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Public Acceptance and User Response to ATIS Products and Services: The Role of Operational Tests in Understanding User Response to ATIS

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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 University 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.

A Note to the Reader

The content of this report reflects the authors knowledge of FHWA sponsored ATIS Operational Tests at the time that this report was written.

There are potential sources of error in the details regarding the operational tests. First, many of the operational tests described are still in the planning stages and thus may be altered quite significantly before they become operational. Second, the source material for many of the operational tests described in this report was taken from draft documents; the content of these documents may change drastically between the draft versions and final versions of the report. Finally, evaluations are often adjusted in the field in order to respond to specific conditions which were not envisioned when the evaluation plan was drafted.

The author cautions the reader when using this report as a source of detailed information regarding any of the operational tests described. More accurate information is available from the participants of each of the projects.

Table of Contents

1. Introduction

Background

In order for ATIS to be developed successfully it is important to understand the market for ATIS, the impact of ATIS on travel, and ultimately, the impact on congestion, and the environment. The root of both the market for ATIS and the impacts of ATIS lies in users' response to ATIS (Figure 1.1). Therefore it is important to understand user response to ATIS.

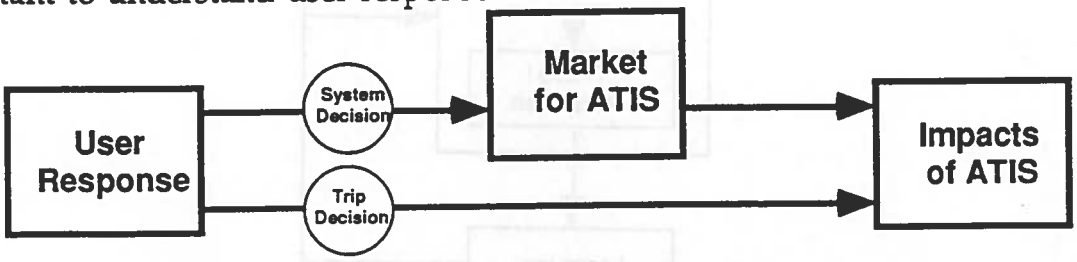

Figure 1.1 - The Relationship of User Response to the Market for ATIS and the Impacts of ATIS

User response is being addressed by a number of ATIS operational tests. Other sources of information on user response to ATIS include driving simulators, traveler surveys, and other market research techniques. In order for the information from these sources to be most useful, this information needs to fit together to form a coherent and complete description of users' response to ATIS (Whitworth, 1993).

Following is a conceptual framework which describes user response. The framework outlines the different stages of user response. By gathering information on each stage of user response a coherent and complete description of user response can be constructed. This framework is described in greater detail in (MIT, 1993).

User response has three major components: system decision, trip decision and learning. The system decision has two stages awareness and access while the trip decision has two stages usage and travel response; thus, there are five stages of user response (Figure 1.2).

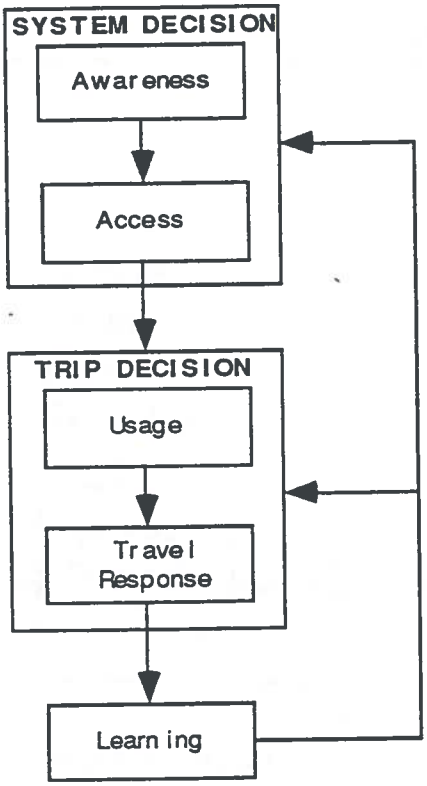

Figure 1.2 - The Stages of User Response to ATIS

During the first stage, awareness, consumers consciously and unconsciously gather information on ATIS. In the access stage, they may or may not choose to acquire access to ATIS, either through subscribing to a service or buying a device. After the consumer has access to ATIS, either by making an access decision or by having access to a system with no access cost, they will make a usage decision one or more times per trip[1]. In the travel response stage, the user will receive information and may then respond to the information by shifting departure time, shifting mode or changing route. The final stage is learning. As users become more familiar with ATIS their perceptions of the system will change; this change in perceptions is learning. Learning affects future decisions made about ATIS, both system decisions and trip decisions. For example, if the ATIS does not provide the user with good information then the user becomes less likely to use the system on subsequent trips, this is short term or trip learning. If this trend continues, the consumer may chose not to subscribe to the service, this is a long term or system decision.

[1]Usage decisions can be made pre-trip and/or en-route depending on the user and on the type(s) of ATIS available to the user.

To fully grasp users' response to ATIS we must understand the influences on behavior at each stage outlined. Therefore, the objective of ATIS operational tests should be to gather information on each of the five stages of user response to ATIS.

Purpose

It is the purpose of this report to outline operational tests which address ATIS and to examine how operational tests can be used to provide information on user response to ATIS. The objectives are:

1. To outline operational tests of ATIS in the United States.
2. To describe the user response component of each ATIS operational test.
3. To describe what information operational tests provide, or will provide on user response to ATIS.
4. To outline how information from operational tests can help in understanding the stages of user response to ATIS.
5. To identify areas that need further information or merit further research.

Scope

This report investigates all federally sponsored ATIS operational tests which have been undertaken or which have been planned in the United States. For the purposes of this report, ATIS Operational Tests include all tests which incorporate real time traffic information (RTT), route guidance (RG) or navigation (NAV). Operational Tests which deal exclusively with transit information, or which test only highway advisory radio and/or changeable message signs as a means of providing information have been excluded as they are more closely related to Advanced Public Transportation Systems (APTS) or Advanced Traffic Management Systems(ATMS) than to ATIS. Some of the ATIS Operational Tests are primarily APTS or ATMS tests; however, they also have significant ATIS components. The report summarizes the following ATIS operational tests:

- SmarTraveler
- DIRECT
- ADVANCE
- FAST-TRAC (ATMS/ATIS)
- Pathfinder
- TravTek

- Houston Smart Commuter (APTS/ATIS)
- Genesis
- SMART Corridor (ATMS/ATIS)

In this report, operational tests are described with varying levels of depth. This is because each of the tests are at varying stages in their life and therefore varying levels of information are available. There is little information on operational tests which are in the planning stage. Information on project and evaluation structure is available for tests which are underway. Results from the operational test evaluations only become available well after the operational test is completed.

The remainder of this report consists of two sections. Section two includes an overview of federally sponsored ATIS operational tests in the United States. The subsequent section outlines how data from operational tests can provide information on user response to ATIS. The appendices provide a summary of each ATIS operational test including a description of the user response portion of the evaluation.

2. Overview of ATIS Operational Tests

This section summarizes ATIS operational tests. More detailed descriptions of each operational test have been included in the appendices. This section provides basic information on the operational tests and the operational test evaluations. Information includes:

- the size of each of the projects,
- an overview of the evaluations,
- an overview of the experimental techniques used in the evaluations, and
- the different user interfaces or products tested.

There are nine ATIS operational tests which are either being planned, underway, or have been completed. The time frames for these projects have been outlined in Figure 2.1. Pathfinder is the only project which has been completed. It is expected that results from the SmarTraveler and TravTek will be available early in 1994. Smart Corridor was scheduled for completion in late 1993. Results will not be available until 1994. Other projects including DIRECT, ADVANCE, FAST-TRAC, Houston Smart Commuter and Genesis are not yet operational.

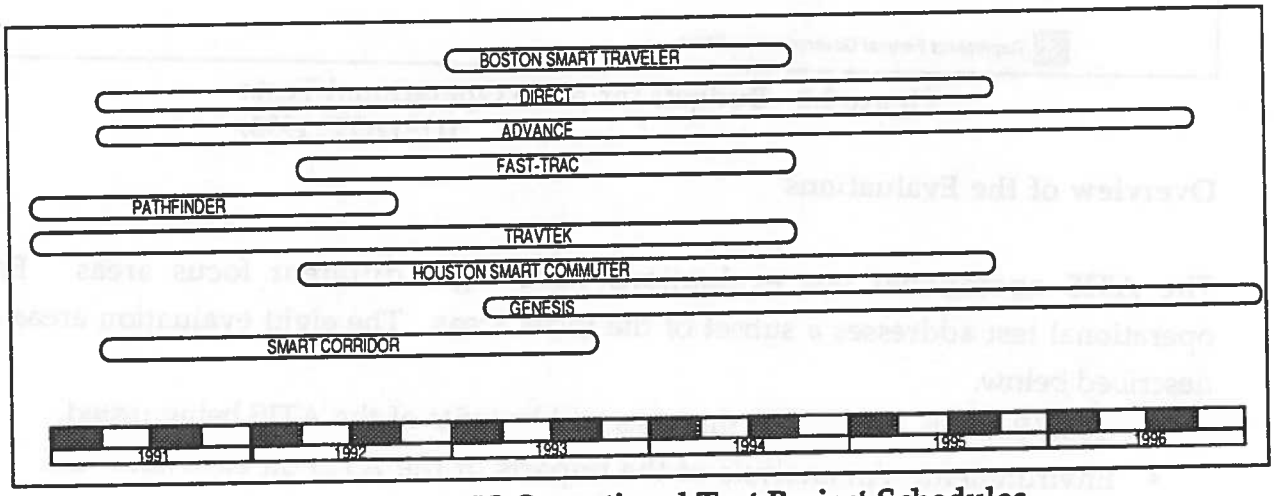

Figure 2.1 - ATIS Operational Test Project Schedules (USDOT, 1993)

Projects range in size from $2.5M for Pathfinder to $47M for Smart Corridor. The budget of each of the operational tests has been outlined in Figure 2.2. Some of the projects have dual purposes and are not purely oriented to ATIS. Smart Corridor is primarily an Advanced Traffic Management System (ATMS) project, FAST-TRAC

has both an ATMS and ATIS component, and Houston Smart Commuter includes a dynamic ride matching system as part of the project.

