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ATIS Market Research: A Survey of Operational Tests and University and Government Research

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FOREWORD

The following is one of a series of papers developed or produced by the Economic Analysis Division of the John A. Volpe National Transportation Systems Center as part of its research project looking into issues surrounding user response and market development for selected Intelligent Vehicle-Highway Systems (IVHS) products or services. The project, sponsored by the Federal Highway Administration's Office of Policy Development, was one part of FHWA's 1992 Institutional Issues Program entitled -- "Public Acceptance and Markets for Various Consumer IVHS Services". John O'Donnell of the Volpe Center and James March of FHWA served as Project Managers for their organizations.

The objective of the Volpe Center project was to better understand factors affecting the development and deployment of selected advanced traveler information products and services (ATIS). The Center addressed the objective by examining the development of markets for selected ATIS-related products and services and reviewing factors affecting the public acceptance and user response to existing traffic information services.

Deployment of many of the newly emerging and projected IVHS products and services will depend upon consumers purchasing and otherwise choosing to make use of advanced traffic and travel information products and services. Through four different projects, each with a distinctive approach to understanding consumer response and market demand, the Volpe Center explored the question: Given the opportunity to buy a product or subscribe to a service that promises to deliver traveler information, will the consumer perceive that there is sufficient benefit to be gained to justify the investment?

The Volpe Center and FHWA jointly conducted a workshop in the Fall of 1992 to discuss issues involved with assessing the market for IVHS products and services. The objectives of the workshop were to help define a research program which would address measuring user acceptance and response to ATIS products and services and the role market research plays in understanding emerging markets for new or unknown products and services.

The results of the workshop are reflected in the four research tasks initiated as part of this program and the seven papers which comprise it. The four task areas are summarized below. Copies of the papers will be provided upon request to the Volpe Center.

TASK 1. Industry Methods for Assessing Consumer Response to New Products/Services

The first project was designed to answer the question of how consumer response and market demand are measured in the commercial sector, where these market demand questions are fundamental to the survival and success of the business. This project has two parts. The first is a primer on how consumer marketing research is done in the commercial sector. The second presents three case studies that examine how three current high-technology

communications and travel products applied marketing research in preparation for market release.

Report 1A. *A Primer on Consumer Marketing Research: Procedures, Methods, and Tools*

The Volpe Center developed a marketing research primer which provides a guide to the approach, procedures, and research tools used by private industry in predicting consumer response. The final two chapters of the primer focus on the challenges of doing marketing research on "revolutionary" products, or those products which the consumer has had no direct experience with, as is the case with most IVHS products and services. This primer was designed to provide the non-marketing researcher with a good understanding of how this particular type of human behavior research is pursued.

Report 1B. *Case Studies of Market Research for Three Transportation Communications Products: Electronic Toll Collection, Advanced Vehicle Information and Location, and Cellular Telephones*

Three case studies were undertaken to demonstrate the application of marketing research to products which are analogous to ATIS products and services, to learn from the market experience of these three ATIS-analogous products any lessons which might be applicable to future ATIS research, and also to demonstrate the uncertainty - despite good research design and assumptions - of marketing research predictions. The case studies were written by Thomas Parish of Arthur D. Little, Inc.

TASK 2. *ATIS Market Research: A Survey of Operational Tests and Universityand Government Research*

The challenge of marketing research is much more difficult where the consumer has not had direct personal experience using the proposed product in daily life. The operational tests provide an excellent opportunity for gathering consumer response and market demand information from "experienced" consumers. The Volpe Center team surveyed the operational tests that were extant or complete (as of 8/93) to learn whether any consumer response/market demand information had been collected and analyzed. The survey was extended to include government-sponsored university research projects so as to provide a more complete overview of the current national research program in relation to this question.

TASK 3. *A Market Analysis of the Commercial Traffic Information Business*

What kind of traffic information is available to consumers right now? How do consumers respond to current offerings? What are the market/economic fundamentals that underlie this market?

The traffic information services business is well-established and a study of its market fundamentals yields insight into consumer response to ATIS as well as providing useful information to policy makers who are considering the future role of government in this arena. This report describes how traffic information is gathered, processed, packaged, wholesaled, and retailed on the variety of platforms which are available on the market today.

TASK 4. Laboratory Simulation of ATIS for Testing Drivers' Response

This project was formulated to explore the feasibility of enhancing existing laboratory or PC-based driver decision simulators which have the ability to gather revealed preference data and test drivers' decisions in the presence of traffic information. Such simulators, it was hypothesized, could supplement operational tests as a source of consumer response and market demand data. The work was performed at MIT under the leadership of Professor Moshe Ben-Akiva.

Report 4A. *State of the Art of ATIS Driver Simulators*

The project was divided into three parts. The first, covered in this report, reviewed all existing driver simulators to learn whether any were sufficiently sophisticated to be used, as is, to reliably test drivers' response to traffic information.

Report 4B. *A Review of ATIS Operational Tests*

The design of any laboratory-based simulator is based upon a model of how individuals respond to stimulus, in this case ATIS products. To construct a model, one must first study the natural behavior of live subjects in an actual ATIS driving situation. Report 4B looks to the existing and completed ATIS operational tests to learn whether data has been produced that is suitable for the purposes of developing or improving ATIS models.

Report 4C. *A Modeling Framework for User Response to ATIS*

This report focuses on the information required to support the development of a modeling framework for driver response to ATIS. In it, the author identifies the stages of user response to ATIS, outlines the key factors associated with each decision, and discusses the data which would be required to complete the model, and thus construct a reliable, durable driver simulator.

ATIS Market Research: A Survey of Operational Tests and University and Government Research

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EXECUTIVE SUMMARY

The following report outlines research that examines the market for Advanced Traveler Information Systems (ATIS). The report is intended to provide FHWA and the IVHS community at large with an overview of market research activities currently being conducted within the scope of federally sponsored operational tests, and at university and government transportation research centers.

There are currently eight federally-sponsored ATIS operational tests. Three of the operational tests have been implemented; the remaining five operational tests are still being planned. This report includes more detailed descriptions of the "live" tests, Pathfinder, TravTek, and SmarTraveler, including basic background information and an assessment of market information which has been or will be collected. For the five operational tests in the planning stages a brief description of the project has been provided.

This report also outlines market-related research projects which are underway or have recently been completed at universities and government transportation research labs. Work-in-progress has been described briefly. Descriptions of recently completed research include an outline of the research, a brief summary of results, and citations referring the reader to where the work was published.

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INTRODUCTION

PURPOSE

The purpose of this report is to present FHWA with a summary of market research activities planned or underway at ATIS-related publicly sponsored operational tests, supplemented by a list of known market-related analysis work-in-progress at university and government transportation research centers. It is hoped that the provision of an inventory of public domain market research activities will help to structure future market research efforts.

BACKGROUND

Deployment of ATIS products and services will depend in large part on the purchasing behavior of the traveling public. Given the opportunity to buy a product or subscribe to a service that promises traveler information, will the consumer perceive that there is sufficient benefit to be gained to justify the investment? Planning for deployment of ATIS requires that this question of market response be answered.

In the U.S., consumers' experience with traveler information is largely limited to traffic information provided by radio and television broadcasts. Consumers have infrequently, if ever, paid directly for this information, and they have little or no experience with products and services that can provide more situation-specific travel/traffic services, as many of the emerging ATIS products promise. Without providing consumers with direct personal experience with a new product or service, it is difficult to gather reliable market demand information.

Publicly sponsored operational tests which provide travelers with personal experience with potential ATIS products and services provide a unique opportunity to generate market information. Publicly sponsored operational tests offer an opportunity to measure whether there is a viable consumer market for IVHS products and services. The information gained through properly planned and integrated market research protocols can help to predict how consumers will react to ATIS.

SCOPE

In reviewing the U.S. operational tests, the authors considered the following:

- What consumer products and/or services the tests are evaluating,
- Whether the evaluation protocol has specifically included market research components, and
- Market research results, if any, that have been obtained.

Where data is available, the paper identifies its source and summarizes the findings.

There is very little market data as yet available from U.S. operational tests. To date, results are available from only two operational tests: Pathfinder and TravTek. Results from preliminary SmarTraveler market research will be reported in 1994.

It should be noted that the operational tests were not originally designed to include market research. The majority of tests were primarily designed to test product performance and features, with a few tests additionally incorporating some market research. As questions regarding the market for ATIS have presented themselves, it has become necessary to retrospectively review the completed tests to learn what market data exists. Within this constraint, the authors have developed a market research framework (described below) and applied it to each operational test.

This report presents a summary of market research activities planned or underway at ATIS-related publicly sponsored operational tests. To begin, the report focuses on the definition of market research and the successive stages of inquiry performed within a market research framework. The authors have provided descriptions of the various research tools that are used to collect valid data about the market and about consumer response to the products being tested.

Second, using the market research framework as a guide, the authors addressed eight operational tests that are either completed, operational, or in the planning stages. For each test, the authors provided a description of: the test and its evaluation, the market research tools used within that test, and the results of any market research that was conducted.

Third, a survey of market research conducted at universities and government transportation research centers is provided. Both recently completed papers and on-going research are included.

Finally, the authors have included a more detailed description of each operational test within an appendix to provide the reader with a more in-depth analysis of the work being performed within each test.

MARKET RESEARCH AND OPERATIONAL TESTS

DEFINITION OF MARKET RESEARCH

Market research is a structured series of analytical and evaluative activities which begin with either the recognition of an unfilled consumer need, or the development of a new technology which has the potential to create and fill a new, undefined market niche (or latent demand). This latter approach is sometimes known as "supply-side marketing". Jean Baptiste Say, a classical economist (1767-1832), wrote that supply of a product can produce its own demand. Modern market researchers have observed that the infancy of every high technology market has been characterized by supply side conditions in which the marketer's job is to stimulate primary or basic demand for the product, process, or service at hand. It has been asserted that the IVHS market is a solution in search of a market. If this is true, the IVHS market shares this condition with many such high technology products.

The market research activities which companies pursue in the exploration of a potential product generally follow a series of progressively more detailed stages of inquiry. Each stage of inquiry utilizes a number of different market research tools that aid in further defining the product and the consumer. More specific detail helps the company focus on the features and benefits of the product that consumers find most appealing and valuable. It also helps the company position the product on the market at a price point which will generate the most profit.

In theory, each stage in the series of market research activities is successive, with the inquiry at the first stage leading to a better definition of the inquiry at the next stage (see Figure 1 on page 6). However, in practice these stages overlap, are at times pursued simultaneously, and often inform the previous stage. For instance, if, in a focus group that was convened to provide more conclusive, detailed information (stage 5), a consumer pointed out an undiscovered benefit from the product, the market research group would then use that information to refine the product presentation and expand the definition of the market (stages 1 and 2).

