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Public Acceptance and User Response to ATIS Products and Services: Modeling Framework and Data Requirements

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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.

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1. Introduction

1.1 Motivation

Increasing congestion has brought in the need for a more efficient use of existing transportation facilities and services. Benefits to individual travelers and an overall enhanced performance of the transportation system are likely to be attained by the implementation of Advanced Traveler Information Systems (ATIS). ATIS use the latest technology to provide accurate traffic information and navigation aid to travelers, assisting them in their pre-trip and en-route decisions. Therefore, the use of ATIS services has the potential to produce faster, safer trips associated with lower levels of anxiety.

Questions relating to the market for ATIS as well as usage of and response to traffic information have been raised and need to be addressed to ensure an efficient implementation of ATIS and enable a proper evaluation of their benefits. Evaluating potential benefits from and effectiveness of future ATIS strategies and guiding the design of ATIS products and services necessitates a proper understanding of user response to ATIS. However, our knowledge of the potential user reactions to ATIS is quite limited. The above goals can be achieved by developing comprehensive models that capture user behavior in the presence of information and which can provide insights into the following issues:

- what role can ATIS play in alleviating traffic congestion?
- what impact can ATIS have on travelers decisions to alter their trips or change destination?
- what impact can ATIS have on encouraging modal shifts?
- what impact can ATIS have on departure time and parking choices?
- in general, what user and system benefits may be anticipated from various ATIS schemes?
- how much are users willing to pay to gain access to different ATIS services?
- how do users value different ATIS features?

The outcome of this research is presented in 3 volumes. This first volume presents a comprehensive modeling framework for user responses to ATIS services and identifies the data needs for the validation of such a framework. Volume 2 (Koutsopoulos *et al,* 1993a) reviews and evaluates existing travel simulators and data collected through these simulators. Volume 3 (Whitworth, 1993b) reviews operational tests and evaluates behavioral data collected through these tests. Volume 2 and 3 identify the gaps in current data collection methodologies and create the basis upon which this volume was built.

An elaboration of the overall research objectives is presented in the following section.

1.2 Research Objectives

Since ATIS services represent new products, little is known about their market potential and user response. Towards that end, innovative approaches may be needed to model the demand for ATIS and user response coupled with non-conventional data collection approaches through simulators and stated preference surveys, as discussed below. Within this context, the objectives

of the current research are the following:

1. Develop a comprehensive modeling framework of the user response to ATIS products and services. The modeling approach will provide a key input of the investigation of travelers' behavior under the provision of traffic information through ATIS.

2. Determine the data needs that will allow the estimation and validation of the above modeling framework.

3. Evaluate current data collection methodologies based on travel simulators, field experiments, and travel surveys, and propose enhancements to be implemented in order to satisfy the data collection needs.

In the next subsections, we present brief overviews of the framework being proposed to model the various stages in user response to ATIS, the data needs associated with implementing the framework, and the state-of-the-art in modeling such response.

1.3 Framework for ATIS User Response Analysis

The general framework for ATIS user response includes five stages (Figure 1). The first two stages (Awareness and Access) are system decisions, while the third (Usage) and fourth (Travel Response) stages are trip decisions. The fifth stage (Learning) presents a feedback to the system and trip decisions. Next, the various stages will be presented and briefly illustrated by referring to a hypothetical in-vehicle route guidance ATIS service.

System Decisions

Awareness - The awareness of ATIS services relates to the level of knowledge of the existence of ATIS services and their attributes. It is the first stage in the travelers' decision process and helps explain the level of ATIS access adopted by travelers. The likelihood of a traveler being aware of a specific ATIS service depends on his/her travel information needs, the traveler's personality factors, and the sources of information for ATIS services. For the in-vehicle route guidance service, this stage relates to whether and to what extent travelers are aware of such service and the steps they are willing to take to seek more information about system and service attributes.

Access - This stage relates to the decision of travelers to acquire equipment or subscribe to services that permit access to ATIS information systems. The ATIS access decision is based on the travelers' awareness and perceptions about ATIS and on the travelers' willingness to pay for ATIS which depends on their personal characteristics and their usual travel patterns. For instance, this stage in user response would relate to the individual traveler's decision of whether or not to purchase the route guidance system referred to above.