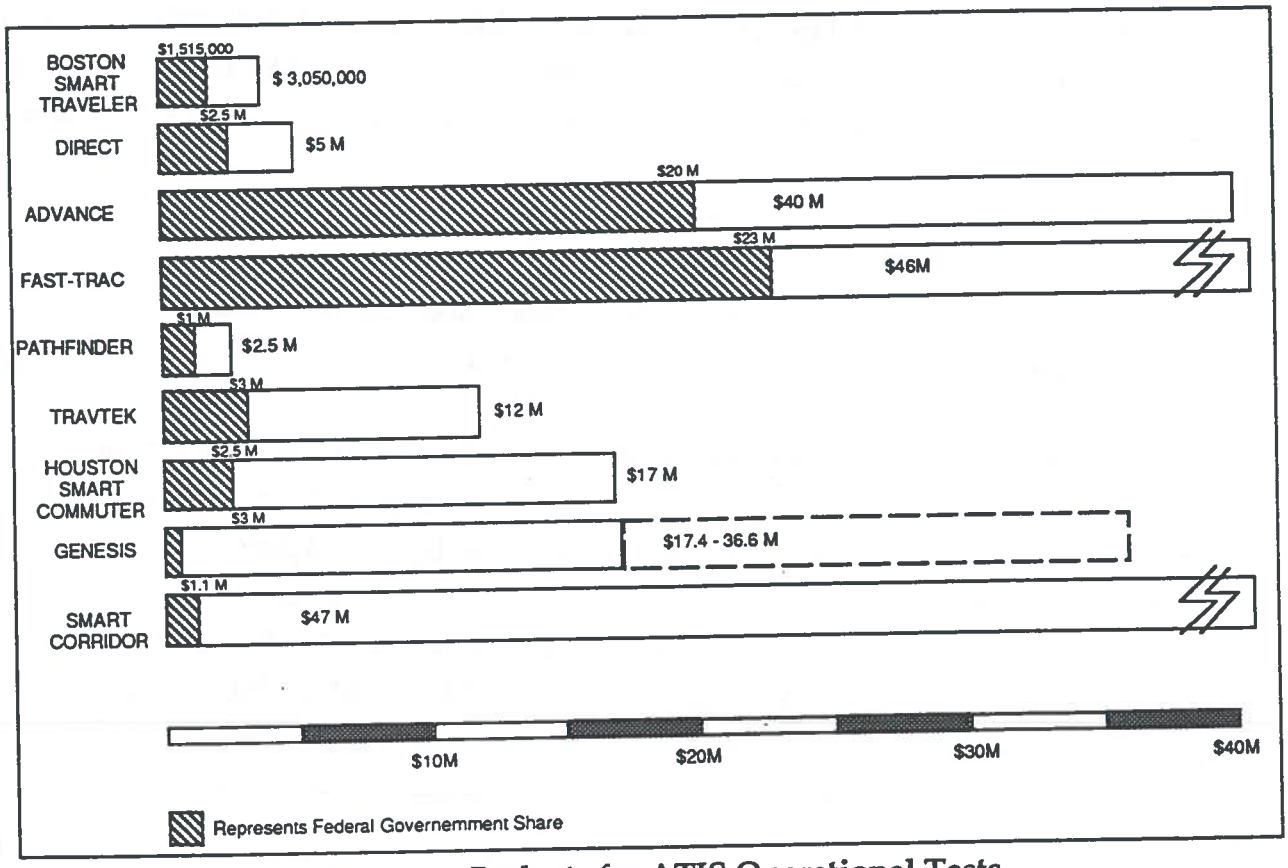

Figure 2.2 - Budgets for ATIS Operational Tests (USDOT, 1993)

Overview of the Evaluations

The ATIS operational test evaluations have eight different focus areas. Each operational test addresses a subset of the focus areas. The eight evaluation areas are described below.

- Cost/Benefit: A study of the costs and benefits of the ATIS being tested.
- Environment: An analysis of the impacts of the ATIS on emissions and energy consumption.
- Human Factors: A study of the ergonomics of the ATIS, including display types, control placement, value of voice synthesizer system, etc..
- Institutional Issues: Investigation of non-technical impediments which if addressed would allow for easier implementation of ATIS in the future.
- Network Benefits: Analysis of the benefits of the ATIS on the road network, during the test phase and/or when the ATIS has higher levels of penetration.

- Safety: Investigation of the effects of the ATIS on accidents and safety.
- Technical: Evaluation of the technical components of the ATIS system, including and evaluation of the quality of the ATIS traffic information and/or route guidance.
- User Response: Investigation users' response to ATIS, this area is the focus of Section 3 of this report.

Table 2.1 describes which project evaluations have each of the components outlined above.

Table 2.1 - Evaluation Components

	Smart Traveler	DIRECT	Advance	FAST-TRAC	Pathfinder	TravTek	H.S.C.	Genesis	SMART Corridor
Cost/Benefit			✓					✓	✓
Environment				✓			✓*		✓
Human Factors		✓	✓	✓	✓	✓			
Institutional Issues		✓	✓	✓		✓		✓	✓
Network Benefits	✓		✓	✓	✓	✓	✓*	✓	
Safety		✓		✓		✓			
Technical	✓	✓	✓	✓	✓	✓	✓*	✓	✓
User Response	✓	✓	✓	✓	✓	✓	✓*	✓	✓

* Estimated, based on Concept Design (evaluation plan is yet to be completed)

Evaluation Techniques

The nine operational tests outlined in this report utilize a number of different techniques to address the different evaluation segments. The experimental techniques incorporated in each operational test have been outlined in Table 2.2. This section describes and discusses these techniques, their application and limitations in relation to user response data. A more detailed discussion of evaluation techniques can be found in some of the draft evaluation plans (FAST-TRAC, 1993) (Fleischman, 1991) (Farradyne, 1991) (DIRECT, 1992) (PATH, 1993).

Table 2.2 - Evaluation Techniques

	Smart Traveler	DIRECT	Advance	FAST-TRAC	Pathfinder	TravTek	H.S.C.	Genesis	SMART Corridor
Camera Car		✓		✓		✓			
Focus Groups			✓	✓					
Natural Use Studies	✓	✓	✓	✓	✓	✓	✓	✓	
Network Surveillance	✓			✓		✓		✓	✓
Network Modeling		✓		✓		✓			
Surveys: Telephone mail out	✓		✓	✓	✓	✓	✓		✓
Test Market	✓								✓
Yoked Studies		✓		✓	✓	✓			

Camera car experiments use a vehicle equipped with cameras to monitor the driver, the driving scene and the road lane markings. Subjects drive the specially equipped vehicle while operating the ATIS product being tested. Recordings from the cameras are used to study the effects of ATIS on safety and to provide human factors information. Camera car data has no application to user response.

Focus groups are used to gather in-depth input from subjects about their attitudes and perceptions. The focus group meetings are moderated by a market research professional, have roughly six to ten subjects and are generally loosely structured. In ATIS operational test evaluations, focus groups are generally comprised of subjects who have used the system being tested. Focus groups provide information on human factors, safety, and user response. However, data produced by focus groups is generally anecdotal and therefore is not useful in developing a full understanding of user response.

Natural use studies allow subjects to use the ATIS in their daily routines with few restrictions to their behavior. Data from natural use studies is collected using an electronic log imbedded in the ATIS, a user diary or a survey, or surveys, conducted

some period of time after the system was used. Electronic logs are the best form of data collection since the computer can record many different variables and is not prone to recording errors which are present with the diary system. However, the diary allows users to record any special circumstances which might have occurred during travel. The last form of data collection, surveys, ask subjects to recall their behavior; thus increasing the chance for error. Data from natural use studies is used for user response studies, cost/benefit analysis, network benefit analysis and technical analyses.

Network surveillance is used to collect information on the state of the traffic network, with and without ATIS in operation. When analyzed, this data will provide information on the network benefits and environmental impacts of ATIS. This data is also used in the cost/benefit analyses.

Network modelling uses computer models to project the impacts of ATIS to higher market penetration rates. These models provide information for making projections about the costs and benefits of ATIS, the environmental impacts of ATIS, and network benefits of ATIS.

Telephone and mail surveys are sent to users and/or members of the public to gather data on users' knowledge, perceptions and attitudes of ATIS. These surveys provide data on user response to ATIS. Surveys in conjunction with operational tests provide a means to collect data on awareness, access, and system learning.

In a test market, a product or service is made available to consumers, in a similar manner to how the product would be made available if it were for sale. Consumer behavior is then monitored. Test markets are important for learning about user response especially awareness and access. However these experiments are very costly to run, and must operate for a long period of time in order for consumers to become educated about the product or service being tested.

In a yoked experiment, two or more subjects drive from the same origin to the same destination at approximately the same time; each subject uses a different ATIS product or no system at all. After the trip, the subjects are asked a few questions about the trip and then the drivers go repeat the sequence. Yoked driving studies provide information on network benefits, human factors and user response. Yoked

studies are useful in understanding a number of stages of user response: travel response (route choice) and trip learning. However, data from yoked experiments is not as good as data from natural use experiments since subjects are acting in a controlled setting.

User Interfaces and Products

The nine operational tests also investigate many different user interfaces or products for providing traveler information. The products range from sophisticated in-vehicle systems which provide route guidance, and navigation such as TravTek, Pathfinder and ADVANCE, to simple telephone based traffic information services such as SmarTraveler (IVHS America, 1992). Other technologies tested include two types of hand held route guidance systems, a pager based system and a personal digital assistant (PDA)[2], and three radio based traffic information systems area wide highway advisory radio (AHAR), low powered highway advisory radio (LPHAR) and Radio Broadcast Data Systems (RBDS) (DIRECT, 1992).

Table 2.3 User Interfaces

	Smart Traveler	DIRECT	Advance	FAST-TRAC	Pathfinder	TravTek	H.S.C.	Genesis	SMART Corridor
AHAR		✓							✓
LPHAR		✓							
Pager								✓	
PDA								✓	
RBDS		✓							
Telephone Service	✓	✓					✓		✓
Navigation and Traffic					✓	✓			
Dynamic RG			✓	✓		✓			

[2]Personal Digital Assistant is the generic term for the group of pocket sized computers with a date book, address book and other functions built in. An example of a PDA suitable for ATIS would be the HP-95.

There are two types of HAR being tested. Area wide highway advisory radio (AHAR) is designed to provide information to a whole urban area, while low powered HAR (LPHAR) only provides information to a small area thus the information can be screened and information relevant to the route traveled is provided to the traveler.

The pager based system delivers traffic and transit information, and dynamic route guidance to the user. The information is presented to the traveler on the LCD display on the pager.

The PDA based system provides the same information as the pager system. Information is provided to travelers using a specially equipped PDA which receives traffic information via a FM transceiver.

Radio Broadcast Data System (RBDS) provides route specific traffic information over the car radio. This system operates using a specially equipped car radio. Information is broadcast on an FM side band. The specially equipped radio interrupts whatever station is being listened to and airs the information.

Telephone service systems provide route specific traffic and/or transit information over the telephone.

There are two primary types of in-vehicle systems. One type provides navigation and traffic information to the user. The second type provides dynamic route guidance to the user. In-vehicle systems usually have a display mounted in the car and many systems also have computerized voice instructions. These systems are also equipped with a vehicle location device.