Conducting market research through the stages of the framework produces information on:

Consumers:

- Who they are
- Their needs/their lifestyles
- Their likelihood to purchase the product
- Consumer segmentation by characteristics that affect the product's success (i.e., income)

The Market:

- Market opportunities that exist
- Market niches that can be defined

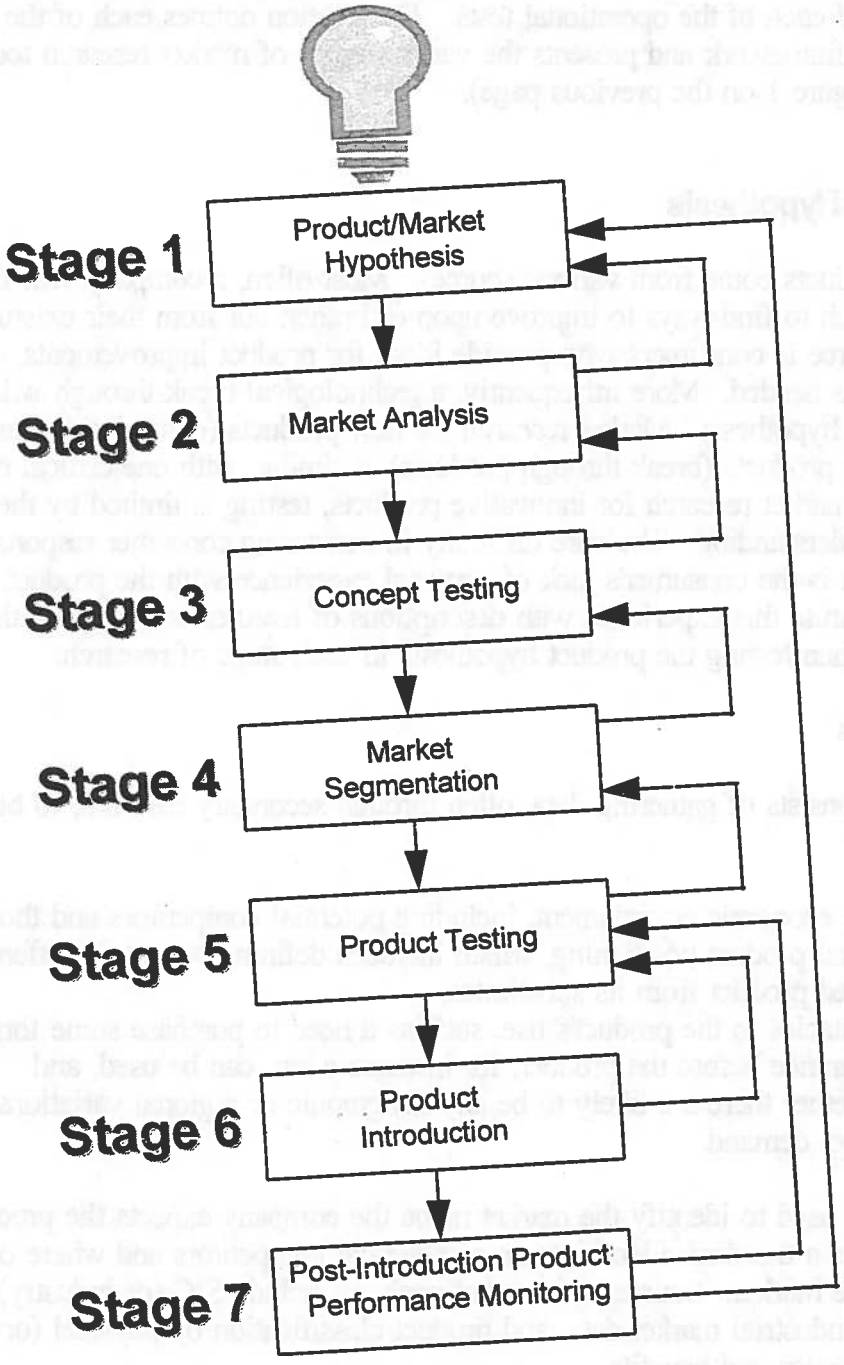
- The influence of competitors
- Other environmental influences likely to affect the product's success (i.e., recession)

The Product:

- How consumers use it
- How it affects their behavior
- How the product solves consumer/social problems (i.e, congestion).

It should be noted that the presence of questions in a survey that are intended to collect demographic information or to test participants' responses to certain product features does not, in and of itself, comprise a market research study. As with any evaluation, the test design, study design, survey content and methods, and other information gathering methods must all be integrated into a consistent study protocol in order to ensure valid, applicable results.

Figure 1: Market Research for New Product Introduction



MARKET RESEARCH FRAMEWORK

In this paper, the authors employ this market research framework to assess the market research content of each of the operational tests. This section defines each of the component stages within this framework and presents the various types of market research tools used at each stage (see Figure 1 on the previous page).

Product/Market Hypothesis

Ideas for new products come from various sources. Most often, a company will fund exploratory research to find ways to improve upon or branch out from their existing product line. Another source is consumers who provide ideas for product improvements, or define a new product that is needed. More infrequently, a technological break-through will form the basis of a product hypothesis. Market research for new products (extensions of existing lines) and for innovative products (break-through products) is similar, with one critical exception: when conducting market research for innovative products, testing is limited by the consumer's experience and understanding. The core difficulty in measuring consumer response to an innovative product is the consumer's lack of personal experience with the product. Thus, it is necessary to substitute this experience with descriptions of features and benefits the consumer is familiar with when testing the product hypothesis in each stage of research.

Market Analysis

Market analysis consists of gathering data, often through secondary research, to better understand:

- The economic environment, including potential competitors and their offerings,
- Initial product positioning, which includes defining what will differentiate the tested product from its substitutes,
- Obstacles to the product's use, such as a need to purchase some form of insurance before the product, for instance a car, can be used, and
- Whether there are likely to be any geographic or regional variations which will affect demand.

Market analysis is used to identify the market niche the company expects the product to occupy. It requires a thorough identification of potential competitors and where competitors' products are on the market. Sources for market analysis include SIC (or industry) codes, industry profiles, industrial market data, and product classification by physical (or other relevant) characteristics and benefits.

Concept Testing

Concept testing measures the appeal of a product idea to consumers by drawing upon embedded company knowledge and experience, frequently in conjunction with expert user interviews and focus groups. It is used to formulate a hypothesis about the product's benefits and features, and about the segments of the general population which will comprise the primary target market. Concept testing is product- and benefit-oriented and uses the following market research tools:

- Focus groups,
- "Expert" interviews, and
- Product prototypes.

Market analysis and concept testing are often done concurrently. Together, they support the formation of a preliminary hypothesis about product benefits, consumer response, and level of demand for the product on the market. They create an outline of the needs and motivations of the potential consumer, which then supports the product and market development process. The product/market hypothesis is then tested and refined against the following, more conclusive forms of market research in order to produce a plan for product introduction and support.

Market Segmentation

Market segmentation divides consumers into distinct groups, or segments, of consumers with similar needs and characteristics. Well-defined segments are easier to target with specific products and market strategies. This stage of research depends heavily upon interrogative research methods of all types. Gathering more conclusive lifestyle and demographic information on the potential consumer allows the company to develop greater depth of knowledge about the targeted market and consumer. Most important, more detailed market and consumer information helps the company identify who the early and secondary product buyers are likely to be. Consumer information can be gained from census data, proprietary secondary sources and reports on consumer trends (such as the Popcorn report), followed by surveys and focus groups.

Product Testing

Product testing allows a company to better understand product performance and features. It defines who uses the product, how they use the product, when/where they use the product, as well as the actual performance and functionality of the product in "normal" use. Product testing includes:

- The use of simulated products or prototypes in order to give consumers experience with and understanding of the products and its benefits,
- Surveys,
- Focus groups, and
- Logs (both computerized and manual) used for the quantified measurement of benefits, such as the amount of time saved by the use of the product.

Through the use of product prototypes, surveys and focus groups, product testing allows the company to generate data on consumers' perceptions, including:

- Information regarding the most acceptable models of payment,
- What price points correlate to which bundle of services,
- Which product features are most valuable,
- Whether any feature designs require adjustment, or
- Whether other issues will crop up with product introduction such as increased or decreased insurance rates or specific repair needs and servicing.

Product testing may also uncover additional applications of the product that were unrecognized at the point of concept generation. Product testing is particularly critical when testing an as yet unknown product, for it helps provide insight into how to stimulate market demand when that demand is latent or unconscious. Much of the market related research conducted within the IVHS operational tests falls into the product testing category of market research.

Product Introduction

The outcome of these stages of research is a market and product introduction plan that provides increasingly detailed information about product roll-out, market development, and product support.

Product Performance Monitoring

Product performance monitoring begins at the time of product introduction and is designed to monitor market response to the product; this activity becomes intertwined with ongoing product development and market development activities.

ATIS OPERATIONAL TESTS

The ATIS operational tests were not designed to be market research projects. However, some market data does exist from surveys that were conducted either for explicit market purposes or for other purposes; several of the tests which are in the planning stage appear to include market research components. For each operational test, the authors have included the following market research information:

- Identification of the operational test as either a market test or as a product feature test,
- A review of the market research tools that may have been used within the scope of that test, and
- A description of any available results.

There are a total of eight ATIS operational tests which are operational, in planning or complete in the United States. They are as follows:

- Pathfinder
- TravTek
- SmarTraveler
- DIRECT
- ADVANCE
- FAST-TRAC
- Houston Smart Commuter
- Genesis

Each of these operational tests are testing a bundle of IVHS features related to traveler information. The feature bundles are described in Figure 2 on the following page.

Following is an outline of each operational test. The outlines have been broken into two groups: currently operational and completed tests, and tests being planned. For tests which are operational or have been completed, the outline includes a discussion of the test in general, the test evaluation, market research, market research results, and conclusions about the test. For tests which are being planned, only a brief discussion is included since many of the details regarding these tests remain to be finalized.

Figure 2: IVHS Features Tested in Each ATIS Operational Test

Location	SmarTraveler Boston, MA	Pathfinder Los Angeles, CA	TravTek Orlando, FL	DIRECT DETROIT MI
Status	Operational	Completed	Completed	Planning
Pre-Trip Planning	✓	✓	✓	
Driver Information	✓	✓	✓	✓
En-Route Transit Advisory				
Traveler Service Information			✓	
Route Guidance			✓	
Emergency Notification and Personal Security			✓	

Location	ADVANCE Chicago, IL	FAST-TRAC Oakland Co., MI	Houston S. C. Houston TX	Genesis Twin Cities, MN
Status	Planning	Planning	Planning	Planning
Pre-Trip Planning	✓	✓	✓	✓
Driver Information	✓	✓		✓
En-Route Transit Advisory				✓
Traveler Service Information	✓			?
Route Guidance	✓	✓		✓
Emergency Notification and Personal Security	✓			✓

DEFINITIONS

Pre-Trip Planning:	Services which assist travelers in making mode choice, travel time estimates, and route choice decisions prior to trip departure.
Driver Information:	Provides vehicle drivers with information which will allow alternative routes to be chosen for their destination.
En-Route Transit Advisory:	Provides travelers with real-time transit and high occupancy vehicle information allowing travel alternatives to be chosen once the traveler is en-route.
Traveler Sevice Information:	Provides travelers with service and facility data for the purpose of assisting the traveler either pre-trip or en-route.
Route Guidance	Provides travelers with directions to selected destinations.
Emergency Notification and Personal Security:	Provides for faster notification of travelers involved in an incident.

CURRENTLY OPERATIONAL AND COMPLETED TESTS

Pathfinder

The Pathfinder test was completed in June of 1992. Pathfinder was an operational test of an in-vehicle navigation system with real time traffic information. Pathfinder was designed to address the following objectives:

- To design, install, and operate an experimental system that will provide real time traffic information to motorists in their vehicles,
- To evaluate driver response to real time traffic information,
- To evaluate the utility of using vehicles to provide information regarding traffic conditions, and
- To evaluate a computer-assisted method of combining real time traffic information from various sources.

The test area was the Santa Monica Freeway and neighboring arterial streets in the City of Los Angeles. The test evaluation was released in February of 1993 (JHK & Assoc., 1993).

Evaluation

The evaluation had two main components: a yoked driving study in which paid drivers drove between specific points in the corridor, and a natural use driving study in which volunteers used the system in their daily commuting trips.

The yoked driving study was a controlled experiment to determine the objective benefits of the ATIS. In the yoked driving study three drivers traveled a predetermined route at approximately the same time. One driver acted as a control by driving an unequipped vehicle, another driver drove a vehicle with just a navigation system, and the third driver drove with the navigation and traffic information system. Drivers were timed to determine the travel time savings of the equipped drivers over the control condition. By equipping the vehicles with sensors, the benefits in terms of distance and speed were also measured. The experiment was repeated many times to achieve statistically significant results. Drivers were also surveyed to collect information regarding their perceptions of the system.

The natural use driving study was a free-form experiment where drivers used the system in their daily trips. This produced information on drivers' perceptions of the system.

Market Research

The Pathfinder evaluation did not have a market research focus but did contain elements of market research product testing. The focus of the evaluation was on testing a specific product prototype. The evaluation included quantified measurement of product benefits, and data collection on user perceptions including product features, feature design, and a single price point. Data on user's perceptions was collected using surveys, while the measurement of benefits was performed through the yoked driving study. Information on product benefits was collected through electronic logs and trip logs completed by drivers at the end of each trip in the yoked study. A single pricing question was included as part of the survey distributed to system users.

Market Research Results

The Pathfinder evaluation report documented the results of the operational test. Some of the most significant findings regarding willingness to pay, product performance and product features are included below.

Willingness to pay:

- Participants were asked if they would purchase a Pathfinder System for their own car for the price of a car radio; 66% of respondents said they would, 15% of subjects were neutral while 16% of subjects said they would not.

