful distinction between slow, stop and go, and heavy traffic were. In focus groups, users indicated that they were not interested in slow traffic messages unless the traffic was significantly slower than usual. That is, reports of recurring congestion are not useful to regular traveler who have already taken it into account. Users indicated that they would prefer to receive travel time (in minutes) or travel speed (in miles per hour) over messages with imprecise adjectives or adverbs.

Pagers have become a critical business tool for many people. Those who want to supply traffic information on pagers will need to avoid interfering with existing pager uses that are perceived as critical to users. Previous users were least positive about congestion messages, and expressed more skepticism regarding the timeliness of incident messages. Previous users were recruited through employers who supplied their pagers. These users were sensitive to the perceived interference of traffic information messages with the use of the pagers for business and personal pages. Thus it appears that ratings of timeliness and usefulness were influenced negatively, among the Previous User group, by frustration with the perceived interference between traffic and other messages.

5.2 Suggested Improvements for Service

Users suggested several improvements in the Genesis service. Most seemed to consider the operational test as a suggestion of what may be possible, rather than a demonstration of a finished product. 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 included:

- Include more roadways
- Expand the coverage area
- Enable personalized reports — reports only for roads and times of day specified by the user
- Report travel speed, travel time, or otherwise more clearly describe the severity of congestion
- Suggest alternative routes
- Report anticipated clearance time for incidents and congestion.

The first three items in this list should not be viewed as contradictory. Users want information about all the roads on their planned routes, but would like the system to filter out information irrelevant to their trip. Thus, expanded coverage without improved filtering of information would probably not be viewed positively, as it would be likely to result in more irrelevant information for any particular trip.

PDA users suggested improvements that would take advantage of the computer platform such as graphical maps and two-way communication.

5.3 Perceived Benefits

As illustrated in Figure 21, users perceived Genesis as helping them to avoid congestion by providing more information for their route planning. Reducing travel time was not viewed as a major benefit. Respondents did not apply the information to decisions regarding transit and carpool options.

Focus group participants tended to stress the potential for benefits, rather than benefits received during the operational test. In particular, focus group participants stressed that the timeliness of incident messages would need to improve before they could expect actual benefits.

Focus group participants were suspicious of potential benefits to be derived from widespread use of improved traffic information. Many participants expressed the belief that widespread use of real time information would negatively affect personal benefits by pro-
duc ing congestion on alternative routes. Public agencies should note belief when attempting to reduce congestion by making traffic information more available.

5.4 Perception of the Delivery Devices

Pager users were generally satisfied with the Motorola advisor. Some suggested a larger display area would be useful. With a few exceptions, users did not report difficulty receiving messages. Members of the Previous User group did not like the feature that prevented them from viewing messages while new pages were being received. This feature had a negative influence on their perception of Genesis messages, as volleys of traffic information messages could tie up the device for approximately 20 seconds.

PDA users were not satisfied with the MessagePad and Messagecard combination. The process of downloading messages was viewed as inconvenient. Some users who left their Messagecard on at all times, developed a practice of downloading messages first thing in the morning — a process that could take up to 25 minutes — so that they could view the latest traffic information before they left for work. Other users commented that the PDA was too bulky and too valuable to be carried everywhere.

The Genesis system developers were aware of the problems with the interface between the MessagePad and Messagecard. The interface was a design compromise to met the test schedule and did not reflect an inherent limitation of paging and PDA technology. Users comments about the bulk and value of the PDA may represent challenges to the technology and should be considered by ITS developers.

5.5 Willingness-to-Pay

The Genesis volunteers were high mileage drivers who were eager to maximize there opportunities to avoid traffic congestion. Therefore, given some improvements in the service are made, they expressed a willingness to pay for the service. In focus groups, estimates of the value of Genesis service tended to range between $5 and $10 per month. In the questionnaire, willingness to pay was derived by asking participants to compare the value of other services to that of Genesis. In this comparison, Genesis was viewed as more valuable than a premium cable television station subscription, a one month daily
newspaper subscription, an issue of a national magazine, or four hours of parking downtown. Traffic information was rated much more valuable than sports score and stock quote messages on the pager — two services that are already provided as part of the basic paging service. Based on comparisons of value with other products and services, it was concluded that the value of pager traffic messages may be as high as $20 per month. Note that a value of $20 per month does not imply end users would be willing to directly pay $20 per month. For instance, traffic information on the radio was valued similarly to Genesis information, and, given that the radio information is already provided free to end users, it is unlikely users would voluntarily pay for the same information. The value information may be more useful to public decision makers who need to justify providing information, and to private sector decision makers looking at ways to increase the value of products they provide.

5.6 Safety

Approximately half the pager users, and nearly all the PDA users indicated that they don’t think it is safe to consult their respective devices while driving. None-the-less, many users, almost all of them pager users, at least occasionally consult their device while driving. There is little evidence that Genesis participants created a hazard when they checked their pagers, and no evidence that providing traffic information on pagers will increase the overall incidence of traffic accidents. However, given that users will occasionally wish to obtain traffic information while on the move, efforts to make the device driver friendly might have a safety payoff and would be likely to increase user acceptance.
6. Conclusions

The Genesis operational test results suggest that there is a demand for traffic information that may be met by transmission to personal communications devices such as pagers. Users, whose median annual mileage exceeded 25,000 miles, reported that the pagers were a convenient way to receive traffic messages. Participants, most of whom reported annual incomes between $40,000 and $80,000, indicated that they would be willing to pay $5 to $10 per month for a Genesis-like service that distributes timely, accurate, traffic information for relevant routes.

Genesis users also indicated some disappointments with the service as they experienced it. The number of roadways for which information was available was perceived to be too limited. At the same time, users perceived that too many of the messages they received were not relevant to their travel. Users indicated that they would prefer a service that allowed them more control over the routes for which they received messages. Users who were already using alphanumeric pagers when the test began, found that streams of traffic messages made it difficult for them to access their pager messages; these users would like a pager that continued to allow access to older messages as new messages arrived.

PDA users were more disappointed with their experience with Genesis. Not only did they find the MessagePad / Messagecard combination clumsy, but they also failed to perceive a compensating benefit. These users felt that the PDA technology should provide more functions such as a graphical map that would allow them to input routes and request route specific information.

Genesis 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.
7. References