3. ATIS Operational Tests as Data Sources for Understanding User Response

In order to understand user response to ATIS we must have complete and coherent information on all stages of users' decisions regarding ATIS. While simulators and traveler surveys can provide some data, there is no substitute for real life data which is available from operational tests.

This section describes how operational tests provide data on user response to ATIS and makes recommendations on areas which need further information or further research. Additional recommendations for improvements were outlined by Carter (Carter, 1993). This section includes:

- a discussion of an ideal operational test,
- data sources for the five stages of user response outlined in Section 1,
- a discussion of the quality of operational test data and
- general recommendations on how operational tests could be altered to improve user response data.

The Ideal Operational Test

To evaluate the quality of operational test data, it is useful to consider the ideal operational test. Once the ideal operational test has been outlined, existing operational tests can be evaluated against this standard. Following is a discussion of an ideal operational test evaluation which addresses user response including a discussion of the setting, data gathering techniques and control conditions.

The ideal data gathering environment would closely resemble a marketplace setting but with data available on users' actions and perceptions. Subjects should not know that they are participating in an experiment, SmarTraveler provides and example where subjects are unaware that they are participating in an experiment. Subjects should be provided with the ability to chose from different systems and each of these systems should have different characteristics such as cost, level of service, features, etc.. The experiment would also have to run over a long period of time, six months to a year or more in order to capture changes in perceptions over time.

Data collection would have two forms, logs and surveys. Logs would be used to record the subjects daily travel behavior, providing information about access, usage and travel response; surveys would record changes in attitudes including awareness and learning about ATIS.

Surveys are the only way to collect information about users' perceptions of the system and how they change over time. Surveys of perceptions should also be distributed at regular intervals. Daily surveying is required to understand trip learning while surveys distributed over the course of the project, a year or more, provide data on system learning.

To properly measure changes in behavior, control groups are required. Ideally there would be two types of controls. The conventional parallel control group with separate subjects should be used. Also, data should be collected from both groups before and during the operation of the ATIS. These test groups have been outlined in Figure 3.1.

	BEFORE ATIS TEST	DURING ATIS TEST
CONTROL GROUP	✓	✓
TEST GROUP	✓	✓

Figure 3.1 - Test Groups for User Response Evaluation

Information as has been described above, is not available from any of the operational tests; however, some of the operational tests do fit some of the criteria above and provide information on user response. Comparison between the ideal situation and each operational test evaluation provides insight on the quality of data on user response and potential improvements to each ATIS operational test.

Data to Support the Five Stages of User Response to ATIS

Following is a discussion of specific requirements for each of the five stages of user response to ATIS, including important sub-sections of these categories. Usage includes a discussion of pre-trip and en-route usage. The discussion includes:

- Awareness
- Access
- Usage, including: pre-trip, en-route
- Travel response, including: mode choice, departure time choice, and route choice
- Learning, including: trip, system

An outline of study types and information collection techniques which can be used for each stage are shown in Figure 3.2.

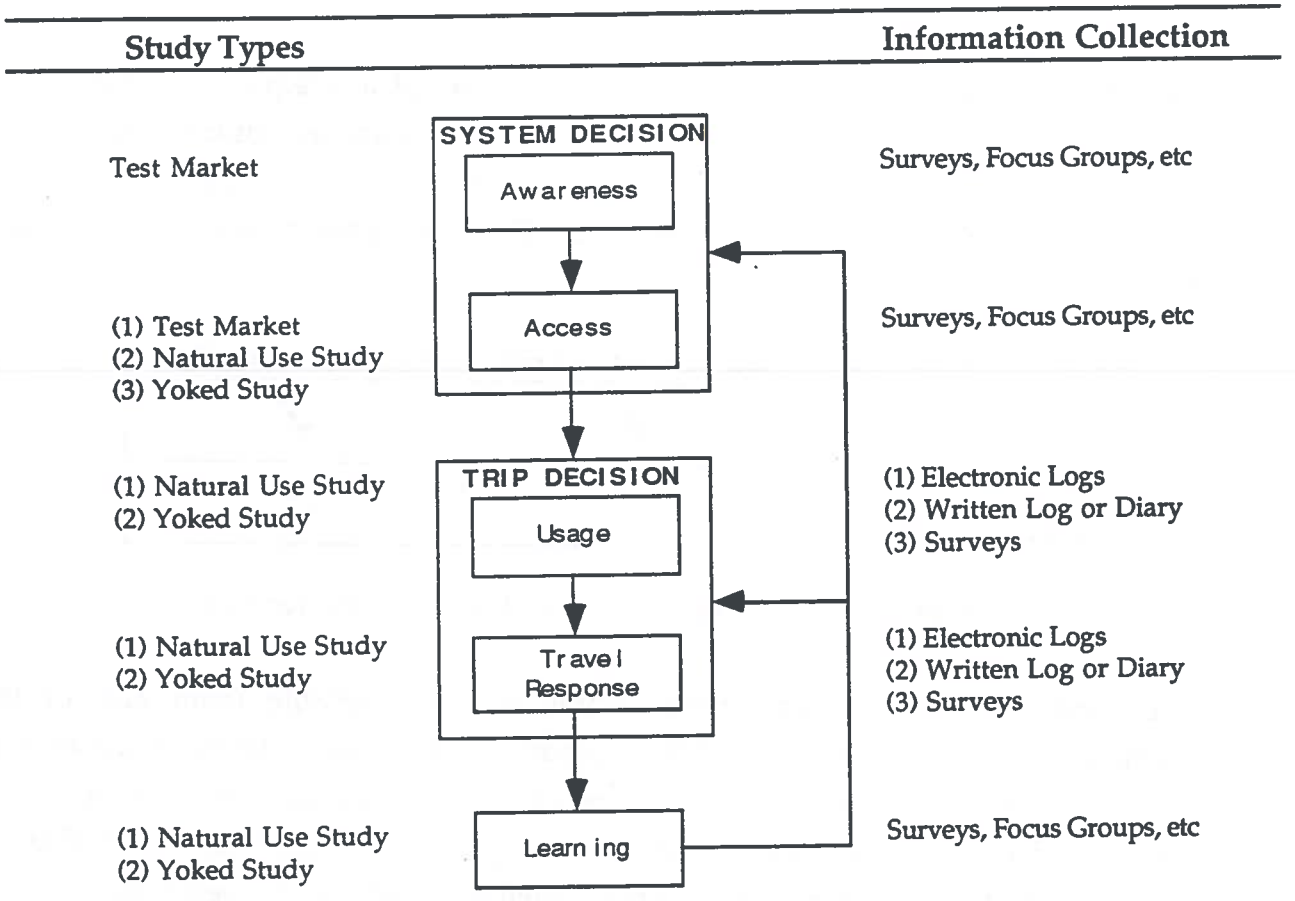

Figure 3.2 - Study Types and Information Collection methods for the Stages of User Response to ATIS

In the ATIS operational tests, logs are used to collect data on user behavior while attitudinal and perceptual data are generally gathered using surveys. Outlined

below are the potential sources of data from ATIS operational tests which could be used for understanding the five stages of user response.

Awareness: Data on awareness can be obtained from surveys of users of ATIS and the general public in a market where ATIS is available commercially. Operational tests which have a test market structure will provide data on awareness. For a complete understanding of awareness the test market should have multiple product offerings. Unfortunately, no operational test offers multiple products in a test market environment; however, radio traffic reports offered in the test area could provide some comparative information.

Access: Like awareness, data on access is best obtained through surveys of users and non users of ATIS in an actual market situation. Operational tests where an access cost is involved (a sign up fee, or equipment purchase cost) could provide experimental data on access. However, operational tests which have an access cost for subjects are very limited. Instead, we can get data by surveying operational test subjects about their willingness to pay for access to a set of specific ATIS services.

Usage: Usage should be considered in two parts: pre-trip and en-route.

Pre-Trip: Information on pre-trip usage can be best collected using a natural use study. Yoked studies could be used but no yoked study to date tests a system which provides pre-trip information. Only certain ATIS technologies provide pre-trip information, therefore only some of the operational tests provide data on user response. Usage information should be recorded in an electronic or written log. In the absence of log data, survey data asking subjects about their pre-trip usage could provide acceptable data.

En-Route: Data can be obtained from natural use or yoked experiments using data from electronic logs of system use. Written logs could be used but these are difficult to use en-route and drivers would have to record information after they arrive at their destination. Alternatively, survey data could be used; however, this data would not be as accurate as the electronic logs of usage.

Travel Response: In order to collect data on travel response to ATIS, information on how users behave after receiving information should be recorded. Information on travel response should be collected using of logs as was discussed regarding usage. There are three types of user response which we are concerned with: mode shift, departure time shift and route choice.

Mode: To collect information on mode choice the operational test should provide travelers with information on several mode options. It is essential that operational test areas include multiple modes if mode choice is to be examined. Ideally users would log their response to information however in the absence of logs survey data would be sufficient, especially since the mode choice is usually made at the beginning of the trip.

Departure Time: To measure shifts in departure time choice, natural use experiments where the ATIS provides pre-trip information should be used. Also subjects should be tested "in-situ" (in their regular patterns). Data could be collected using surveys but user logs are preferred.

Route Choice: Route choice information is best collected through a natural use study; however, a controlled study such as a yoked study could also be used. Data collection must include route choice based on information received. Data collected en-route should use an electronic log, while pre-trip data could be collected by either a written log or an electronic log. In the absence of other data, survey data could be used.

Learning: Information on learning can only be gathered using surveys of drivers perceptions. In order to gain insight into changes in perceptions over time, operational tests should use the same subjects on a repeating basis. Information collection should be conducted using surveys.

System: Learning regarding system decisions requires repeated ATIS use and monitoring of the user over a long period of time, at least six months to a year. Subjects should be engaged in a natural use study so that they

can learn about how the system interacts with their daily lives. Users should have the option to change their ATIS access so that the effects of learning on the access decision can be observed directly rather than estimated based on subject's survey responses.

Trip: Learning regarding trip decisions occur on a trip to trip basis. As a result information collection is required daily. A natural use study environment would provide the best source of information on trip decision learning; however, to survey users daily is impractical. Yoked studies provide a more practical data gathering environment due to the closely supervised nature of the yoked experiments.

Evaluation of Operational Tests

This section outlines what role each operational test could play in the collection of data on user response to ATIS. Table 3.1 shows how the various ATIS operational tests support the stages of user response to ATIS.