Product performance:

- An important finding came from the study of travel time, travel distance, and travel speed benefits of the system: no significant difference for any of these benefits was found through objective measurement comparing the system group and the control group.

Product features:

- Nearly 80% of the drivers reported that trips they made using Pathfinder were faster than trips they made without Pathfinder, despite the fact that the Pathfinder device did not provide any advantage in the yoked study,

- 83% of the drivers rated the map as either very helpful or moderately helpful, while 69% rated the congestion location symbols as either very helpful or moderately helpful,

- 95% of drivers indicated the map was either very accurate or moderately accurate; 80% of drivers rated the other components very accurate or moderately accurate.

Conclusion

The Pathfinder evaluation was not designed to produce market research information; however, the results from the evaluation did contribute to product refinements incorporated into the design of future in-vehicle ATIS. In fact, findings from Pathfinder were incorporated into the design of the product tested in TravTek.

A couple of changes in the Pathfinder test could have produced more consumer market information. First, the criteria for subject selection was not defined so as to maximize applicability of test findings to any specific consumer segment. Second, the surveys did not fully explore consumers' willingness to pay for the system: one question was asked regarding a single, vaguely defined price point.

TravTek

TravTek is a test of an in-vehicle navigation and dynamic route guidance system with real time traffic information, a business directory, emergency request services, and built-in cellular telephone. TravTek was designed to address the following objectives:

- To improve efficiency of individual and collective trip making under varying traffic conditions,
- To decrease and make travel times more predictable,
- To reduce traffic congestion through directions to a segment of road users,
- To improve environmental quality, including air quality, noise levels and visual esthetics,
- To reduce energy consumption,
- To reduce vehicle operating costs,
- To increase benefits to all travelers in the area, not just travelers in TravTek equipped vehicles,
- To provide more current traffic information by the use of instrumented TravTek vehicles as traffic "probes,"
- To increase knowledge of and experience with vehicle-to-highway communications systems,
- To provide information and data to inform national decisions regarding advanced traffic management and future highway programs,
- To establish improvements which will provide permanent value to the Orlando Metropolitan Region beyond the TravTek Demonstration and Evaluation Project,
- To increase safety.

The test took place in the greater Orlando area and ran from March 1992 to March 1993. The evaluation was performed by SAIC and the evaluation report is expected in the spring of 1994.

Evaluation

The test had two primary components: rental car driver study and high mileage driver study. The test evaluation also included a yoked study similar to the one in Pathfinder and a camera car study, in which a driver's eye movements and driving behavior were monitored while driving. In each study, three versions of the product were tested and compared:

- Business directory only,
- Business directory, static navigation and static route guidance,
- Business directory, dynamic navigation, and dynamic route guidance with real time traffic information.

In the rental car study subjects were recruited through the AAA and the AVIS rental car company, and used one of the three product configurations in a specially equipped rental car for approximately a week. The specially equipped vehicle included an electronic log which recorded system use. Drivers were surveyed regarding their perceptions of the system at the end of their rental period.

In the high mileage driver study, subjects were recruited from the area. They used the system for one month in each of the product configurations in a specially equipped vehicle. The specially equipped vehicles included a log which recorded system use. Drivers were surveyed and interviewed regarding their perceptions of the system at the end of the month.

The yoked study and camera car study were conducted to gather controlled data on benefits and safety.

Market Research

The TravTek evaluation focused on product testing in two particular market segments, high mileage drivers and rental car users. The evaluation focused on the measurement of benefits, and users' perceptions of payment models, price points, product features, and feature design. Data on users' perceptions was collected through surveys and interviews while quantified product benefits were measured through the yoked driving study. System usage information was collected using electronic logs in the vehicle which recorded how the system was used. Demographic information was collected through interviews and surveys. Pricing was addressed in the questionnaire; in contrast to Pathfinder, the questionnaire used a scale rather than asking about a specific price or price analogy. The study may explore the correlation between demographic factors and perceived product benefits, but because the participant selection process was not representative of the general population, these findings will have limited applicability.

In conjunction with TravTek, General Motors conducted its own proprietary market research. This study was funded and managed independent of the publicly sponsored operational test and the information is not in the public domain. It is expected that the resultant consumer and product information will support GM's product development and marketing strategies.

Market Research Results

While the operational test evaluation has not been released, some results from the user questionnaire, including willingness-to-pay, were presented at the Vehicle Navigation and Information Systems conference in October of 1993. Researchers found that 50% the of subjects, who were self-selected and AAA members, were willing to pay $1000 or more, and 30% were willing to pay $1195 or more for the TravTek system as an option on a new car. The study also found no significant difference in willingness-to-pay between the TravTek system with traffic information and without traffic information (Perez, 1993).

Conclusions

TravTek will provide in-vehicle ATIS product features and performance information based on product use among two potential market segments, rental car drivers and high mileage drivers. The participant framing and selection procedure limits the extent to which any of the consumer related findings can be generalized to a larger segment of the population. While the willingness-to-pay information is indicative of general intent, the study structure and approach taken by the questionnaire limits the applicability of the results.

SmarTraveler

SmarTraveler is a test of a telephone-based ATIS providing route specific real time traffic information and public transit information[1] to commuters in the Boston area. Traffic information is provided for all major routes in the Boston area. SmarTraveler has been designed to address the following objectives:

1. Demonstrate public acceptance and utility of widely available, telephone delivered, real time, location specific traffic and transit information,
2. Evaluate the impact on travel of widely available, telephone delivered, real time, location specific traffic and transit information,
3. Assess the effectiveness of new technologies in enhancing the collection, fusion and dissemination of traveler information,
4. Design and demonstrate the viability of a privatization strategy for the delivery of widely available travel information.

The system is available to land based callers and cellular callers. The test is currently in its operational phase. The evaluation is expected to be completed early in 1994.

Evaluation/Market Research

One of the primary goals of SmarTraveler is to determine whether such a service could be a profitable business and to determine how best to market the service to the public. To achieve

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[1] The transit information, provided by the Massachusetts Bay Transit Authority (MBTA), is not as comprehensive as the traffic information. Generally only major delays are reported to callers; callers are referred to the MBTA's phone system that provides transit schedule information.

this, the SmarTraveler evaluation is designed as a test market where users are unaware they are participating in an experiment. Evaluation subjects are selected at random from people who call the service. The evaluation includes a telephone survey of system users, and collection of usage statistics (Multisystems, 1993). Based on information collected, a plan to privatize the service will be developed by Smart Route Systems (SRS) and an overall evaluation will be performed by the evaluation contractor. Data collection on the product includes:

- Surveys for product feature testing, consumer perceptions and demographics,
- Focus groups for concept testing, questionnaire development, product feature testing and consumer perceptions.

Market Research Results

Some preliminary market research was conducted by Smart Route Systems independent of the operational test. A series of telephone surveys and focus groups was performed. Some of the results from that research regarding the effectiveness of the service have been included below:

- Average use is 5 times per week,
- 82% of users consider the service "very useful",
- 97% of users consider SmarTraveler "more useful" than radio; 71% consider it "much more" useful than radio,
- 30% of users change travel behavior "frequently" after using the service; 96% change "occasionally".

Conclusion

The SmarTraveler evaluation is well designed from a market information stand point. The operational test is being conducted in a test market format. As a result, this evaluation should provide a great deal of information regarding the market for low cost, real time traffic information services. Unfortunately, the transit information provided as part of the operational test is not comprehensive and thus results from the evaluation regarding the value of transit information will be less meaningful.

TESTS BEING PLANNED

The following five operational tests are each in various stages of planning or development. Following is a brief description of each of the tests, and a brief description of the potential of the test to produce market research information. The details of the evaluations of many of these tests have not been finalized; for those tests, it is premature to determine whether they will produce market research information.

FAST-TRAC

The FAST-TRAC operational test will test an in-vehicle dynamic route guidance system. The test area is in Oakland County, Michigan. FAST-TRAC will be a test of ATIS which includes commercial vehicles and private drivers. The evaluation design is being finalized and the evaluation is expected to begin "shortly" (Underwood et. al., 1993). FAST-TRAC will also test an Advanced Traffic Management System in conjunction with ATIS.

The FAST-TRAC system differs from the TravTek and ADVANCE systems in two significant ways. First, the FAST-TRAC system uses a simple, low cost, in-vehicle device in which the majority of the computation is performed by road-side computers. The system has a less sophisticated display and does not provide navigation or a business directory.

The FAST-TRAC evaluation has been designed to collect market research information through the "user preferences and behavior" component of the evaluation, the purpose of which is to understand how users perceive and value in-vehicle route guidance. The FAST-TRAC evaluation is designed to provide product testing information, including product feature definition and product performance. Product testing is expected to include measurement of objective benefits and information on models of payment, price points, product features, and feature design. Information will be collected through the use of interviews and a questionnaire. Consumer information will be collected using surveys and focus groups. Demographic data is expected to be collected for correlation with other results.

ADVANCE

ADVANCE will test an in-vehicle navigation and dynamic route guidance system with real time traffic information, a business services directory, and emergency request services. 4000 to 5000 vehicles are expected to be equipped with these systems; each equipped vehicle will act as a probe providing traffic information for the system. The test will take place in the north-west suburbs of Chicago. The operational test is in the design and development stage. Implementation is expected early in 1994. A draft evaluation plan has been completed and is currently under review (MITRE, 1992; MITRE, 1993).

The planned ADVANCE evaluation is very similar to the TravTek evaluation but on a larger scale. ADVANCE will test an in-vehicle ATIS developed by Motorola with four potential consumer groups: commercial vehicles, fleets, high mileage drivers and commuters.

The ADVANCE evaluation has been designed to collect market research information through the "Evaluation of Driver Perceptions and Route Choice Behavior," the purpose of which is to evaluate route choice behavior and perceptions and attitudes of participating drivers. Data collection is expected to include the measurement of benefits, and users' perceptions of models of payment, price points, product features, and feature design. Demographic data will be collected for correlation with other results. Data collection methods are expected to include surveys of users, focus groups and electronic logs of system use.

Genesis

Genesis will test the ability of personal communication devices (PCDs), specifically, personal digital assistants (PDAs) and pager devices, to provide traffic and transit information. The test area for the first phase will be west of the Minneapolis - St. Paul metropolitan area. Later phases will include progressively larger portions of this area. The preliminary system design has been completed, including the evaluation design. The final design and execution of the evaluation will be performed by SAIC. The first phase of the project is expected to be deployed in 1994.

Genesis is the only operational test to date which is planning to provide information on hand held ATIS devices usable for pre-trip and en-route traffic and transit information. Based on the preliminary evaluation design, the Genesis evaluation will collect market research information for the purpose of evaluating user acceptance of the PCD as reflected in attitudes and frequency of use. The evaluation plan is still under development; however the operational test evaluation is expected to incorporate product testing, including the measurement of benefits, models of payment, price points, product features, and feature design. Demographic data will be collected for correlation with other results.

DIRECT

DIRECT will test four different systems for providing real time traffic information to drivers. The test area is 21 miles of Interstate I-94 in Detroit. The four systems to be tested are area wide highway advisory radio, low power highway advisory radio, radio broadcast data system (RBDS), and a cellular telephone based service. The operational test is still in the planning stage. A draft operational field test evaluation plan was released in December of 1992 (Underwood et. al., 1992); however, due to budget constraints, the project plan is under review.

The operational tests planned compare the technical and user acceptance strengths and weaknesses of each of the four systems. The operational test has the potential to provide product testing information on the four systems tested. Information will be collected using surveys, in-depth interviews and focus groups of system users. Data is expected to be collected on product features and feature design. The extent to which market research will be included is unclear at this time.

Houston Smart Commuter

Houston Smart Commuter (HSC) will investigate the potential for traveler information services to promote mode shifting to public transit. The HSC operational test has two components: a dynamic ride matching service, and an ATIS which will provide traffic and transit information through telephone and home and office computer systems. The test area for the ATIS component of HSC will be the I-45 corridor running north from Houston.

The evaluation is expected to encompass market research. Some exploratory market analysis work has already been performed. The test is still in its early stages of planning; a deployment date has not yet been set. A "Concept Design and Implementation Program Outline" has been developed (Texas Transportation Institute, 1991).

In the development of the Houston Smart Commuter operational test, a literature review of existing market research information was performed by Texas Transportation Institute. The literature review concluded that providing increased information on transit services can have a positive influence on ridership. The HSC evaluation will be designed to test this hypothesis.

The Houston Smart Commuter evaluation has the potential to provide information on how consumers value a low cost system which provides traffic and transit information. No other operational test which is testing low cost traveler information services is planning to offer good quality transit information to consumers. The value of the Houston Smart Commuter evaluation will depend on how the test evaluation is designed. It is expected that the test will be operated as test market, where subjects are unaware they are participating in an experiment. The focus will be on users' perceptions including product features and feature design. It is unclear whether pricing issues will be pursued as part of the operational test.

MARKET RESEARCH AT UNIVERSITIES AND GOVERNMENT TRANSPORTATION RESEARCH CENTERS

There are a limited number of market related research efforts which are ongoing or have recently been completed at universities and government transportation research centers. Following is a brief description of these efforts. The descriptions which follow are based on information supplied by the authors of the studies. It should also be noted that this compendium is not intended to be a complete, comprehensive listing of all research being conducted in this field.

The following has been divided into two sections: on-going efforts which describe work in progress, and recently completed research which describe results that have been published in the last few years. The title for each description is taken from the title of the study or from the title of the publication which outlined the results. Each description outlines the nature and scope of the study, the parties involved, and the state of the project.

RECENTLY COMPLETED RESEARCH

Assessing the Acceptability of IVHS: Some Preliminary Results

This research was conducted by Robert Marans and Cyrus Yoakam at the University of Michigan (Marans, 1991). The paper presents the results of a survey distributed to 150 attendees of a one day conference on IVHS geared to representatives of the trucking industry. Less than one quarter of attendees were from the trucking industry the remainder were from government, private research, publishing, marketing, and other industries. 83 out of 150 surveys were returned. Questions dealt with market issues including estimated willingness to pay for different types of IVHS.

This study produced some information on how consumers value traffic information. It should be noted however that the sample was of transportation professionals and therefore was biased.

- 72% of subjects thought information on traffic tie-ups is useful,
- 72% thought information on traffic tie-ups and alternative routing to be useful,
- 50% thought information on road maintenance useful,
- 24% thought general trip time information useful, and
- 20% thought specific trip time useful.
- 50% of respondents indicated being willing to pay $0.50 or more for tie-up and alternate route information while 15% indicated being willing to pay $1 or more and less than 1 in 20 indicated being willing to pay $2 or more per day.

Behavioral Impacts of Recurring and Incident Congestion and Response to Advanced Traveler Information Systems in the Bay Area: An Overview

This report presents results from a survey which was conducted by California PATH; the lead researcher was Asad Khattak (1993c). The survey was distributed to 9000 commuters using the Golden Gate Bridge on February 16th and 17th of 1993 and 3238 surveys out of 9000 were returned. The 62 questions fall into 5 categories: normal travel patterns, pre-trip response to unexpected congestion information, en-route response to unexpected congestion information, willingness to change driving patterns, and personal information.

Some findings from the survey are presented in the report. Only 2% of the respondents took public transportation in response to unexpected congestion information received at the pre-trip stage; however, 18% said they would take transit if instructed to do so by an ATIS. Additional findings are expected to be presented at the Transportation Research Board Annual Meeting in January 1994 and at the IVHS America Conference in April of 1994.

Commuter's En-Route Diversion and Return Decisions: Analysis and Implications for Advanced Traveler Information Systems

This paper outlines research conducted by Asad Khattak, at the University of California, Berkeley, and Joseph Schofer and Frank Koppelman at Northwestern University published in 1993 (Khattak, 1991; 1993a; 1993b). The study examines short-term commuter response to unexpected congestion. A survey of approximately 700 downtown Chicago commuters was conducted. The survey gathered information on driver characteristics, travel and trip characteristics, delay and diversion experience, ratings of routes and stated preference about diversion.

The effect of radio traffic information on trip decisions was evaluated. A majority of the automobile commuters indicated that they had changed their trip decisions based on radio traffic reports. Researchers also found that most subjects use traffic information en-route rather than in planning their trips. Drivers may be more receptive to information if they listen to predominantly news radio stations. Traffic reports reduced en-route anxiety and frustration of drivers even if drivers did not alter their route.

Demand for IVHS In Charlotte, North Carolina: A Marketing Study

This paper outlines research conducted by Prof. Kent Gourdin and Prof. Patricia McIntyre at the University of North Carolina, Charlotte published in April of 1992 (Gourdin, 1992). Telephone surveys were conducted with four potential IVHS user groups: 584 consumer respondents, 45 commercial vehicle operator respondents, 4 emergency response organization respondents, and 20 fixed site manager respondents. From the research, willingness to pay for reduction in travel time was determined, as was the effects of where the respondent lives, the type of services offered, and other variables.

Following are some results from the survey. The authors point out that many of the people surveyed knew little about IVHS and that this may have biased the results of the survey. 50% of consumers reported being "very likely" to be willing to pay $10 per month for

reduction in travel time while 35% and 20% were "very likely" to be willing to pay $15 and $20 respectively. Commercial vehicle operators indicated a much higher willingness to pay for reduction in travel time; 75%, 58%, and 22 % were "very likely" to pay $50, $100, and $150 respectively. Based on responses to the survey, the authors estimated a possible monthly revenue of $1.1 million for an IVHS system in Charlotte.

Real-Time Motorist Information for Reducing Urban Freeway Congestion: Commuter Behavior, Data Conversion and Display, and Transportation Policy

This project was conducted by Mark Haselkorn at the University of Washington (Haselkorn, 1992a) (Haselkorn, 1992b). The project was to develop a PC-based ATIS called Traffic Reporter. As part of development, surveys and usability tests were conducted to ensure the effectiveness and ease of use of the system.

A survey and two follow up studies were conducted by Mark Haselkorn, Jan Spyridakis, and Woodrow Barfield at the University of Washington (Haselkorn, 1991). The results of these studies were used to develop a Traffic Reporter PC computer-based ATIS. The survey was conducted in 1988; information was collected about the travel behavior of 3893 commuters in the Seattle area (Barfield, 1991) (Spyridakis, 1991). The first follow-up study tested the effectiveness of five different display types using a sample of 97 commuters; subjects answered questions on the usability of the traffic information presented, and the effect of the screen on their choice of driving options including alternate routes mode choices, and departure time. In the second follow-up study 100 Seattle commuters were surveyed by telephone regarding their preference for screen-based traffic information.

The 1988 survey reached a number of conclusions regarding the effectiveness of existing traffic information in the Seattle area. Four general commuter subgroups were defined according to commuting behavior. They are:

- Route changers,
- Non-route changers,
- Route and time changers, and
- Pre-trip changers.

Results from the survey also demonstrated:

- Commercial radio is rated as the most useful and preferred medium for receiving traffic information.
- Those groups whose behavior is most flexible are most likely to act upon motorist information.
- Only a small, discrete group of Seattle's commuters are likely to be influenced to change mode.

Following the 1988 survey, laboratory testing was conducted to determine the effectiveness of Traffic Reporter. Some highlights of the findings are:

- Commuters who evaluated the system stated they would be willing to change their departure time, route, and occasionally their mode, given the right kind of information.

- Commuters also indicated they would like Traffic Reporter to include information on arterials and alternate routes, as well as explanations of traffic delays.
- Several commuters said they would make consistent changes on the basis of Traffic Reporter's information only if after time they found these changes saved them time and frustration.

Social and Institutional Considerations in Intelligent Vehicle-Highway Systems

This paper reports the findings from a delphi study performed by Steven Underwood at the University of Michigan (Underwood, 1990). The study presents experts' opinions on driving forces for the implementation of IVHS, barriers to market penetration, government initiatives, socio-technical impacts, and items of special interest for various IVHS technologies.

This study found traffic congestion and the public's demand for travel information to be the most important driving forces behind ATIS, while cost to consumers and government were found to be the most significant barrier. The study ranked possible government initiatives which would drive ATIS:

- Appropriating adequate funding,
- Establishing standards, and
- Liability protection.

These were found to be the most significant possible government initiatives. The most significant socio-technical impacts were found to be reduced congestion, improved safety, and consumer acceptance.

ON-GOING EFFORTS

Bellevue Smart Traveler

This project is investigating the effects of providing commuters with information on alternatives to single occupancy vehicles and whether such information will reduce the number of single occupancy vehicles on the road. This project is being undertaken by the University of Washington, Bellevue Transportation Management Association, City of Bellevue, Washington State DOT and the Federal Transit Administration. As part of this initiative 1000 employees in a downtown Bellevue office complex were surveyed on their commuting habits and needs, knowledge of HOV options, their information delivery preference, and their interest in the information services proposed. The results of the survey have not yet been published.

Demand for Advanced Traveler Information Systems

Research is being conducted by Brian Benson at George Mason University. Mr. Benson has developed the following four step research program to address the demand for ATIS.

(1) Evaluation of travel time: information will come from a literature review both inside and outside of the transportation area, followed up by survey research if appropriate,
(2) Human factors bearing on demand for ATIS: a literature review will be conducted to identify key areas for further research,
(3) Application of insights into travel time evaluation and human factors to specific ATIS systems: information from phases 1 and 2 will be used to make recommendations regarding ATIS deployment,
(4) Placing findings in the overall context of cost-benefit analysis: conclusions from part three will be costed out to determine if they are feasible.

Rural Applications of Advanced Traveler Information Systems

The objective of this project is to assess rural traveler information requirements, identify and evaluate potentially applicable ATIS technologies, and develop, evaluate, analyze, and test one or more systems. This research is being conducted by JHK & Associates of Norcross, GA. The project is sponsored by the Federal Highway Administration. The project was started in January of 1993 and is expected to be completed in July of 1995.

As part of this research effort a series of focus groups and telephone interviews are being conducted throughout the country to determine how rural and urban travelers value ATIS services. Subjects are asked to rate three groups of services: pre-trip planning, en route--no problem, and en route--problems. Based on the results of the interviews, five pre-trip planning services, four en route--no problems services, and five en route--problems services will be weighted by importance.

Rural IVHS Applications Scoping Study

This study is being undertaken by the Minnesota Department of Transportation as part of their Guidestar Program. The purpose of the project is to identify and define the application of IVHS technologies in rural Minnesota. The study will review the characteristics of rural highways and recommend how IVHS technologies might address the needs of the users of rural highways. The investigation includes focus groups and a telephone survey of 500 rural Minnesota residents. The study is being conducted by Castle Rock Consultants and C. J. Olsen and is expected to be completed in March of 1994. Results are expected to be presented at IVHS America in April of 1994.

Stated and Reported Diversion to Public Transportation in Response to Congestion: Implications on the Benefits of Multimodal ATIS

The purpose of this study is to evaluate the propensity of auto commuters to switch to public transportation in response to unexpected traffic congestion. The research is being conducted by Asad Khattak at the Institute of Transportation Studies, University of California, Berkeley. The study was conducted using a detailed survey of drivers in the Golden Gate bridge corridor in 1993. Data gathering has been completed and a report is expected in the near future.

CONCLUSIONS

This project was designed to retrospectively and, where applicable, prospectively examine the federally sponsored ATIS operational tests to learn whether any research had been performed that described consumer market demand and willingness-to-pay. This project builds from an earlier Volpe Center paper, "Public Acceptance and User Response to ATIS Products and Services" (December 7, 1993), which reviewed information describing driver decision-making response to advance traffic information as measured by operational test evaluations. The goal of the authors here was to produce a baseline of ATIS market information, derived from direct consumer experience with product prototypes, as a foundation for structuring future ATIS market research endeavors.

To expand this survey's base of information, market-related research from universities and transportation research centers was included. This enabled the authors to review findings developed through surveys, which provide respondents' stated preferences in response to hypothetical situations, and the operational tests' findings, which can provide information describing respondents' actual choices in situ (or revealed preferences).

The consumer-related findings to date from the operational tests are limited. First, the tests focus(ed) primarily on the performance of the product and services being tested, with less emphasis on market response information. While demographic and other respondent data has been collected as part of the evaluations, it is very difficult to retrospectively pick out parts of data gathered to serve one purpose and reshuffle it to produce valid, broadly applicable market demand and consumer response information. Second, at the time of this study's survey activities, there was only one completed ATIS operational test with published findings (Pathfinder), and one completed operational test with preliminary findings (TravTek). This limits the number of samples from which to draw conclusions.