Table 3.1 Data Sources for the Stages of User Response to ATIS

	Smart Traveler	DIRECT	Advance	FAST-TRAC	Pathfinder	TravTek	H.S.C.	Genesis	SMART Corridor
Expected Completion	1994	1995	1996	1994	Done	March 1994	1995	1997	1993
Awareness	✓						✓		✓
Access	some	✓	✓	✓	✓	✓	✓	✓	some
Usage									
Pre-Trip	✓	some					✓	✓	✓
En-Route	some	✓	✓	✓	✓	✓		✓	✓
Travel Response									
Mode	✓						✓	✓	
Time	✓						✓	✓	✓
Route Choice	✓	✓	✓	✓	✓	✓	✓	✓	✓
Learning									
System	✓		✓	✓			✓	✓	✓
Trip		✓	✓	✓	✓	✓		✓	

Since each operational test is unique, each test will provide different levels of information on each stage of user response. Following is a discussion of what information might be available from each of the operational tests and a brief discussions of how the operational tests could be altered to provide better quality information.

SmarTraveler

Unique Strength: This operational test is a test market. Therefore SmarTraveler is an important source of information on awareness and a natural use study of usage.

This project provides data for many of the stages of user response. The majority of system users who use the telephone based system will provide data on pre-trip usage decisions and on travel response. There is the possibility that some users will have purchased a cellular phone for the purpose of receiving traffic information. These subjects will have incurred an access cost and therefore provide information on access. Subjects who use the system from cellular phones will use the system while en-route thus providing information on access and en-route usage and en-route response. As part of the SmarTraveler evaluation, a survey of the general public is also being planned; this survey will provide information on awareness of ATIS. System learning information is also gathered since the operational test evaluation lasts over three months and subjects will therefore have differing levels of experience with the system.

SmarTraveler does have some short falls. The information is collected by survey. If logs had been used to record usage and travel response the information would have been better; however, if logs were used then subjects would be aware that SmarTraveler is an experiment. Data on learning could also have been improved if a sample of users had been surveyed at regular intervals over time. This would have provided information on better learning. (MultiSystems, 1993)

DIRECT

Unique Strength: DIRECT provide a direct comparison of four separate low cost ATIS products.

DIRECT is a natural use study testing different ATIS types. While this operational test is useful for determining what type of traffic information system is preferred, the project is unlikely to provide significant useful information for modeling user response. DIRECT could provide data on usage, travel response, and trip learning.

The operational does not provide transit information and therefore is not an accurate measure the mode choice travel response. The project will provide information on trip learning but since users will only use each technology for two months; as a result, system learning will not be significant. (DIRECT, 1992)

ADVANCE

Unique Strength: ADVANCE is expected to have a large sample size, long duration, natural use study which will provide excellent information on en-route usage, route choice, and trip learning.

ADVANCE could potentially provide an excellent source of data to evaluate user response. The evaluation will use a natural use study with a large sample size. The large sample will provide excellent data on en-route usage, route choice, system learning (awareness) and trip learning, if users are surveyed regularly.

Since ADVANCE is an in-vehicle system, information will only be available en-route. Also, the system does not include transit information which limits its usefulness in learning about mode choice. ADVANCE will provide information on system learning, but since users are preselected for the duration of the test information on the effect of learning on access can not be observed as part of the operational test. (Bolczak et. al., 1992) (Bolczak et. al., 1993)

FAST-TRAC

FAST-TRAC is primarily a technical and organizational test to study how ATMS and ATIS can be operated together by local government. As a result, FAST-TRAC has no unique strength in assessing user response. However, the operational test will provide additional data on user response and provide information on the Ali-

Scout system. FAST-TRAC will provide information on en-route usage, travel response (route choice) system learning and, trip learning. It anticipated that information will be collected using logs which will provide information of usage, and travel response. Whether the project will provide information on learning will depend on the type of surveying of users' perceptions conducted. A duration of a year or more with surveys distributed to all subjects monthly and a sub-set of subjects surveyed daily would provide an excellent source of information on both trip and system learning. If subjects were allowed to leave the experiment at the end of each month, then learning effects on access could measured directly.

FAST-TRAC uses an in-vehicle ATIS, thus the project will only provide information on en-route usage. The test area is small and lacks a logical transit alternative after the user has begun their trip by car, therefore FAST-TRAC does not provide information on mode choice. (FAST-TRAC, 1993)

Pathfinder

Unique Strength:	Pathfinder served as a prototype test of an in-vehicle navigation and information system. Pathfinder is the only completed operational test. Thus, is the only source of real life data on user response.

The Pathfinder evaluation has been completed. As a result this information is already available. Pathfinder was primary a yoked driving study, complemented by a small natural use driving study of commuters. Unfortunately, since Pathfinder was primarily a yoked study on an in-vehicle systems, the project will only be useful for en-route usage, mode choice travel response, and trip learning.

TravTek

Unique Strength:	TravTek tested a finished product with a large sample; however users generally were not exposed to the system for more than a week. The renter study also provides information on ATIS usage in a non-commuter environment.

The results of this operational test are due to be completed in March of 1994. There are two components of the operational test which will be useful in evaluating user response: the renter study and the high mileage driver study. Both studies focus on in-vehicle use, thus TravTek will only provide information on en-route usage. TravTek primarily provides information on route choice. Since tourists are unaware of transit alternatives and TravTek does not provide information on transit, only the local user study will provide information on mode choice. The renter study will provide information on users of the system over a short period of time, approximately a week, thus learning can not be measured effectively. The high mileage driver study had a smaller sample size but drivers used the system for three months (one month in each of services info, services and navigation, and services, navigation, and traffic information) thus this test will measure the learning effect on a trip to trip basis, and some system learning.

It should also be noted that neither of the studies used demographically balanced samples. The renter study focused on travelers visiting the Orlando area, who rented a luxury vehicle. As a result this sample neither accurately reflects the general population, nor are samples using the system in their day to day driving patterns. the local driver study used professionals who use their vehicles for work, thus this sample is also not indicative of the general population. (Farradyne, 1991)

Houston Smart Commuter

Unique Strength: The strong transit orientation of Houston Smart Commuter will provide excellent data on pre-trip usage and travel response including mode choice, departure time choice and route choice.

The focus of this operational test is to encourage people to use transit, using an ATIS which provides pre-trip information. As a result, the test could provide an excellent source of information on pre-trip usage and on departure time choice, mode choice and route choice. This project will probably have the best balance of traffic and transit information, thus it will probably be the best source of data on mode choice travel response. The project is expected to be operational for 36 months, with surveys at yearly intervals. It will provide information on system

learning. Depending on how survey samples are chosen the project might also provide information on ATIS awareness and access. (Texas A&M, 1991)

Genesis

Unique Strength:	The large sample size natural use study, of two portable ATIS devices which provide traffic and transit information, is the most promising of the operational tests for providing data on pre-trip and en-route usage, travel response (including mode, time and route choice), and trip learning

This operational test has the potential to provide good quality data for access, usage (pre-trip and en-route), travel response (departure time, mode choice, and route choice) and learning (system and trip). Genesis is a natural use study which will utilize trip logs for collecting information. The device is also portable and thus can be used pre-trip or en-route, and for switching departure time, mode and route choice. Subjects will use the system every day for a long period of time thus trip and system learning can also be measured. Like FAST-TRAC, if subjects were allowed to enter of exit the program at the end of each month the effect of learning on access could be observed directly.

Smart Corridor

Unique Strength:	Smart Corridor is one of two test market operational tests, thus an important source of awareness data. Smart Corridor will also test multiple user interfaces, thus provides a comparison of different products.

This operational test could provide information on all five stages of the user response framework; however, the evaluation plan calls for two large surveys, one early in the project and one later in the project, and a series of three surveys of a sub-set of subjects. These surveys are not sufficient to capture information to a great degree of depth. It is clear that logs would be a better source of data for usage and travel response, however the surveys will provide some data on these stages. The surveys will serve to measure awareness but in a setting where only one ATIS is available and access. The three surveys using the same group of subjects will

provide information on system learning, however the use of logs would have captured data on trip learning. (PATH, 1993)

Quality of Data Collection

While the projects discussed above have the potential to provide information on the stages of ATIS user response, the quality of that information depends on the information collection techniques used. Some of the important aspects of the information collected have been outlined in Table 3.2.

Table 3.2 - Information Collection on User Response to ATIS

	Trip Log Data	Sample Size	Survey Sampling Frequency	Day to Day Environment?	Duration with Subject	Control* Group?
Smart Traveler	No		Once	Yes	1 year	No
DIRECT	Electronic	5 x 30	Monthly	Yes	2 months	Parallel
ADVANCE						
Nat. Use	Electronic	800	3 Times	Yes	3 x 2-4 weeks	Before
Yoked Study	Electronic	TBD	TBD	TBD	TBD	Parallel
FAST-TRAC						
Nat. Use	Electronic	240+	Monthly	Yes	Various	No
Yoked Study	Electronic	1,920 trips	Once	No	~ 1 day	Parallel
Pathfinder						
Nat. Use	Written	~25	Weekly	Yes	3 months	No
Yoked Study	Written	~8000 trips	Weekly	No	8 weeks	Parallel
TravTek						
Yoked	Electronic	~ 150	Once	No	~ 1 day	Parallel
Renter	Electronic	~3000	Once	No	~ 1 week	Parallel
Local Users	Electronic	~50	Once	Yes	3 x 1 month	Before
H.S.C.	No	TBD	Annually	Yes	3 years	Before
Genesis	Yes	420+	?	Yes	months	?
Smart Corridor	No	TBD	Every 3-4 months	Yes	1 year	Before

Note: * Two types of control groups are used "Before" and "Parallel". "Before" collects information from test subjects before they are exposed to ATIS. "Parallel" collects information from a control group at the same time as the test group. Neither of these situations is ideal. The ideal situation is described in figure 3.1.
TBD - To Be Determined

General Conclusions and Recommendations

After analyzing the operational test a number of general conclusions and recommendations become apparent.

1. Many of the operational tests contain a great deal of overlap in terms of information collection while other areas which require information remain uncovered. To eliminate this inefficiency, an overall ATIS user response strategy should be developed. Once this strategy is developed operational tests can be designed to fulfill specific information needs.

2. In the absence of an existing market for ATIS, a test market is required to collect good quality user response data, especially regarding awareness and access.

3. In order to compare differing ATIS technologies a wide range of technologies need to be tested under similar conditions. Each operational test should test multiple and significantly different technologies.

4. The quality of analysis depends on the quality of the control data as well as the quality of the test data. Operational tests should have better control groups including data collection from the test subjects and the control subjects before and during the ATIS testing.

5. In order to fully test the potential of ATIS to cause travelers to shift mode adequately, timely transit data must be provided. Most of the ATIS operational tests provide little or no transit information, this must change if the affect of ATIS on mode shifting is to be accurately measured.

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Appendices A to I :

Descriptions of ATIS Operational Tests

This section contains a description of each of the nine ATIS operational tests. Tests described include:

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

Descriptions include a project summary, a narrative about the project and the project evaluation. The summary includes:

- general facts about the project,
- a list of the project participants,
- contact names of people involved with the projects, and
- summary of the project status.

The narrative includes some background information about the project, a list of the evaluation objectives, a discussion of the structure of the evaluation, and an outline of the user response component of the evaluation.

Each operational test is structured differently and is of a different scale, scope, and duration; further, each operational test is at a different point in its development. As a result, there is a change in depth of focus for each project in order to provide the reader with as much information as is available and relevant.

Appendix A: SmarTraveler

Summary

Features: Real time traffic information available by telephone
Location: Greater Boston, Massachusetts
Cost: $3,050,000
Federal Share: $1,515,000
Time Frame: 1992-1994

Project Participants

SmartRoute Systems -- Partner and System Operator
Massachusetts Executive Office of Transportation and Construction
-- Partner, Project Supervisor and Sponsor
Multi-Systems -- Evaluator
Massachusetts Turnpike Authority -- Partner
Massachusetts Bay Transit Authority -- Partner
Massachusetts Port Authority -- Partner
Massachusetts State Police -- Partner
FHWA -- Sponsor
Central Transportation Planning Staff, Massachusetts -- Evaluation Design

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Evaluation Contacts
Richard Juster, Multi-Systems

Project Status

Evaluation of User Response: Yes
Evaluation Budget: $ 818,000
Project Status: Data gathering through January of 1994
Results Available: Some preliminary results

Background

SmartRoute Systems (SRS) provides real time, route specific traffic information by phone in the greater Boston area. The service was started as a privately run, for profit service. Since January 13, 1993 the service has been offered free, as part of a FHWA operational test to study IVHS. SRS offers both traffic information and information on events and construction which affect traffic conditions for major routes in the greater Boston area. Telephone callers select a specific route through a menu of choices provided when they call. Callers are then provided with a route specific traffic report. The operational test and evaluation focuses on the telephone service.

As part of the Federal Highway Administration project, the SmarTraveler service being operated by SRS is being evaluated by an outside organization selected and monitored by the Central Transportation Planning Staff of Massachusetts (CTPS). CTPS has selected Multi-Systems to perform the evaluation.

Evaluation Objectives

The evaluation has five primary objectives:

- the assessment of the quality of the information being provided, (Technical)
- evaluation of public acceptance of the utility of the traffic information, (User Response)
- estimation of the impact of the project on traffic congestion now and in the future, (Network Benefits)
- recommendations of improvements in the collection and dissemination of traffic information, (Technical)
- assessment of whether this service can be sustained as a profitable business.

Structure of Evaluation

The evaluation has three components: data collection, analysis, and project assessment.

Data collection includes: usage statistics, call source segmentation and a set of three telephone surveys. Usage statistics are counted by gathered and categorizing incoming calls to SmarTraveler. Calls are segmented into three markets, land based calls, NYNEX

Mobile and Cellular One[1] calls. Calls are also counted by time of day, day of week, and weather conditions. The three surveys are: the mobile and two-way radio probe survey, user survey, and non-repeat user survey. A survey of the general public to find out about awareness of the system is also being considered

Three separate analyses have been mandated as part of the evaluation. The analysis includes an assessment of data sources, a survey analysis, and an analysis of institutional issues. The analysis of the data sources will use data from the mobile and two way radio probe survey and more general information to determine which data sources produced the most useful, and reliable traffic information. The survey analysis summarizes and draws conclusions from the data collected in the three surveys including using data from the user and non-repeat user surveys to assess user response. The analysis of institutional issues will explore issues such as whether project participants were satisfied, if jurisdictional boundaries effect project performance, and what participant would change.

Finally, project assessment will bring together all of the information to address each of the objectives and provide general conclusions and recommendations.

User Response

The user survey and the non repeat user survey, will provide information on user response to ATIS. The user survey is designed to solicit information from consumers on how they value the service. Subjects are to be selected at random from those who call SmarTraveler each day. Calls to SmarTraveler will be intercepted at random and the caller will be asked to answer a telephone survey within one week. The traffic information provided to the caller will be recorded and time tagged. Data collected through the interview will include:

- Basic data about the caller, socioeconomic data, trip data, and usage of SmarTraveler.
- The result of the information obtained by the call. Did the caller change time, route, or mode of the trip? was the trip was made on the desired route at the desired time regardless of the information?
- Whether there is any benefit from the information perceived by the and if so how it would be quantified by the traveler?

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[1] NYNEX offers the SRS service free while CELLULAR ONE customers have to pay for the call. It is hoped this will provide some revealed preference data for willingness to pay.

- Rating of the timeliness, content, quality, and usefulness of the message and the most useful part of the message and identification of the part of the message which caused the user to change time, mode, or route of their trip.
- If information will effect future behavior.
- Future plans of the consumer to use the service.
- Whether the consumer would be willing to pay for the service.

The focus of the non-repeat user survey is to determine why one time service users did not continue to use the service.

Appendix B: DIRECT

Summary

Features:	Traffic information provided to motorists
Location:	Detroit Michigan
Cost:	$5,000,000
Federal Share:	$2,500,000
Time Frame:	1991-1995

Project Participants

Michigan DOT -- Sponsor
FHWA -- Sponsor
University of Michigan and Michigan State University -- Evaluation

Contacts

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Yili Liu, Message Characteristics, UofM
Paul Green, Driver Attention and Vehicle Operation, UofM
Marlin Ristenbatt, System Monitoring and Cost, UofM
William Taylor, Video Image Detection and Performance, Michigan State Univ.

Project Status

Evaluation of User Response:	Yes
Evaluation Budget:	To be determined
Project Status:	Being scaled back to stay within budget Draft Evaluation Plan completed, December of 1992
Results Available:	None

Background

DIRECT has been designed to evaluate the effectiveness of different low cost communications mediums for providing drivers with traffic information. Specifically the project will test the effectiveness of the following:

- low-power highway advisory radio (LPHAR),

- automatic highway advisory radio (AHAR),
- radio broadcast data system (RBDS), and
- cellular telephone traffic advisory services.

The project will compare these systems in terms of travel benefits, projected system costs, driver distraction and safety and institutional issues associated with the systems. The evaluation will use 25 vehicles: four sets of five vehicles will be equipped exclusively with one of the ATIS to be tested and the remaining five vehicles will be equipped with all five systems. Field tests will be performed along I-94 between downtown Detroit and the Airport.

The scope of the project is currently under review. It is expected that the scope of the project will be reduced in order to lower costs.

Evaluation Objectives

The evaluation, in its current form, is summarized below. The project objectives are:

1. Comparison of ATIS Alternatives (User Response)
2. Message Characteristics (Human Factors)
3. Technical and Hardware Effectiveness (Technical)
4. Attention and Vehicle Operation (Safety)
5. Institutional and Practical Lessons (Institutional Issues)
6. Video Image Detection Performance (Technical)

Structure of the Evaluation

The Comparison of ATIS Alternatives has been designed to assess driver attitudes, benefits, and public support for the product and system. The evaluation will be conducted using questionnaires, focus groups, interviews and instrumented vehicles. Measures of effectiveness include:

- satisfaction, acceptance,
- willingness to pay,
- perceived accuracy of info.,
- perceived improvement of travel,
- behavioral response to info. and

- impact on choice.

In order to assess system and user impacts at higher levels of market penetration a traffic simulation study will be performed.

In order to investigate message characteristics a two part study has been proposed: a lab based simulator study, and a field study. The lab study will use a computer-based driving simulator to evaluate driver comprehension, memory, and preference of message compositions. The field study will encompass three experiments: (1) a small scale pilot study of 10-20 subjects, (2) an experiment to complement the lab study in the less controlled, more realistic, real world environment using 20-40 subjects, and (3) a less controlled experiment to yield hypotheses for further research using 10-20 subjects.

The investigation of Technical and Hardware Effectiveness will monitor the performance of the system during the evaluation period, and determine the likely production costs of the alternative systems. Measures will include:

- fraction of time equipment is within specification,
- identification of malfunctions,
- projected production costs,
- signal-to-noise ratio of sound reaching driver's ear, and
- listener judged quality.

The investigation of Attention and Vehicle Operation uses a camera car to measure eye fixations, lane variance, speed variance and inter key stroke intervals (the time required to activate the information system either using the phone or tuning the radio). Drivers will be tested for each of the four systems.

Institutional and Practical Lessons will be investigated using interviews and participant interview logs. The investigation will include the following issues:

- intra-agency,
- inter-agency,
- public-private,
- legal,
- skills and training,
- politics,
- legislative,
- standards and protocols, and

- financing.

The objective of the evaluation of Video Image Detection Performance is to compare incident detection algorithms[2]. The analysis will consist of a statistical comparison of the detection rate, false alarm rate and mean time to detect of each algorithm. Data for this study will come from logs of detector data and videotaping of incidents.

User Response

The Comparison of ATIS Alternatives will use questionnaires, focus groups, interviews, and instrumented vehicles to investigate user response. The following measures have been targeted for investigation:

- satisfaction,
- acceptance,
- willingness to pay,
- perceived accuracy of information,
- perceived improvement of travel
- behavioral response to information
- impact on choice (e.g. delay, diversion route characteristics, etc.)

The investigation will use a total of 150 subjects assigned to one of six two month periods. Subjects will then be assigned to one of five groups (LPHAR, AHAR, RBDS, cellular, control). Thus each group will have a total of thirty subjects. Subjects will be recruited from work sites located near the terminus of the DIRECT instrumented route, and will use the system during their daily commuting trips.

The majority of data collection will be automated using vehicle location identification technology. Data about the subjects, and their perceptions, will be collected by surveys of subjects before the experiment, after one month, and after two months. Survey data will be supported by a focus group conducted at the end of each two month period; focus groups will have one subject from each technology. Analysis will be conducted to compare the differences in responses between the groups.

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[2]DIRECT will compare the effectiveness of two incident detection algorithms. One was developed by the PATH organization in California, the other was developed at McMaster University in Hamilton, Ontario, Canada.

Appendix C: ADVANCE

Summary

Features: In-vehicle navigation, route guidance, and real time traffic
Location: Chicago (Northwestern Suburbs)
Cost: $ 40,000,000
Federal Share: $ 20,000,000
Time Frame: 1991-1996

Project Participants

Illinois DOT -- Partner and Sponsor
Motorola -- Partner and Sponsor
Illinois Universities Transportation Research Consortium (IUTRC) -- Partner
Including: University of Illinois,
Northwestern University,
FHWA -- Partner and Sponsor
Parsons De Leuw Inc. -- Contractor
MITRE -- Evaluation design
Farradyne Systems -- Contractor, designed traffic info. system
Contributors: Navigation Technologies, ETAK, Nissan Motor Co., Volvo Car Co., Saab-Scania, DonTech, Ford Motor Co., Toyota Motor Corp., Peugeot S. A., Sun Microsystems Inc. and the National Center for Supercomputing Applications

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Project Status

Evaluation of User Response: Yes
Evaluation Budget: To be determined
Project Status: Evaluation design on-going
Results Available: None

Background

ADVANCE(Advanced Driver and Vehicle Advisory Navigation Concept) is a demonstration project currently under development in the northwestern suburbs of Chicago. ADVANCE will will involve up to 4500 private vehicles and 500 fleet vehicles. The system will provide users with real time traffic information, route guidance, navigation, and a directory of services through an in-vehicle system.. The ADVANCE system is composed of 4 sub systems:

- the Mobile Navigation Assistant (MNA),
- the Communications Network,
- the Traffic Information Center (TIC), and
- Traffic Related Functions (TRF).