Taken as a whole, the findings to date from the operational tests and from university and government transportation center research, provide some insight into consumers' response to ATIS products and services. Generalizing broadly, certain consumers, under certain circumstances, report themselves to be willing to purchase or otherwise access traffic and travel information (mostly en-route), to change from their habitual commutation or travel pattern in response to traffic information, and very occasionally, to change modes of transportation. While there has been some expression among operational tests participants of willingness to pay for traffic and travel information products, because of the way the questions were asked, this information should be considered indicative of intent, but not conclusive.

What is missing regarding consumer response and market demand information from the operational test evaluations is a systemmatic approach to collecting market research. What is needed is a nationally consistent market research framework that guides operational test teams through the design and development process with programmatic goals and standards governing the collection and analysis of market research information.

The following conclusions approach the subject prognostically, with the perspective that these observations will help to inform future efforts to incorporate more focused market research components into government sponsored operational tests. The conclusions are presented in the following three sections:

- Operational test goals and market research protocols
- Specific market knowledge to date
  - Findings from operational tests
  - Findings from research centers
- A framework for market research.

Operational Test Goals and Market Research Protocols

Overall, the quality and content of market research information generated by the tests is a function of test goals and design. Where a primary public sector goal of the test is to provide valid, reliable answers to questions related to future market size, composition, and willingness to pay, the design of the test - from recruitment through cross-tabulation - will be tailored to this end. The two most progressed operational tests, Pathfinder and TravTek, *were not* designed to support more general market research; they were designed to test product performance and features. Thus their findings [are expected to] relate largely to the product's performance and to the man-machine interface with the product features.

Participant framing, recruitment, and selection protocols are critical elements of all market research projects. Findings cannot be generalized to a larger segment of the population unless the participant sample has been appropriately defined and selected. The Pathfinder and TravTek evaluations were focused on assessing product usage variables, and so the participant recruitment and selection protocol focused on drivers who would use the product in certain ways. For example, to ensure that the full scope of product features would be used by the drivers, TravTek high-mileage drivers were chosen to include drivers who drive long distances to different and frequently unfamiliar locations during both the day and at night. Because the recruitment frame and selection protocol were not primarily designed to produce statistically representative consumer segments, market information from these evaluations cannot be reliably generalized to a larger population.

SmarTraveler was designed as a test market to measure demand for the service, as well as product performance and features. All of its protocols were designed to this end. For example, SmarTraveler is studied by surveying its "customers"; study participants are selected randomly throughout the day through phone intercepts. This produces a statistically valid sample of respondents for the purposes of test market research.

The five tests which are still in planning each have consumer response and market research components of various scope and depth included in their evaluation plan. Each program is in a different phase of planning, and it is too early to ascertain whether these components will be operationalized as planned.

Specific Market Knowledge To Date

Findings From Operational Tests

This project reviewed the operational tests' evaluation goals, approach, methods, and findings to learn what market information had been developed and whether any of the basic data could be re-processed to produce market demand and willingness to pay information. For the reasons discussed above related to participant recruitment, the Pathfinder evaluation data should not be re-processed for further market information. The TravTek evaluation is not complete, but it is likely that there will be market demand information included in the forthcoming final report. However, because of the recruitment and selection protocol, the general applicability of these findings may be limited.

Currently, Pathfinder, TravTek, and SmarTraveler each offer varying types and quality of market information, which were described earlier in this paper:

- Willingness to pay for navigation
- Willingness to pay for traffic information
- Product performance and features

The operational tests' findings do not conclusively establish consumer willingness-to-pay or product price points for either navigation or traffic information products. This requires a more detailed, controlled approach than any of the tests have thus far incorporated. Thus, the findings should be considered indicative. Generalizing from the findings, 50% of the study respondents from TravTek and Pathfinder indicated that they were willing to pay some amount of money for an in-vehicle navigation and travel product. The preliminary data from TravTek describing participants' willingness-to-pay for traffic information alone is based on driver experience with a product of limited functionality and cannot be generalized. The SmarTraveler project will provide more conclusive willingness-to-pay information.

Product performance and features evaluation is a standard part of most large-scale market research programs, especially where the product being introduced is very new or innovative. Product performance evaluation was a primary goal among all operational tests. The findings vary by test site, depending upon the product type and configuration. It should be noted that product-related findings from Pathfinder informed product configuration for TravTek. The three completed/current operational tests evaluated low cost traffic information via telephones and several different in-vehicle traffic, navigation, routing, and service directory configurations. Upcoming tests will evaluate products which feature:

- In-vehicle full-service traffic and travel services
- In-vehicle dynamic route guidance
- Fixed location traffic and transit information
- Low-cost portable traffic information
- Radio based service.

As a set, the current group of ATIS operational tests will provide information on all basic variations of ATIS services.

Findings from Research Centers

Market research programs begin with a hypothesis about a potential product and a potential market. The research is carefully designed to incrementally increase levels of surety in predicting the level, location, and type of demand for the product. In the greater IVHS community, there are many independent researchers pursuing varied hypotheses through different methods.

Unlike proprietary market research programs, the research activities of the greater research community do not necessarily build efficiently upon the hypotheses and findings of others. Many venues enable researchers to share information, and where applicable, to collaborate and build from the findings of others. However, there is no formal structure external to the individual institutions which supports a more formal progression of hypothesis-through-conclusive-testing to occur between research groups from different institutions.

There is a great deal of interesting market-related ATIS research being pursued among university and government transportation research centers, but there is a limit to consumers' ability to provide meaningful responses to a hypothetical product or service when the product is very different from anything currently in use in their life. There is also a difference in the response a consumer predicts versus the real-life decision actually made.

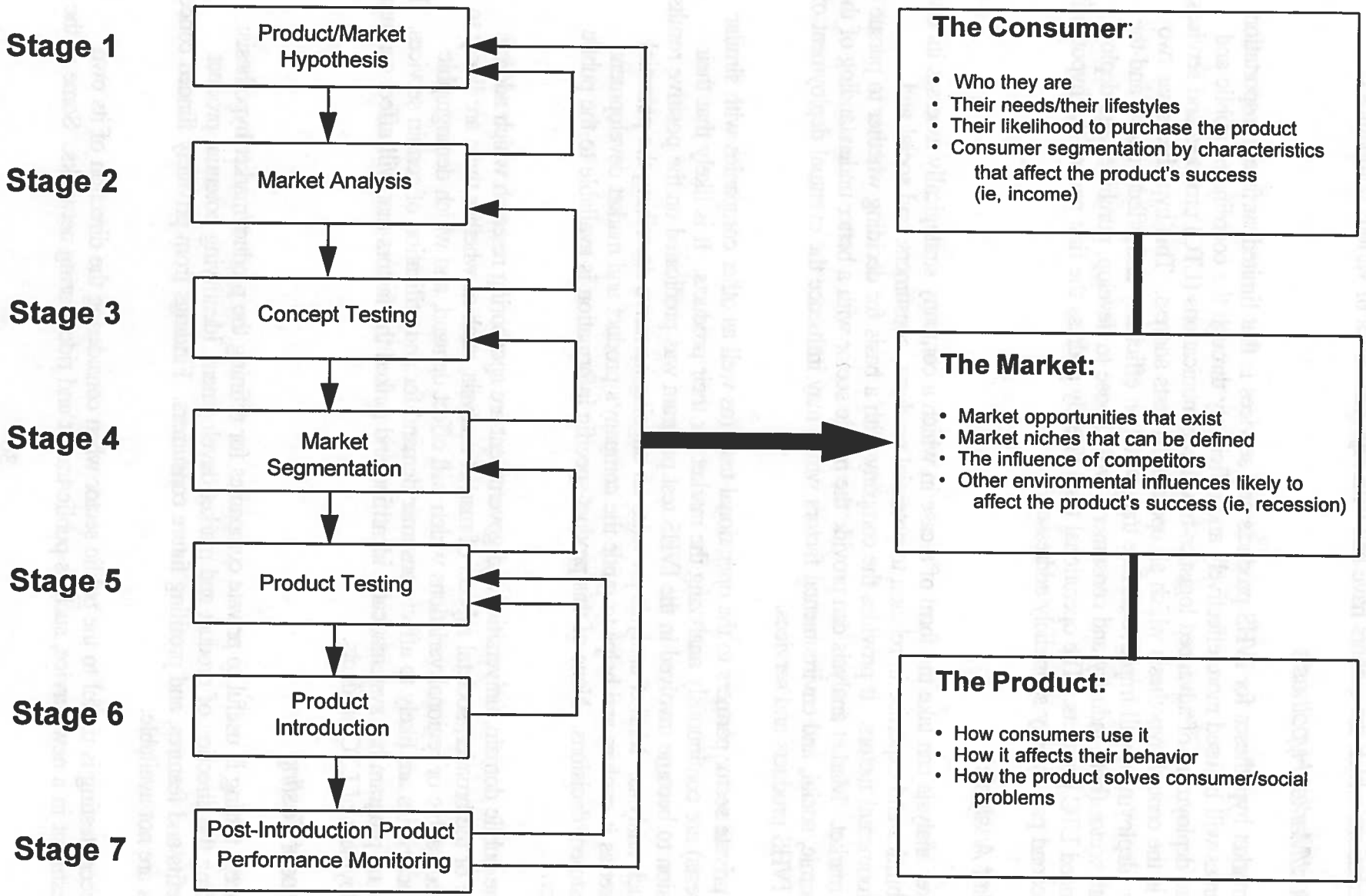
Findings from the research centers focus on consumers' stated response to actual and hypothetical traffic and transit information products. Findings include drivers' stated response to varying types of traffic when provided with traffic information and travel/transit alternatives before and during their trip (Khattak, 1991;1993a; 1993b; 1993c); and, segmentation of drivers according to their response to traffic and transit information (Haselkorn, 1992a; 1992b). Summarizing broadly, the findings quantify which drivers under what circumstances, using traffic and transit information products, will change their time of departure, route, or mode of travel. These research projects provide useful hypotheses for further operational testing.

A Framework for Market Research

In chapter two, a framework of market research components was defined to provide the reader with a point of reference for the observations which followed. It was stated that various combinations of these components are used in market research to answer questions related to the market, the consumer, and the product. Figure 3 graphically presents that relationship.

The framework provides a simple taxonomy of the textbook approach to private sector market research. In this context, it is a useful analytical tool for examining the IVHS operational test program as a whole, including the activities of both private and public sector partners, as though the operational test program comprised a systematic approach to gathering insight into consumer and market response to market-dependent IVHS innovations. In this section, the authors return to the framework for a discussion of where and how the research from current and completed operational tests fits into the framework.

Figure 3



Market Research leads to information on the consumer, market, and product

[Please note that the references to proprietary market research activities are based on conversations which the authors have had with representatives of various companies.]

Product/Market Hypothesis

The market hypotheses for IVHS products and services is that limited surface transportation resources will be used more effectively and efficiently through the coordinated public and private deployment of advanced logistics-travel-communications (LTC) products and services. This is the central hypothesis which all operational tests address. This hypothesis has two parts: deployment will improve surface transportation efficiency and effectiveness, and the private sector (both industry and consumers) will choose to develop, purchase, and deploy advanced LTC products. The operational tests directly address the first part of the hypothesis, the second part is only sporadicly addressed.

Market Analysis

Market analysis can take the form of a case in which a company strategically assesses its own capabilities and expertise in relation to potential products, consumers, and social and environmental factors. It provides the company with a basis for deciding whether to pursue a new market. Market analysis can provide the public sector with a better understanding of the economic, social, and environmental factors which may influence the eventual deployment of new IVHS products and services.

The private sector partners to the operational tests (as well as other companies with similar interests) are continuously analyzing the market for their products. It is likely that their decision to become involved in the IVHS test program was predicated on the positive results of such analysis. Market analysis provides an ongoing narrative describing the potential market as it evolves and helps to guide the company's product and market development investment decisions. None of this product-specific information is available to the public sector.

In the public domain, universities and government are sponsoring research which address some of the broader, societal aspects of market analysis, such as whether there are likely to be geographic or regional variations which will affect demand, and which demographic characteristics are likely to affect consumer demand for and utilization of certain services. To date, no program has systematically identified and ranked the factors that will affect consumer deployment of LTC products.