The Mobile Navigation Assistant is the in-vehicle component of the system. The in-vehicle system communicates with the Traffic Information Center through the Communications Network. Traffic information is collected at the TIC from the in-vehicle units which act as probes and from historical data stored on computer.

Evaluation Objectives

The objective of ADVANCE is to evaluate IVHS applications for congestion relief. Specifically, 11 evaluation goals have been drafted:

- Evaluate performance of probe vehicles as a source of link travel times, (Technical)
- Evaluate the information products created by the advance system, (Technical)
- Evaluate the performance of the in-vehicle ...human factors, (Human Factors)
- Evaluate the performance of the radio frequency communication system, (Technical)
- Evaluate the performance of the TIC, (Technical)
- Evaluate the effects of the advance system on driver perception, route choice behavior and fleet vehicle operations, (User Response)
- Estimate the performance of the route guidance system in reducing travel times and travel distances, (Network Benefits)

- Perform benefit/cost analyses of the advance system, (Benefit/Cost)
- maintain an information source and make the info. accessible to organizations interested in IVHS projects, and
- Document and evaluate the effect of institutional issues on the advance project. (Institutional Issues)

Structure of the Evaluation

The ADVANCE evaluation primarily relies on the use of a natural use study with information logs kept by all of the parties involved. The primary data source for the evaluation is in-vehicle electronic logs which record how the in-vehicle system is used and the users' travel response. Information will be collected on RAM memory cards[3] which will be turned in by users on a monthly basis. Along with the user logs, a number of logs will be kept by the agencies involved. The TIC log will record traffic conditions and traffic information given, maintenance logs will track system reliability.

The log data from the natural use study will be supported by a yoked study, simulator experiments, surveys of users, trip diaries, focus group interviews and quantitative analysis of real-time data.

User Response

The investigation of User Response is divided into two objectives:

1. Evaluate the effects of ADVANCE information products, including static navigation, dynamic route guidance, business directory, and emergency request services, on driver route choice behavior; more general travel behavior including choice of trips and frequency , departure times, and mode of travel; and driver perceptions of the effectiveness, contribution to safety, anxiety, comfort, and security, and worth of the ADVANCE system

2. Evaluate the effects of the ADVANCE system and its information products on the operations of participating commercial and public fleet vehicles, and fleet operators' perceptions of the effectiveness and worth of the ADVANCE system.

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[3]The Mobile Navigation Assistant is equipped with a PCMCIA slot similar to the expansion slot on many Intel based portable computers. Log information will be recorded on these memory cards. The cards will then be collected from users each month.

The investigation of the first objective will utilize a natural use experiment of 800 private drivers participating in ADVANCE. The travel patterns of these drivers will be recorded on memory cards. The study will have three phases with more information provided to drivers with each phase. The first phase will last two to four weeks with no information; this will provide control condition information. The second phase will last two to four weeks and provide only static information. During the final phase participants will be provided with dynamic route guidance, traffic information and static information. Data collected using memory cards will be supplemented by surveys distributed periodically during the investigation. Surveys will collect information about driver characteristics, travel behavior patterns, and perceptions of the system. Surveys will also be issued to the 800 participants after each phase of the study and on three occasions during the third phase of the experiment. Focus groups will be used to explore issues brought up in the surveys in greater depth.

In order to investigate the second objective, 200 commercial and fleet vehicles will be equipped with memory cards. The study structure will be similar to the private driver study. The investigation will target objective measures of operational activity (e.g. trips, miles, calls per unit time), productivity, efficiency, and safety. Operating data will also be collected from selected fleet operators before and during the experiment.

Appendix D FAST-TRAC

Summary

Features:	In-vehicle navigation, route guidance, and real time traffic via Siemens' Ali-Scout system
Location:	Detroit (Oakland County), Michigan
Cost:	$ 46,000,000
Federal Share:	$ 23,000,000
Time Frame:	1992-1994

Project Participants

Road Commission for Oakland County (RCOC)-- Partner and Project Manager
FHWA -- Partner and Sponsor
University of Michigan -- Partner and Evaluator
Siemens Automotive -- Partner and Supplier of ATIS System

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Project Status

Evaluation of User Response:	Yes
Evaluation Budget:	$ 930,000
Project Status:	Draft Evaluation Plan, completed
Results Available:	None

Background

FAST-TRAC is a federally funded IVHS demonstration project being undertaken by the Road Commission for Oakland County(RCOC), a rapidly growing suburb of Detroit. FAST-TRAC, is an infrastructure based ATIS system, using the Ali-Scout system. FAST-TRAC also shows a possible future scenario for ATIS, and will provide extensive field test information once the project becomes fully implemented.

The project was originally undertaken as a ATMS project by RCOC in order to reduce congestion increasing road capacity. The county adopted a strategy to better manage their existing road capacity through the use of ATMS and later entered into an agreement with Siemens to install the Ali-Scout system. In 1990, the Board County Commissioners approved $2 million in seed money for phase one of the FAST-TRAC project. Subsequently FAST-TRAC was selected as an IVHS demonstration project and now receives federal funds.

RCOC was selected as the project manager for the federally funded project. As a result they are responsible for the project evaluation. They have selected Steven Underwood at the University of Michigan to design the evaluation.

Evaluation Objectives

The evaluation will include a technical evaluation of the ATIS and ATMS technologies, analysis of institutional issues, analysis of network and environmental benefits of the combined ATIS and ATMS, human factors and user response evaluation of the ATIS, and evaluation of the effect of the ATIS and ATMS on safety.

Structure of the Evaluation

Based on the draft evaluation plan, the FAST-TRAC evaluation will include the following studies:

- Traffic impact modeling, (Network Benefits and Environment)
- Yoked and natural use studies, (User Response)
- Human factors of vehicle operation (Human Factors)
- Technical evaluation, (Technical)
- Institutional analysis, (Institutional Issues)

- Stakeholder analysis, (Institutional Issues)
- Global evaluation, (Overall Report)
- Control center evaluation (Technical)
- Accident analysis (Safety)
- SCATS link-time study (ATMS)
- Delay at individual intersections (Network Benefits)

Evaluation of user response to Ali-Scout will utilize yoked and natural use studies. These studies will be supported by surveys, subject interviews, and driver logs.

User Response to ATIS

Information on user response will primarily be collected through a natural use study with some information possibly being provided by the yoked study. The natural use study will use subjects who are familiar with the roads in the area. Subjects will be from key demographic groups. Information collection has been broken into two groups of variables: independent variables, and dependent variables. Independent variable will be collected from driver logs and information from RCOC. Dependent variables will be collected using surveys, subject interviews, focus groups, driver logs, automated data collection.

Information on the following independent variables will be collected:

- trip purpose
- trip length
- beacon coverage
- incident / non incident road conditions
- available features (e.g. portability, debit card)

Dependent variables will include:

(via surveys, subject interviews, focus groups, and driver logs)

- user perceptions
  - information adequacy
  - ease of use/convenience
  - usefulness for route guidance
  - acceptable route
  - origin to destination time savings (subjective)

- safety/close calls
- "unusual experiences"
- effective measures (e.g. stress, frustration, uncertainty)

- confidence with system
  - accuracy
  - timeliness
  - best/most efficient route
- willingness to pay
  - likelihood to purchase
  - $$ per feature

(via automated data collection)

- system use by driver
- information provided by system to driver
- where user drives
- network conditions

In the yoked study two subjects will be tested together; one subject will have a car with the Ali-Scout system and the other subject will be in an unequipped vehicle. The two subjects will drive the same origin-destination pair with staggered departure times. As part of the experiment, the following independent variables will be measured:

- trip length,
- trip purpose,
- time of day,
- peak/non peak conditions,
- position of origin-destination pair relative to instrumented intersections and
- SCATS implementation

The following dependent variables will also be measured:

(via surveys, subject interviews, focus groups, driver logs)

-- the same as natural use study

(via automated data collection)

- number of stops
- time at stop
- travel time
- distance traveled
- road types used

- number of turns

Appendix E: Pathfinder

Summary

Features:	Navigation with real time traffic information
Location:	Los Angeles, California
Cost:	$ 2,500,000
Federal Share:	$ 1,000,000
Time Frame:	1990-1992

Project Participants

General Motors -- Sponsor and Partner
FHWA -- Sponsor and Partner
California Department of Transportation (Caltrans) -- Sponsor and Partner
JHK & Associates -- Evaluation Contractor
Farradyne Systems -- Systems Integration Contractor
City of Los Angeles Department of Transportation -- Information Providers
California Highway Patrol -- Information Providers

Contacts

Federal Contact:
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Project Status

Evaluation of User Response:	Yes
Evaluation Budget:	
Project Status:	Evaluation complete
Results Available:	Evaluation Report

Background

Pathfinder was the first operational test of an in-vehicle navigation and traffic information system in the United States. The project was initiated in October of 1988 and project evaluation was completed in June of 1992. The project had a budget of $1.6 million, split between Caltrans and FHWA, and used 25 dedicated vehicles provided by GM. The tests were conducted on a 13 mile section of the Santa Monica Freeway and surrounding arterial streets called the Smart Corridor. The Pathfinder system used the ETAK Travel Pilot in the vehicle, with modifications to provide real time traffic

information. Three different display modes were tested: blank (control condition), map mode (static information only) and Pathfinder mode (with real time traffic information).

Evaluation Objectives

The Pathfinder Evaluation had the following general objectives:

- To assess whether real-time traffic information directed to individual vehicles can increase the efficiency of routing for motorists with navigational In-Vehicle Information Systems;

- To assess the feasibility of combining traffic information systems with an in-vehicle navigation system;

- To assess the feasibility of using vehicles equipped with in-vehicle navigation as a means of providing "floating car" type traffic data at a centrally located control center;

Structure of the Evaluation

The operational test was broken up into four stages, as follows:

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

Stage II: Specially hired drivers conducted structured paired comparison tests in each of the 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 information. Drivers traveled assigned routes in a yoked driving study, collecting travel time data for each display mode.

Stage III: Employees of the City of Los Angeles operated the vehicles during their normal commutes and business trips. The evaluation focus was on user perception of the Pathfinder System.

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

Table 3.1 - Summary of The Pathfinder Evaluation: Objectives and Methods

STAGE	OBJECTIVE	METHOD(S)	TIME FRAME
I	Training Technical Human Factors	Natural Use Study	July 1990 - Aug. 1991
II	Benefits User Response	Yoked Study Driver Surveys	Sept. 1991 - Nov. 1991
III	Human Factors User Response	Natural Use Study	April 1992 - June 1992
IV	User Response	Yoked Study	November 1991

User Response

Stages II, III, and IV provide information on user response. Stage II was the most rigorous portion of the evaluation; a yoked study was used to provide trip by trip data. Stage III used volunteer City employees; they provided subjective and human factors evaluations of the Pathfinder System. Stage IV was performed using the same drivers as Stage II put drivers drove to destinations unknown to them. Following is more in-depth description of the Stage II/Stage IV yoked experiment followed by a summary of finding regarding user response presented in the Pathfinder Evaluation Report.

In the yoked study, data was gathered for 8400 trips. Trips were distributed amongst the three modes: Pathfinder mode (providing navigation and traffic information, 34% of trips), map mode (providing only navigation, 32% of trips), and blank mode (control condition, 34% of trips). 42% of trips were long trips (about 10 miles) and the remainder were short trips (about 5 miles). Trips were also distributed by time of day: AM peak 30%, PM peak 30% and mid-day 40%. Drivers in the yoked study were also distributed by age, gender, education level and familiarity with the corridor.

The yoked study provided data for comparing the map mode and Pathfinder mode with a control group. Statistical tests were performed on the results. Two comparisons on the data from the three groups were performed: comparison for all observations, and comparison of data from only the trips where drivers diverted from the intended route. Data was analyzed in terms of the following measures of effectiveness (MOEs).

From trip log data:

- Travel time
- Travel distance
- Travel speed
- Ratio of road distance to straight line distance

From radio database

- Number of stops per minute
- Standard deviation of one minute speeds

Statistical analysis was performed on the data from users using the blank mode, the map mode, and the Pathfinder mode to determine if there were any significant differences in measures of effectiveness between the two groups (the Evaluation Report calls this paired comparisons). Statistical analysis was performed for all data and again using data only from trip where drivers diverted from their usual route. The findings were as follows:

For the general case:

> " Specifically paired comparisons were made for Pathfinder mode vs. Blank mode, Pathfinder mode vs. Map Mode, and Map mode vs. Blank mode. ... This test found no significant difference among display modes for any of the MOEs. "
>
> " Because paired comparisons for the overall trip sample showed no significant results, it was decided to study diverted trips only. "
>
> Pathfinder Evaluation Report
> JHK and Associates

Results for the case of diverting drivers:

Of 54 possible differences[4] between diverted trips in Pathfinder Mode and concurrent trips in Map and Blank Modes, only 5 were found to be significant (Table 3.2). When the data sample excludes trips where drivers got lost only 3 of 54 differences were significant (Table 3.3).

TABLE 3.2 - SIGNIFICANT DIFFERENCES BETWEEN DIVERTED TRIPS IN PATHFINDER MODE AND CONCURRENT TRIPS IN MAP AND BLANK MODES
(SAMPLE INCLUDES TRIPS WITH LOST DRIVERS)

MOE	O/D Pair Category	Time Period	Finding
Travel Time	Long O/D Pair	AM	Map mode < Pathfinder mode
Travel Time	Long O/D Pair	Mid-day	Map mode < Pathfinder mode Blank Mode < Pathfinder mode
Travel Time	Medium O/D Pair	Mid-day	Map mode < Pathfinder mode Blank Mode < Pathfinder mode
Travel Speed	Long O/D Pair	Mid-day	Map mode > Pathfinder mode Blank Mode > Pathfinder mode
Travel Speed	Medium O/D Pair	Mid-day	Map mode > Pathfinder mode Blank Mode > Pathfinder mode

TABLE 3.3 - SIGNIFICANT DIFFERENCES BETWEEN DIVERTED TRIPS IN PATHFINDER MODE AND CONCURRENT TRIPS IN MAP AND BLANK MODES
(SAMPLE EXCLUDES TRIPS WITH LOST DRIVERS)

MOE	O/D Pair Category	Time Period	Finding
Travel Time	Long O/D Pair	AM	Map mode < Pathfinder mode
Travel Speed	Long O/D Pair	Mid-day	Map mode > Pathfinder mode Blank mode > Pathfinder mode
Travel Dist.	Long O/D Pair	PM	Map mode < Pathfinder mode Blank mode < Pathfinder mode

As part of Pathfinder drivers were surveyed regarding their perceptions of the system. This survey provided data on how drivers valued the system and on how Pathfinder could be improved. Results of questions related to user response have been included In figure 3.4.

[4] There are 54 data subgroups as follows:

(6 MOEs) X (3 ORIGIN TO DESTINATION PAIR TYPES) X (3 TIME PERIODS) = 54

Table 3.4 - Survey Responses Regarding User Response

Did Pathfinder save you time during _____ period?		
TIME OF DAY	YES	NO
AM Peak	30%	70%
Mid-Day	34%	66%
PM Peak	32%	68%

Sample size: n=810 responses

Overall with Pathfinder in my car my commute to and from work is:	
Much faster	24%
A little bit faster	40%
About the same	30%
A little bit slower	2%
	96%

Sample size n=96 responses

Pathfinder is more accurate than the traffic reports on my car radio:	
Agree	45%
Disagree	15%
	60%

Sample size n=96 responses

I prefer to receive traffic information from Pathfinder instead of my car radio:	
Agree	45%
Disagree	15%
	60%

Sample size n=96 responses

I would purchase a Pathfinder system for my own car for the price of a car radio:	
Agree	66%
Neutral	15%
Disagree	16%
	98%

Sample size n=96 responses

Appendix F: TravTek

Summary

Features: In-vehicle navigation, route guidance, and real time traffic
Location: Orlando, Florida
Cost: $ 12,000,000
Federal Share: $ 3,000,000
Time Frame: 1990-1994

Project Participants

General Motors -- Partner and Project Manager
American Automobile Assoc. -- Partner, Operated Traveler Information. Center
FHWA -- Partner, Paid for Evaluation and Traffic Management Center
City of Orlando -- Partner, Operated Traffic Management Center
Florida Department of Transportation -- Partner
SAIC -- Evaluation Contractor
Farradyne Systems -- Contractor, Systems Integration

Contacts

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Project Status

Evaluation of User Response: Yes
Evaluation Budget:
Project Status: Data collection complete, full report due 03/94
Results Available: Some preliminary results

Background

TravTek was an operational test in the Orlando Florida area which ran from March 1992 to March 1993. The project used 100 test vehicles supplied by GM. The TravTek system provides the user with navigation, dynamic route guidance, real-time traffic information, services information and a cellular phone link. The operational test was conducted using three different ATIS configurations. The configurations were services information only (control condition), services information, navigation and route guidance with out real time traffic information (static information only), and services, navigation and route guidance with real time traffic information (dynamic information). Results of the evaluation are due to be released in the Spring of 1994. Below is a brief summary of the TravTek evaluation.

Evaluation Objectives

The evaluation of TravTek was designed by the TravTek Evaluation Working Group with representatives of the five partners involved in the decisions. The evaluation was designed to encompass concerns on human factors, marketing issues, system concerns, global IVHS interests, safety issues, and economic questions. The specific objectives are:

- provide field test data on technical feasibility and performance
  (Technical)
- examine driver acceptance and information usability
  (User Response)
- provide subjective and objective measures of benefits to users and society
  (Benefits)
- provide a model for dealing with technical and institutional systems issues facing public sector - private sector partnerships
  (Institutional Issues)

Structure of Evaluation

The TravTek evaluation includes ten separate studies, as follows:

- field study on rental car users, (User Response)
- local users driver study, (User Response)
- yoked driving study, (Network Benefits/User Response)
- Orlando test network study, (Human Factors)
- camera car study, (Human Factors/ Safety)

- debriefing and interviews, (User Response/ Human Factors)
- questionnaire study, (User Response)
- modeling and analysis, (Network Benefits)
- TMC and traffic probe study, (Technical)
- global evaluation.

The field study with rental car users is by far the most extensive of the tests. This test involved 75 of the 100 test units. These cars have been rented through AVIS to AAA members who volunteered to participate in the experiment. Subjects were randomly assigned to one of three groups: the full TravTek system, the navigation and services information and the control group had access to only the services information. The rental study records driver behavior and the usage of the system, using the in-vehicle electronic data log. When used in conjunction with data from interviews and questionnaires the renter study can be used to determine:

- the amount of time savings from a reduction in lost and confused drivers,
- how easy TravTek is to learn,
- what system features are difficult to learn, and
- how much money users would be willing to pay for a similar system.

Through analysis of the vehicle logs, researchers hope to evaluate the incremental benefit associated with the supply of real time traffic information.

The local users study, used approximately 25 of the test units. Cars were lent out to local area high mileage drivers for a few months. Each of the subjects for this test used the system for half the time in the TravTek mode and half the time in the navigation only mode. This study is used to learn how much local drivers are willing to pay for ATIS, the learning effects associated with prolonged ATIS use, and to study driver behavior.

In the yoked driving study, drivers were instructed to drive from one point to another. Three drivers would leave the pre-selected place at the same time and they all drive to the same location. One driver used the TravTek system, one driver used the navigation system and one driver navigated using conventional means. These trips were usually conducted during the peak period. This test provided the opportunity to examine the benefits of the TravTek system, primarily real time traffic information, in more controlled conditions than those provided by the renter, or high mileage driver study. Specifically the study was designed to estimate the effects of peak and off peak

conditions, demographic effects, the driver's ATIS experience, the driver's area familiarity, and the effects of night and day conditions.

The Orlando Test Network Study (OTNS) was designed to evaluate the navigation feature of TravTek from a human factors perspective. Participants were paid to drive a predetermined test route, consisting of three destinations, using three different display configurations. This test allows for different display types to be tested. User preferences and performance were measured for different map displays, guidance screens and voice guidance. The investigation also included the effects of driver age, and night time conditions, on the performance of display configurations.

The Camera Car Study was designed to learn how drivers interact with the system and how the interaction affects their driving. The camera car is equipped with cameras focused on the driver, the driving scene and the outside lane line. The car is also equipped with audio recording capability and the vehicle data log which is part of the TravTek system. The study was planned to use routes similar to the Orlando Test Network Study with drivers using each of the display configurations and voice guidance. Through the use of the camera car the partnership hopes to gain information on how drivers interact with the in vehicle system and how this effects safety.

To compliment data collected from experiments, many TravTek participants have been debriefed and interviewed. Roughly half of renter study subjects have been questioned extensively about their experiences with the TravTek system. Questions related directly the experiment in which the subject was involved, and a series of general questions were asked.