Concept Testing

Concept testing is useful to private companies for refining the product/market hypothesis: guiding the direction of product and market development, identifying potential product benefits and features, and profiling future consumers. Findings from privately funded concept tests are not available.

Concept testing is useful to the public sector when considering the direction of its own investment in a new service, such as public transit and ride-sharing networks. Some of the

current survey work and laboratory-based simulations done by universities can be categorized as concept testing. They can provide the public sector with a preliminary sense of what product benefits and features have value, and how consumers will respond to certain products and services under certain conditions.

Because of the innovative nature of most IVHS products and services, it is difficult to extrapolate from consumers' responses to a hypothetical concept their likely response to the actual product once it is on the market. The consumers who have used product prototypes in operational tests can provide much better insight into related product concepts as a result of their experience. Such follow-up work has not been included in the public domain segments of the operational tests.

Market Segmentation

As with the above research components, the private companies have applied their findings to segment the market. This is an essential step towards finalizing the product and bringing it to market. This is proprietary information.

Market segmentation would help policy makers to predict the location and level of product/service dissemination and utilization over time. Currently, university research projects are segmenting the market for kiosk-based traffic and transit information as a basis for predicting utilization rates and overall impact. Data from operational tests could help to provide the basis for understanding how a new product or service will affect a region's transportation patterns over time by predicting which segments of the population will purchase or otherwise access the service.

Product Testing

The operational tests are largely product tests. Product testing is a conclusive pre-release research phase. In addition to testing product performance, researchers take advantage of consumers direct experience with the product to refine earlier assessments regarding who will buy the product and how they will use it. The product test phase also includes price testing, a critical determinant of market success. The Pathfinder and TravTek evaluations focused on the performance, functionality, benefits, and application of the products and services.

The public evaluations to date have not used reliable methods to gather price point information. This information will provide the public sector with a better understanding of who will purchase the products when they first appear on the market, and refine estimates for product diffusion rates.

Product Introduction/Post-Introduction Product Performance and Monitoring

Product introduction proceeds according to a plan developed through the preceding phases of research. Researchers then carefully monitor post-introduction market response to an innovative product. There are frequently adjustments in strategy as the market responds to the product in unexpected ways.

Products which have high costs relative to uncertain or unestablished benefits may enter the market slowly. For example, an in-vehicle navigation product may be introduced first though an operational test in a beta (version 1); the company would use results from that experience to refine the product and their understanding of the market, release a further developed beta (version 2) through a rental car company, release a market prototype (version 3) through a geographically limited test market, and then proceed to improve the product while expanding channels for product sales.

Information from the evaluations can contribute to the public sector's ability to monitor the response of travellers to newly released advanced traveller information systems. Information from tests of services which will be available in the public domain, such as some of the APTS products, could provide public sector planners with invaluable information on how best to introduce and monitor utilization of these new public services.

Overall, it appears that the private sector partners have fitted the operational tests into their larger market research program, with some of their potentially competitive product information entering the public domain, and some of the market-related information remaining proprietary. The public sector has not yet systematically incorporated into the operational test program those aspects of market research which support the policy needs of the public sector into the operational tests.

RECOMMENDATIONS

The reason for pursuing market research in the public sector is to learn whether the traveling public will access and act upon information received from Advanced Travel Information Systems. This information, in turn, assists the public sector to plan programs which can more effectively encourage a greater number of travelers to use travel resources more efficiently. When structured and pursued appropriately, market research can provide valid, reliable information describing consumer and market response to new and innovative products and services. The IVHS operational tests provide an excellent opportunity to test market response hypotheses with ATIS product and service prototypes in realistic settings. The following recommendations proceed from this perspective.

- Require that all proposed operational tests that are testing products and services where deployment will depend upon consumer market demand incorporate statistically valid methods and protocols for securing consumer market information.

Not all operational tests merit a consumer-oriented market research component. For tests of products that will not depend upon the consumer market for deployment, such research components are unnecessary. Criteria should be developed to establish which tests need to incorporate such components.

It is best if the market research components, along with the evaluation as a whole, are developed in parallel with plans for the operational test. This is the best approach to ensure that all aspects of the test design are consonant with good research standards.
Where the market research component is added following completion of test design, it is usually more difficult and more expensive to structure a suitable protocol

- Insert market research components into formative operational tests where appropriate.

Notwithstanding the observations above, there are likely to be only a limited number of publicly funded IVHS operational tests, and so inclusion of market research components into planned tests should be considered.

- Fund discrete market research programs.

Where there are specific consumer market response questions which will not be answered by any existing research or operational test, FHWA should consider funding focused, conclusive market research projects.

- Write a guide to market research at publicly funded IVHS operational tests.

A guide to conducting public sector market research at IVHS operational tests would support the development of systematic, consistent, valid, nationally comparable consumer market research information. Such a guide should include criteria for which types of tests require a

market research component, and a clear statement of the FHWA goals and objectives for market research information.

The guide should recommend a framework, similar to that employed in this paper, to address the programmatic need for a more systematic approach to measuring the public's response to IVHS. A framework supports greater research program efficiency by purposefully working from agreed upon hypotheses through to more conclusive findings. It provides direction to currently independent research programs towards a more coordinated national approach to market research.

- Encourage operational test evaluators to work with university and government transportation research centers to test consumer market response hypotheses from the research centers which are based on stated preference surveys.

Surveys which provide good insight into consumers' stated preference for (or response to) traffic and travel information also provide excellent working hypotheses for more conclusive revealed preference testing. Where policy questions require more conclusive and generalizable consumer response information, an iterative research program which works towards more conclusive forms of research will provide more reliable information. Where policy goals include the development of ATIS consumer response models, this approach will provide data required to validate developing ATIS behavior models.

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APPENDIX

The following appendix provides additional detail regarding each of the ATIS operational tests currently completed, on-going, or being planned in the United States. Descriptions include a detailed account of the system being tested, a summary of the test's evaluation, and a discussion of market research information available from each of the tests.

CURRENTLY OPERATIONAL AND COMPLETED TESTS

Pathfinder

Pathfinder was the first operational test of an in-vehicle navigation and information system in the United States The project was initiated in October of 1988, testing was completed in June of 1992, and the evaluation report was released in February of 1993. Pathfinder was a cooperative project between the Federal Highway Administration (FHWA), the California Department of Transportation (Caltrans), and General Motors Corporation (GM). The project had a budget of $1.6M split between Caltrans and FHWA; GM donated 25 equipped test vehicles. The test was conducted on a 13 mile section of the Santa Monica Freeway and surrounding arterial streets. The test area was referred to as the Smart Corridor.

System Description

The Pathfinder system used the ETAK Travel Pilot, a commercially available in-vehicle navigation system, with modifications, to provide real time traffic information. The in-vehicle system components included a microprocessor, a speech synthesizer, and a radio for transmitting and receiving data. Traffic information was collected and broadcast to vehicles by the Pathfinder workstation once per minute; information from the vehicles, including longitude, latitude, distance, heading, and speed, were transmitted to the workstation once per minute.

The Pathfinder workstation received its information from the Caltrans Semi-Automated Traffic Management System. This system receives information from loop detectors along the freeway and from the Los Angeles Department of Transportation Automated Traffic Surveillance and Control System, which collects traffic information from loop detectors on arterial streets. Other sources of information collected by The Smart Corridor Traffic Management Center included information from the Southern California Rapid Transit District, Caltrans, the California Highway Patrol, the Los Angeles Department of Transportation, and the Los Angeles Police Department.

Evaluation

The Pathfinder evaluation was designed to determine whether providing drivers with detailed real time traffic information regarding freeway and arterial street traffic congestion is beneficial. The evaluation was divided into four stages:

Stage 1 - Hardware and software testing was conducted using state employees commuting on the Santa Monica Freeway Smart Corridor. Emphasis was on system performance and human factors evaluation.

Stage 2 - Specially hired drivers conducted structured paired comparison tests in each of three Pathfinder display modes. The modes included a control group receiving no information, a group receiving only navigation information, and a group receiving real time traffic information. Drivers traveled assigned routes in a yoked driving study, collecting travel time data for each display mode.

Stage 3 - Employees of the City of Los Angeles operated the vehicles during their normal commutes and business trips. The evaluation focus was on users' general perception of the Pathfinder System.

Stage 4 - Hired drivers conducted a structured yoked driving study. The evaluation focused on the benefit of real time traffic and navigation information for travel to unfamiliar destinations.

Market Information

The primary focus of the evaluation of Pathfinder was to evaluate the system design and provide information on how that design could be improved. Much of what was learned in Pathfinder was later applied to the TravTek system. Although the focus of the evaluation was system design issues, some information on market related issues was collected.

Market research data was collected using surveys of test subjects; one survey was administered to each subject after their use of the equipped vehicle and another survey was administered after each trip made in the yoked study. Results of these surveys are discussed in the body of this report and can be found in the Pathfinder Evaluation Report (JHK, 1993).

TravTek

The TravTek project was a demonstration and test of an ATIS which ran from March 1992 to March 1993 in Orlando Florida; the results of the evaluation are expected in March of 1994. The $12M project was conducted as a public-private partnership between General Motors, American Automobile Association (AAA), Federal Highway Administration, Florida Department of Transportation (FDOT), and the City of Orlando.

System Description

The TravTek system provided the user with navigation, dynamic route guidance, real time traffic information, business services information, emergency request services and a cellular phone link. The majority of the system was contained within the vehicle. The in-vehicle system consisted of two computers with hard disks (navigation computer and routing computer), a GPS receiver, electronic compass, wheel sensors, dashboard-mounted color CRT display, steering wheel-mounted buttons, a cellular phone, voice synthesizer, and FM data transceiver. The navigation computer administered navigation, services information, and the driver interface; the routing computer handled route selection, route guidance, traffic information, and data logging.

Two computers were used in order to overcome problems with incomplete and inaccurate databases. Two companies had ATIS map databases of the Orlando area: Navigation Technologies and ETAK. The Navigation Technologies system was better suited to route guidance while the ETAK system was better suited to navigation displays. Neither system could handle both tasks to the satisfaction of the partners, so both systems were used.

Traffic information was supplied to the TravTek cars from the Traffic Management Center (TMC) operated by the City of Orlando. The TMC collects traffic data from the various sources in the Orlando area, processes the data and provides traffic information to the in-vehicle units. The two primary sources of traffic information are the Traffic Signal System operated by the City of Orlando and the Freeway Management Center operated by the FDOT. Incident information was gathered from many sources including police radio dispatchers, media sources such as Metro Traffic Control, and secondary dispatchers such as Florida Power & Light and other utilities. Information was also collected from the TravTek vehicles which acted as probes. The processing of traffic data at the TMC was performed using the data fusion process developed by Farradyne systems for Pathfinder; this process has since been patented by Farradyne Systems (Sumner, 1993). This process sorts information from all of the sources and applies weights to the information based on the quality of the information source and the age of the information.

Evaluation

The TravTek evaluation is considered by many to be the most comprehensive operational test evaluation to date. The evaluations being planned for ADVANCE and FAST-TRAC followed the model established with TravTek.

The TravTek evaluation was comprised of ten individual approaches:

1) Field Study With Rental Car Users
2) Field Study With Local Users
3) Yoked Driving Study
4) Orlando Test Network Study
5) Camera Car Study
6) Debriefing and Interview Study
7) Questionnaire Study
8) Modeling and Analysis Study
9) TMC and Traffic Probe Study
10) Global Evaluation

Each of these approaches is described in detail in the TravTek Evaluation Plan (Farradyne Systems, 1991). A brief outline of the approaches can be found below.

Vehicles were tested in three different configurations: (1) with services information only (control); (2) with route guidance, navigation, and services information (without traffic information); and (3) with dynamic route guidance, navigation with real time traffic information, and services information (full system). Information on how the three systems were used in day to day conditions was collected in the field studies (approaches 1 and 2).

The yoked driving study and the Orlando Test Network Study were more tightly controlled experiments which provided more direct comparative information on system benefits and human factors issues. The camera car study was designed to provide information on the safety effects of the TravTek system and to provide human factors information. Another two approaches gathered information on user perceptions of the system: the debriefing and interview study, and the questionnaire study. The TMC and traffic probe study is a technical study of the effectiveness of the TMC and of using vehicles as traffic probes. Finally, the global evaluation was designed to evaluate the overall success of the project.