Subjects in all studies were asked to fill out a questionnaire. Three questionnaires were designed, one for the full system group, one for the navigation group, and one for the services group. Questions were asked regarding:

- background information,
- perceptions of the TravTek features
- perceptions of general map functions,
- perceptions of traffic features,
- perceptions of voice functions, and
- overall impressions of TravTek,

The surveys for the navigation and services groups contained a subset of the TravTek group questionnaire.

The modeling and analysis study uses data from the other TravTek studies in order to determine the effects of ATIS with larger market penetrations. The study produces predictions of impacts on network performance and subsequent, environmental, and economic effects of differing market penetrations. The study will also determine the benefits for ATIS equipped drivers and non equipped drivers for different market penetrations. This data will help to determine the public and private benefits of ATIS.

The traffic infrastructure components of TravTek are being studied through the TMC/Traffic Probe Study. The study uses data from questionnaires, the TMC log, and system operator logs. The aim of this study is to address the following issues:

- whether the TravTek system provides credible real-time traffic information,
- if the system covers the entire test area adequately,
- what degree of automation which has been achieved,
- how data was processed through the elements of the system, at the source at the TMC, and in the vehicle,
- what risks are involved with the collection of traffic information, and the operation of the TMC,
- what is the reliability of the system,
- what are the benefits and cost of operating the TMC 24 hours per day.
- what is the ability of the system to adapt to different sources of data, and what is the ease of system replication in other locations

Finally a global evaluation is being conducted using information from all the experiments once they are complete. This evaluation will outline whether the project as a whole met objectives and will compare it to other, similar IVHS demonstration projects. Specific tasks include:

- analysis of how well TravTek met objectives
- evaluation of TravTek as a project
- comparison with other systems around the world, for example Ali-Scout

User Response

Data on user response will come from a number of the TravTek studies including: The two natural use studies (renter and local), the yoked study, the interview study and the questionnaire study. The natural use studies will provide objective user response data from vehicle computer logs and driver diary information. The yoked study will provide information on user response from vehicle computer logs, driver diaries, and human observers. The interview study will provide some data on users' perceptions of the system. Finally the interview study will provide subjective and anecdotal information on users perceptions.

Appendix G: Houston Smart Commuter

Summary

Features: real time traffic and transit information
Location: Houston Texas
Cost: $17,000,000 ($8,600,000 for ATIS portion)
Federal Share: $10,000,000
Time Frame: 1992-1995

Project Participants

Texas State Department of Highways and Public Transportation (SDHPT) – Partner
Metropolitan Transit Authority of Harris County (Houston METRO) -- Partner
Texas Transportation Institute (TTI) -- Partner

Contacts

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Evaluation Contacts:
Katherine F. Turnbull, Texas Transportation Institute

Project Status

Evaluation of User Response: Yes
Evaluation Budget: $3,030,000 ($1,515,000 for ATIS portion)
Project Status: In planning stage
Results Available: None

Background

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 on I-45 from downtown Houston running north. Information will be provided pre-trip via videotex and telephone technologies. The system will provide information on traffic conditions and information on 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 months 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.

Evaluation objectives and an evaluation plan have not yet been drafted.

Appendix H: Genesis

Summary

Features: Real time traffic information. using a personal, portable communications device (PCD)
Location: Minnesota, Twin Cities
Cost: $ 17,400,000 to 36,600,000
Federal Share: $ 3,000,000
Time Frame: 1993-1997

Project Participants

Minnesota Department of Transportation -- Partner
FHWA -- Partner
University of Minnesota Center for Transportation Studies -- Partner
Motorola -- Partner
TRW Inc., Battelle, JHK & Associates, Barrientos and Associates -- System Design
SAIC -- Evaluation Contractor

Contacts

Federal Contact:
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Evaluation Contacts:
Joseph Peters, SAIC
University of Minnesota Human Factors Laboratory

Project Status

Evaluation of User Response: Yes
Evaluation Budget: $2,250,000
Project Status: Preliminary Evaluation Plan Completed, and Evaluation contract awarded
Results Available: None

Background

The Genesis operational test is part of the Minnesota Guidestar IVHS Initiative. Genesis will operate and test the effectiveness of portable digital personal communications devices(PCDs) to provide traveler information. Two types of PCDs will be used: a pager with a small LCD message display, and a personal digital assistant equipped with

two way radio frequency communication. The PCD will provide route specific information to make informed modal, route and rerouting decisions. Although, the exact form of information to be provided by Genesis has not been determined, Genesis may provide the following information:

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

As part of the "Concept Definition and Preliminary System Design" prepared by TRW Inc., Battelle, JHK & Associates and Barrientos and Associates, dated March of 1993. a Preliminary Evaluation Plan was released. In the spring of 1993 the evaluation contract was awarded to SAIC.

Following is a summary of the Preliminary Evaluation Plan. The summary includes the evaluation goals, a summary of the user response evaluation, and the information which is planned to be collected as part of the evaluation. Sections pertaining to user response have been outlined in greater detail.

Evaluation Objectives

The following project goals will be evaluated:

1. Define design and implement the operational test using unique public/private, private/private and public/public partnerships;
   (Institutional Issues)

2. Use the PCD and communication infrastructure to improve transportation performance;
   (Network Benefits)

3. Develop and evaluate the performance of an effective communication infrastructure which effectively and efficiently provides advanced traveler information; (Technical)

4. Evaluate costs and benefits of the operational test; and (Cost/Benefit)

5. Evaluate user acceptance of the PCDs as reflected in attitudes and frequency of use. (User Response)

Evaluation Structure

The evaluation is structured according to seven different data sources. These data sources are:

1. Program Management and Partner Input
2. PCD User's logs
3. Intermediate monitoring surveys
4. Algorithms
6. Automation by Genesis
7. User Questionnaire

User Response

The study of user response has four objectives:

- Assess the PCD users estimates of value.
  [MOE: ($) willing to spend]
- Assess the PCD users estimates of significance, i.e. how useful is the PCD in making the traveler's trip more convenient.
  [MOE: user 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 changes, mode changes, time of departure changes]
- Assess the performance of the following with respect to the user's perception of the operational test:
  1. Traffic information distribution and validity
  2. Incident detection

3. Communications
4. Hardware reliability
5. Software reliability
6. Traveler Safety

In order to address these objectives, data will be collected from PCD logs, user logs and from program management input and partner input. Information collected from PCD user logs will provide data on a number of measures of effectiveness (MOEs). Data collected will include:

- travel times,
- delay,
- number of miles traveled per trip,
- time of departure,
- route selection,
- mode choice,
- fuel usage per week,
- trip purpose,
- accuracy of data received by PCD,
- understand ability of messages received,
- timeliness of data received,
- transportation mode costs (in dollars/day or /week), and
- daily performance of the PCD unit.

Appendix I: SMART Corridor

Summary

Features: ATMS with traffic information by kiosks, telephone, HAR, etc.
Location: Los Angeles, California
Cost: $47,000,000
Federal Share: $1,100,000
Time Frame: 1991-1993

Project Participants

Los Angeles County Transportation Commission, Caltrans, City of Los Angeles Department of Transportation, Culver City, Beverly Hills, Los Angeles Police Department, California Highway Patrol, FHWA -- Sponsors
California PATH -- Evaluation Design

Contacts

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A. Khattak (PATH)
J. Moore/ G. Giuliano (USC)
M. Miller (PATH)

Project Status

Evaluation of User Response: Yes
Evaluation Budget: To Be Determined
Project Status: Draft Evaluation Plan completed, February of 1993
Results Available: Non

Background

SMART Corridor is an ATMS/ATIS Operational Test underway in Los Angeles. The test site is a 12.5 mile corridor including the Santa Monica Freeway (I-10), and several parallel arterial routes. ATMS will use existing ramp metering, existing arterial monitoring and control systems, and expanded use of closed circuit television both along the expressway and along the parallel arterials. Motorist information will be provided through:

- the expanded Changeable Message Signs (CMS) on freeways and arterials,
- Trail-Blazer (detour) signs on arterials,
- Highway Advisory Radio (HAR), and
- Highway Advisory Telephone (HAT).

The purpose of the project is to balance delay across all routes in the corridor, thus minimizing overall delay, using ATMS and ATIS.

Evaluation Objectives

The evaluation of SMART Corridor has five components, and will be undertaken by PATH, USC and UCLA. The five evaluation components are:

1.	Institutional Issues	
2.	Traveler Response	(User Response)
3.	Roadway Performance	(Network Benefits)
4.	Emissions & Energy Impacts	(Environment)
5.	Computer Network Performance	(Technical)

Evaluation Structure

The study of Roadway Performance is designed to investigate the actual changes in delay, throughput and speeds on the freeway and arterials in the SMART Corridor. Specifically the investigation will address the following:

- How effective is the SMART Corridor in balancing the traffic load among the freeway and its neighboring parallel arterials?
- What is the change in average speed on the freeway and arterials?
- What is the change in average delay on the freeway and arterials?
- What is the change in traffic volume throughput on the freeway and arterials?
- To what extent may changes be attributed to either individual or groups of technologies?

The investigation will use counts of volumes crossing screen lines throughout the corridor. From volume counts vehicle miles traveled and vehicle hours traveled will be estimated.

The traveler response component of the study will investigate changes in individual travel patterns. The investigation will include assessment of tangible and intangible

user benefits of ATIS, usage of the ATIS over time, and effectiveness and improvement of ATIS and ATMS. The investigation will utilize a series of traveler surveys to assess awareness of SMART Corridor and use of the system's component's. One broad survey will be distributed before SMART Corridor implementation (tentatively scheduled for October of 1993), and one broad survey will be issued one year later. To complement the two broad surveys a series of three panel surveys will be distributed to a smaller sample at regular intervals. The two broad surveys will be mail surveys and the three panel surveys will be telephone surveys. The panel surveys will allow for in depth analysis over time. Survey recipients for the broad surveys will be determined by recording license plate numbers of vehicles using the corridor. The panel for the panel survey will be selected from respondents to the first broad survey.

The institutional evaluation will document and analyze the organizational arrangements which emerged as necessary to facilitate progress of the project. Agency records will be used in this study.

The emissions and energy impacts assessment will determine the impacts of SMART Corridor on air quality. Information collected on vehicle miles traveled and vehicle hours traveled will be used in conjunction with existing data on automobile emissions to determine impacts on air quality.

Computer network performance evaluation is a technical evaluation to evaluate the effectiveness of the computer system and to recommend improvements. The evaluation will address how well the system detects incidents, and the number of false alarms the system gives. Data from this study will come from agency records and the SMART Corridor surveillance system.

User Response

User response will be investigated using data from the surveys in conjunction with transportation system performance data. The first stage of analysis will be to derive measures of effectiveness. Later multivariate models of behavior, such as discrete choice modeling and structured equations, will be used to explore the effects of several variables simultaneously. These techniques will measure the effects of both individual and combined SMART Corridor technologies to be assessed.