Market Information

One of the objectives of GM in participating in TravTek was to determine whether the system was marketable. However, most of the market research work performed by GM was done independent of the evaluation and is proprietary. The operational test evaluation did include a comprehensive questionnaire. The focus of the questionnaire was on product features, and user perceptions; the questionnaire also include a scaled question on willingness to pay. Full results of the evaluation are not expected until March of 1994; however, some preliminary findings have been released.

Early results from TravTek were presented at IVHS America in April of 1993. Two papers were presented at that time. The first paper outlined results from the controlled field experiments; findings related the effect of the TravTek system on trip planning time, travel time, and the number of wrong turns (Inman, 1993). The second paper presented results on survey responses and system use (Perez(a), 1993); more details regarding survey responses and system use were presented at the Vehicle Navigation and Information Systems (VNIS, '93) Conference in October of 1993.

Additionally, at VNIS'93, a paper was presented providing an overview of the TravTek evaluation and recruitment statistics for each of the approaches (Peters, 1993). Another paper presented the survey responses received from subjects of the renter study, including responses from questions on willingness to pay (Perez(b), 1993). A third paper presented results obtained from the vehicle log data outlining how the system was used by drivers (Fleishman, 1993).

SmarTraveler

SmarTraveler is operated by Smart Route Systems (SRS) of Cambridge. The service was started as a privately run for-profit traffic information service. The service provides real time traffic information via telephone for major routes in the Boston area. Since January of 1993 the service has been offered free as an IVHS Operational Test.

System Description

The service is based on a computer system which stores pieces of text and audio data and then links them together to form each individual traffic report. For each route requested the computer selects the relevant data and links them from most important to least important in order to provide the information to the customer.

Real time data on traffic conditions and incident information is collected by SRS from a wide range of sources. Data sources include:

- 30 cameras (live and slow scan),
- 60 contracted, scheduled, mobile phone probes,
- 100 informal mobile phone and 2-way radio probes,
- 2-way radio hook-up with Massport Logan Express buses,
- Radio scanners, scanning public agency and emergency frequencies,
- 2 fixed-wing aircraft during rush hour and one during mid-day,
- 2-way radio communication with Digital helicopter fleet, and
- Direct hard wire communications with Massachusetts Highway Department radio room, State Police radio room, commuter rail dispatchers and MBTA dispatcher.

Real time information is complemented by "static" information. Static information includes reports of construction, and events such as baseball games, etc., which effect traffic.

Evaluation

The SmarTraveler operational test is the first operational test to focus on market and traveler behavior issues. When the evaluation is completed in early 1994, it will provide a great deal of information on these issues. An evaluation of the effectiveness of traffic data gathering techniques will also be performed. The evaluation is being performed by MultiSystems of Cambridge and is described in detail in their proposal (MultiSystems, 1993). A summary of the proposal is described below.

The evaluation has four primary objectives:

- Assessment of the quality and quantity of the information being provided,
- Evaluation of public acceptance of the utility of traffic information,
- Estimation of the impact of the test on traffic congestion now and in the future, and
- Recommendations for improvements in the collection and dissemination of traffic information.

Data gathering for the evaluation includes counting usage statistics, market segmentation into cellular and land line callers, and a set of three telephone surveys. The three surveys are the mobile and two-way radio probe survey, user survey, and non-repeat user survey. The mobile and two-way radio probe survey will be used to assess the quality of the traffic information gathered by probe. The user surveys and non-repeat user surveys will be used to assess user perceptions of the system. Based on an analysis of survey results and a study of institutional issues, an overall analysis will be conducted by the project evaluator and a privatization plan will be drafted by SRS.

Market Research

Data on the market for SmarTraveler will come from the user survey, non-repeat user survey, and market segmentation counts. It is expected that an analysis of the market will be presented in the privatization plan and the overall evaluation based upon the data collected.

The user survey of people who call in to SmarTraveler will be conducted by telephone. Information will be collected regarding the types of trips the system is used for, factors such as commercial versus commuter users, frequency with which the trip is made, length of trip, origin and destination of trip, peak versus off-peak time, and weather conditions. Subjects will also be asked about personal data and their perceptions of the system, including how frequently the subject uses the system, the usefulness of the information received, what the traveler did with the information, and the traveler's willingness to pay.

The non-repeat user survey will be conducted with subjects of the user survey who indicate that they do not plan to call again. The survey will focus on the reasons that the subject will not call again and on improvements which could be made to the SmarTraveler system.

Callers to SmarTraveler can be divided into three segments and each segment counted. The three segments are: NYNEX Cellular callers who use the system free of all charges, Cellular One callers who have to pay air time for the call, and land line callers. Counts from the segments will provide information on willingness to pay for the service and mobile phone usage versus land line phone usage.

Two analyses will be performed using the data from the surveys. SRS will analyze the data and assemble a business plan for their product. The evaluator will analyze the data to address the following market questions and present the findings in their report:

- A profile of the users of the service,
- Statistical characteristics of use,
- The use to which users put the information received,
- An assessment of the impacts of the service on congestion, etc., and
- A quantification of the benefits of the test to the public.

TESTS BEING PLANNED

FAST-TRAC

FAST-TRAC is being undertaken by a partnership between the Road Commission for Oakland County and Siemens Automotive. FAST-TRAC has two major components: ATMS and ATIS.

System Description

The FAST-TRAC Project employs three state of the art technologies, the Sydney Coordinated Adaptive Traffic System (SCATS), the Autoscope video image processing system for traffic detection, and Siemens Automotive's Ali-Scout System. SCATS and Autoscope form the ATMS portion of FAST-TRAC. Autoscope provides traffic data to the SCATS system from pole mounted cameras. SCATS then uses this information to adjust signal timing. Ali-Scout uses traffic data collected by the ATMS and data from the Ali-Scout equipped vehicles, which act as probes, as data sources for the ATIS.

The ALi-Scout system is an infrastructure based, dynamic, vehicle route guidance system. An infrared transmitter/receiver beacon is located at each equipped intersection in the test area. When an equipped vehicle approaches, the vehicle transmits to the system its travel time for the previous link and the destination of the vehicle; the infrared beacon then provides the vehicle with the best route. The vehicle is equipped with a positioning unit so that it will provide the driver with straight line directions independent of the road network when it is away from the equipped area.

Evaluation

The FAST-TRAC evaluation has four components: three components evaluate each of the new technologies being tested in FAST-TRAC, the fourth component is an evaluation of the system overall. The new technologies tested include the Ali-Scout ATIS, the SCATS traffic control system, and the Autoscope video image detection system.

The evaluation of the ATIS has been designed to assess the navigation assistance avoidance of traffic congestion provided, the user interface, the perceptible benefits to drivers, the effects on traffic congestion, the reliability of the system, and the cost of the system relative to consumers willingness to pay. This evaluation is discussed in greater detail below.

The evaluation of the control system will include an assessment of the level of service, the effect on signal timing, the effect on second order impacts such as safety and emissions, reliability, ease of operation by control center staff, and cost relative to public revenues.

The evaluation of the video image detection system has been designed to investigate the performance of the system relative to existing technology (loop detectors). Comparison includes detection performance, flexibility of deployment, ease of maintenance, and cost.

The overall system evaluation will evaluate the traffic prediction capabilities of the system, the ability to use other forms of information, the ability to disseminate the centralized traffic information, and the cost of the system.

The ATIS Evaluation

The ATIS portion of the evaluation has eight primary tasks:

- User preferences and behavior evaluation,
- Human factors and safety evaluation,
- Control center evaluation,
- Technical performance evaluation
- Institutional analysis,
- Stakeholder assessment,
- Traffic modeling, and
- Global evaluation.

The user perception and behavior evaluation is focused on determining "What do the drivers think?". Two studies will be used to provide subjects with familiarity to the system: the natural use study and the yoked study. The natural use study will capture information on users perceptions of the system. It will allow large numbers of subjects to become familiar with the system in their daily routine. At intervals during subjects' use period, they will be questioned about their perceptions of the system including willingness to pay. The yoked study is designed to measure the true benefits of the system. In the yoked study two drivers drive from point to point at approximately the same time; one driver is equipped with the system, the other is not. The experiment is repeated with many pairs of drivers. Thus a direct comparison of the benefits of the system can be made. Benefits measured in this manner include where the drivers go, differences in routes, and differences in trip time.

The human factors and safety evaluation is designed to address issues related to ease of use and safety of the in-vehicle system. This evaluation will be conducted using two experiments. The first is a laboratory experiment to assess how taxing it is for drivers to input their destinations into the system. The second experiment is an on-the-road experiment to assess how easily drivers can recover from being lost.

The purpose of the control center evaluation is to address selected human factors issues regarding the design of the FAST-TRAC control room operation. The control room evaluation will look at control room ergonomics, the user interface, and the automated operation requirements. A secondary objective is to evaluate traveler information needs and candidate technologies for fulfilling those needs through FAST-TRAC facilities. This secondary objective will be addressed through a functional analysis of user information needs and a survey of future users.

The technical performance evaluation will assess the system level and subsystem level performance of hardware, software, and databases. Four subsystems will be evaluated. These include:

- The central computer,
- The vehicle roadway communication equipment,
- The in-vehicle equipment, and
- The probe transmissions from the vehicle.

The institutional analysis will collect information on issues and events which lead to difficulties in the execution of the project. Types of issues may include legal, jurisdictional, organizational, and financial.

The purpose of the stakeholder assessment is gather information on the opinions of various community groups regarding the FAST-TRAC system. Information will be gathered through interviews with community opinion leaders. Groups to be included in the process include emergency vehicle operators, delivery services, environmental groups, and consumer advocacy groups.

The traffic modeling task is intended to address system level questions about the ATIS through the use of traffic network simulation. The modeling technique can assess the impacts of the ATIS at higher levels of market penetration.

The intent of the global evaluation is to synthesize the results of the other tasks and to produce general findings and recommendations regarding the FAST-TRAC system.

Market Research

The FAST-TRAC evaluation promises to collect information on user perceptions, and behavior. This information may prove to be useful market research information.

The evaluation of user perceptions and behavior has been designed to measure perceived information adequacy, ease of use and convenience, perceived usefulness for route guidance, acceptability of suggested routes, time savings, safety, user confidence with system, and willingness to pay and likelihood to purchase. Data collection methods proposed include surveys, interviews, focus groups, driver logs, and in-vehicle automated data collection. Driver logs and in-vehicle automated data collection will collect data on driver's behavior. Surveys, interviews and focus groups will be used to collect data on user's perceptions. Of special significance is a planned series of focus groups which include the distribution of a conjoint analysis survey to be completed by the focus group participants. The focus groups have three components: introduction, discussion and survey. The focus groups take place using subjects who have used the ATIS. The conjoint analysis is expected to quantify participants preferences and their willingness to pay for the system.

ADVANCE

Advanced Driver and Vehicle Advisory Navigation Concept (ADVANCE) is currently under development in Chicago. The project was started in September of 1991. Implementation and testing are expected to begin in 1994 and be completed in 1997. The project is expected to include up to 5000 test vehicles and have a total cost of approximately $40M. The project is a joint venture between FHWA (50%), Motorola (25%), and the Illinois Universities Transportation Research Consortium (IUTRC) (25%). IUTRC includes University of Illinois at Chicago,and Northwestern University.

System Description

The ADVANCE system is composed of four subsystems: the Mobile Navigation Assistant (MNA), the Communications Network, the Traffic Information Center (TIC), and Traffic Related Functions (TRF).

The MNA is the in-vehicle component of the system; the MNA communicates with the Traffic Information System through the communications network. The MNA consists of a video screen, a microcomputer, a data communications radio, CD-ROM data storage and a GPS receiver. The driver interface consists of a 5.7" color liquid crystal display with touch screen, a series of hard keys and voice output. The display itself will be an electronic map.

The TIC provides real time traffic information to the in-vehicle units. The TIC is supported by historical travel time data and routing and transportation network in information stored on computer. The TIC consists of a high end UNIX workstation which receives information from various sources and fuses the data to produce real time traffic information. Data sources include fixed detectors, probe vehicles equipped with the MNA, and anecdotal sources, as well as historical static information stored in the TRF. The system will provide route guidance to destinations selected by the user. The in-vehicle unit calculates the fastest route based on information stored on CD-ROM and from real-time traffic information received from the TIC.

Evaluation

The evaluation of ADVANCE is being designed by MITRE Corporation. A working paper outlining the evaluation was released by MITRE in April of 1992. The ADVANCE Evaluation Subcommittee continues to meet and revise the evaluation. Based on the working paper and amendments released at the March 18, 1993 meeting of the Evaluation Subcommittee, the evaluation has the following objectives:

- Evaluate the performance of probe vehicles as sources of link travel time estimates within the test area;
- Evaluate the functionality of the information products created by the ADVANCE system;

- Evaluate the performance of the in-vehicle information delivery portion of the mobile navigation assistant, in terms of the drivers ability to understand and apply the message content;
- Maintain a history of performance of the radio frequency communications system;
- Evaluate the performance of the traffic information center;
- Evaluate the effects of the ADVANCE system on driver perception, route choice behavior, and fleet vehicle operations;
- Estimate the performance of the route guidance system in reducing travel times and travel distances;
- Perform a benefit/cost analysis of the ADVANCE system concept;
- Maintain an information source and make the information accessible to organizations interested in IVHS projects;
- Document and evaluate the effect of institutional issues on the ADVANCE project; and
- Evaluate the safety impact of the ADVANCE program.

The project will employ 1000 memory cards to gather data from the probe vehicles. These memory cards will record data on travel patterns and system use. Information on traffic conditions and traffic information provided will be logged at the TIC. Additional details on the evaluation including data collection can be found in the MITRE Working Paper "Evaluation Plan for the ADVANCE Project" (Bolczak, 1992).

Market Research

Travel behavior and the perception of the worth of the ADVANCE system are both major focuses of the evaluation (Boyce, 1991). To study user perceptions, an experiment involving 800 subjects has been incorporated into the ADVANCE evaluation.

To capture user perceptions of the system, the 800 subjects will participate in an extended natural use experiment. The group will go through three periods of two to four weeks each receiving additional information in each period. In the first period drivers will receive no information but have their travel pattern recorded on memory cards; during the second period drivers will be provided with static information and business listings; during the third period drivers will have access to the full system. Data on driver behavior will be collected by the memory cards while data on driver perceptions will be gathered via surveys sent out at the end of each period and by focus groups following each period.

Specific details regarding data collection have not yet been finalized; however, major focuses of this work are to determine the effects of ADVANCE on driver travel choice behavior, and to determine driver perceptions of the system including perceptions of safety, anxiety, comfort, security, and the worth of the ADVANCE system.

Genesis

The Genesis operational test is designed to develop the use of personal communication devices (PCD) as a means of providing traffic and traveler information. Two types of PCDs will be used in the test pagers with alphanumeric displays and Personal Digital Assistants (PDA) similar to the Apple Newton or the HP-100. The project is being undertaken by a public/private partnership between Minnesota Department of Transportation, University of Minnesota Center for Transportation Studies, Federal Highway Administration and Motorola.

The project has been divided into five stages:

Phase 1 -	Pager pilot study in Minneapolis (4/93 - 9/94)
Phase 2 -	Pager operational study for Minneapolis (10/94 - 9/95)
Phase 3 -	PDA operational study for Minneapolis (10/94 - 9/95)
Phase 4 -	Pager operational study for St. Paul (1/96 - 12/96)
Phase 5 -	PDA operational study for St. Paul (1/96 - 12/96)

Each phase consists of evaluation and implementation. Evaluation includes the studies design, participant selection, and monitoring of the study.

System Description

The Genesis system includes the following components:

- Personal communications device (PCD),
- Real time data collection,
- Real time data management system, and
- Communications.

Two types of PCDs will be used in the project pagers, both equipped with an alphanumeric display and personal digital assistants. The pager will act as a receiver of traffic information as well as receiving information from other information providers. The PDA will be a "smart" unit and will have two-way communication capability; technical requirement for the PDA include a 80386 CPU processor, a minimum of 8 MB of DRAM, a two way RF modem with internal antenna. It is expected other services will become available via PCD; other services might include two-way message communication, computer functions, e-mail, news access, travel service interface, weather, and banking.

Data collection and processing is considered the heart of the Genesis system. Traffic information for Genesis will be collected using existing loop detectors, new overhead detectors, and, potentially, automatic vehicle identification technology. Data will also be collected on transit schedules. Data management is expected to be undertaken by a series of three networked UNIX servers. One server will act as the interface to collect data from external sources, the second server will be used for maintaining the Genesis data, and the third server will manage communications with the PCDs.

Five broadcast options are being considered for use by Genesis. Other communications links include leased phone lines from the Genesis computer to the broadcast point and fibre-optic links between MnDot and external agencies.

Evaluation

As part of the concept definition for Genesis, a preliminary evaluation plan was developed. The evaluation plan has been designed to evaluate the following five primary goals:

- Define, design and implement the operational test using unique public/private, private/private, and public/public partnerships;
- Use the PCD and communication infrastructure to improve transportation performance;
- Develop and evaluate the performance of a communication infrastructure which effectively and efficiently provides advanced traveler information;
- Evaluate the costs and benefits of the operational test; and
- Evaluate user acceptance of the PCDs as reflected in attitudes and frequency of use.

Each goal contains a number of more tangible objectives. Many of these objectives have predefined measures of effectiveness which will be used to evaluate the test's objective.

Data collection for the evaluation of objectives will come from program management and information from the project partners, PCD user's logs, intermediate monitoring surveys, modeling studies, algorithms and a user questionnaire. Partner input will include information required pertaining to partner's areas of expertise. Participants in Genesis will be required to complete PCD user's logs; these logs will provide daily information on a subject's travel patterns, system usage patterns, and perceptions of the system. Intermediate monitoring surveys, conducted by telephone, will be used to evaluate message quality, accuracy of incident detection, difficulties in using the PCD, and the usefulness of the system to users. Modeling studies will be used to measure the effects of Genesis on emissions, fuel savings, and level of service. New algorithms may be created to monitor the effects of Genesis on the network. The user questionnaire, issued at the end of the test will address a wide variety of issues; some issues might include: effect on traveler behavior, effect on personal safety, quality of messages, ease of use, and willingness to pay.

Market Research

The primary source of market data will come from the evaluation of user acceptance of the PCD. The following objectives have been outlined for assessing the goal:

- Assess the PCD users estimates of value. [MOE: ($) dollars willing to spend]
- Assess the PCD users estimates of significance. [MOE: testimony of usefulness]
- Assess the impact of the use of real-time data in the trip route, mode, and time of departure planning process. [MOE: route, mode, and time of departure changes]
- Assess the performance of system components with respect to user's perceptions of the operational test. [MOE: user testimony for each listed above]

The data to evaluate these objectives will come from the interim telephone surveys and the user questionnaire.

DIRECT

The DIRECT operational test has been designed to evaluate four lower cost systems for providing drivers with real time traffic information. The technologies to be tested include low powered highway advisory radio (LPHAR), automatic highway advisory radio (AHAR), radio broadcast data system (RBDS), and cellular telephone traffic advisory services. The services are to be compared with respect to travel benefits, projected system costs, driver distraction and safety, and institutional issues associated with the systems. The test will be conducted along a 21 mile section of I-94 between the Detroit Airport and downtown Detroit.

System Description

The system will collect information from roadside sensors, process the information at a traffic management center and then broadcast the information on each of the four service media.

(1) LPHAR: A series of roadside transmitters broadcast "exceptional" traffic information on "incidents ahead on this roadway". LPHAR will broadcast on 530 or 1610 KHz at relatively low power illuminating approximately 1 mile to 1.5 miles in length. This allows a new transmitter with a new message to be located another few miles down the highway.

(2) RBDS: Is similar to Radio Data System (RDS) developed in Europe although US standards are somewhat different than the standards for the european system. RBDS uses a subcarrier of 57 KHz of any existing FM station to provide a digital signal, of limited capacity, containing traffic information to drivers in the reception area of the FM station. The additional cost of the broadcasting equipment is $5000.

(3) AHAR: Automatic Highway Advisory Radio uses a special FM receiver to deliver traffic information to the driver. AHAR is similar to regular highway advisory radio except the radio will automatically tune itself to the HAR broadcast when there is new information to be received, if the driver selects this feature in advance.

(4) CELLULAR CALL IN: This system uses existing cellular infrastructure to provide drivers with traffic information. Drivers call in on their cellular phone, key in a route number or location number and receive and obtain traffic information relevant to their travel plans. Automatic alert service could also be provided with cellular; a company could arrange to call the driver if a new incident appears on the commuter's route (however, this is not part of DIRECT).

Evaluation

Based on the DIRECT Draft Evaluation Plan, the evaluation is designed to investigate the strengths and weaknesses of these four systems. The evaluation will include an extensive human factors evaluation, a technical evaluation of the systems, and an investigation of institutional and practical lessons. The DIRECT evaluation has the following six specific areas of investigation:

1. Comparison of ATIS Alternatives
2. Message Characteristics
3. Technical and Hardware Effectiveness
4. Attention and Vehicle Operation
5. Institutional and Practical Lessons
6. Video Image Detection Performance

1. Comparison of ATIS Alternatives

The comparison of ATIS alternatives will assess users' attitudes, benefits, and public support for the system. The investigation will be conducted using a natural use study of commuters. The study will be conducted with 30 subjects in each of the four systems plus a control group; subjects will use the system for a total of two months. Data will be collected using questionnaires, focus groups, interviews at the end of the two month period, and data logged from the instrumented vehicles throughout the experiment.

2. Message Characteristics

The investigation of message characteristics is designed to determine what are the best formats, including phrasing and wording, for traffic advisory messages. Two approaches will be used for the investigation: a computer-based driving simulator and field experiments. The laboratory study will investigate the intelligibility through a recognition and recall test, and quality through a questionnaire of subjects. Accompanying the laboratory research, a series of three field experiments will be conducted. The first field experiment will be a pilot study to refine the design of the operational test. The second experiment is large scale and will be conducted in parrallel with the laboratory experiment and used as a comparison to validate the laboratory data. The third experiment will not be a controlled experiment; it will be used to provide insights for the factors not examined in this project.

3. Technical and Hardware Effectiveness

The evaluation of technical and hardware effectiveness is designed to monitor the performance and reliability of the system during the evaluation period and to determine the likely production costs of alternative systems. The investigation will be conducted using descriptive statistics on reliability, malfunction plotting, cost analysis, and off-line listener tests.

4. Attention and Vehicle Operation

The investigation of driver attention and vehicle operation will assess the ease of use and safety impacts of the four systems. The investigation will be conducted using a specially equipped camera car. The equipment will measure eye fixations, lane and speed variances, and inter-key stroke intervals when operating the devices.

5. Institutional and Practical Lessons

The study of institutional and practical lessons will serve to assess institutional and organizational lessons, identify qualitative factors which may have a significant impact on experiments and summarize lessons. No formal procedure has been defined for this study.

6. Video Image Detection Performance

The objective of the video image detection performance investigation is to evaluate recently developed technology in the area of traffic monitoring and incident detection. The investigation will consist of a statistical comparison of measures of effectiveness such as detection rate, false alarm rate, and traffic congestion detection rate of hardware and software configurations.

Market Research

The DIRECT operational test provides a direct comparison of four, potential, low cost ATIS. As a result the evaluation should provide information on the comparative strengths and weaknesses of these four systems, which in turn would determine which features and benefits are most in demand by consumers.

However, the details of the evaluation have yet to be worked out. As a result, it is difficult to determine the type of market research information that will result from DIRECT.

Houston Smart Commuter

The Houston Smart Commuter has two components: a dynamic ride matching service, and a traffic and transit information system. The second component is of interest in the study of ATIS. The traffic and transit information system will provide information regarding I-45 from downtown Houston running north. Information will be provided pre-trip via videotext by in-home data service and telephone technologies. The system will provide information on traffic conditions and bus service which runs along an HOV lane on I-45. It is hoped that by providing this information people will shift mode from driving alone to using bus service.

The test evaluation is still being planned. However, four surveys have been planned for the 36 month duration of the project. The first survey will be conducted prior to implementation. Subsequent surveys will follow at 12, 24, and 36 months. Survey data will be supported by monitoring of roadway usage and transit usage.

The estimated cost of the test is $17M. It is supported by the Texas Department of Transportation (TxDOT), the Metropolitan Transit Authority of Harris County (METRO), and, the Federal Transit Administration (FTA). Evaluation objectives and an evaluation plan have not yet been drafted.