Trip Decisions

Usage - ATIS usage refers to the frequency that ATIS products and services will be used by

travelers. Factors affecting utilization include the quality of the ATIS services provided, traffic and weather conditions, familiarity with the network, and other traveler and trip characteristics. For the route guidance system, this stage refers to the decision by the traveler who had purchased the unit concerning whether or not to consult the system on any specific trip.

Travel Response - The behavioral responses of ATIS users and the extent to which ATIS systems affect travel behavior are associated with the travel response stage of the framework. This stage focuses on the impact of ATIS services on the traveler's choice of various travel dimensions such as destination, departure time, mode, and route. For instance, the traveler who had consulted the route guidance system has to decide at this stage whether to comply with its advice or not.

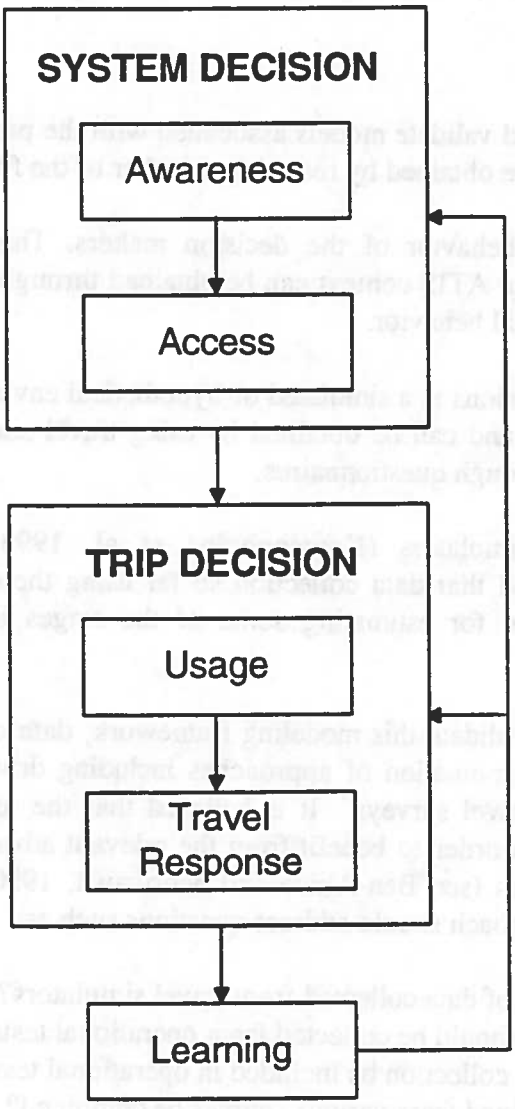

Figure 1: Traveler Decisions in an ATIS Context

Learning - A learning and updating process is expected to take place after each trip. Two types of trip-specific experiences are considered, namely, with regard to travel alternatives and to ATIS services. These experiences will affect both system and trip decisions. Continuing with the illustration, experience with using the route guidance system in repeated trips will have an impact on the traveler's decisions made on his next trips concerning consultation of the system and compliance with its advice. More explicitly, if such experience has been positive and the system has provided reliable advice, the traveler is likely to consult the system more often and to comply in general with its advice. Learning can also impact system decisions in that a negative experience with the route guidance system might result in a decision to seek information regarding alternate ATIS services thereby increasing the level of awareness of these alternatives and possibly leading to a change in the access decision.

1.4 Data Sources

In order to estimate and validate models associated with the proposed framework, reliable data is needed. This data can be obtained by resorting to either of the following approaches:

1. By observing the actual behavior of the decision makers. This data is called Revealed Preferences (RP) data and in an ATIS context can be obtained through field experiments or travel surveys that inquire about actual behavior.

2. By observing travelers' decisions in a simulated or hypothetical environment. This data is called Stated Preferences (SP) data and can be obtained by using travel simulators or inquiring about potential traveler decisions through questionnaires.

Reviews of travel simulators (Koutsopoulos et al, 1993a) and field experiments (Whitworth, 1993b) concluded that data collection so far using these two techniques has been uncoordinated and inadequate for estimating some of the stages included in the framework presented above.

As such, in order to validate this modeling framework, data on user behavior should be carefully collected using a combination of approaches including driving simulator experiments, field operational tests, and travel surveys. It is believed that the usage of data from multiple sources will be appropriate in order to benefit from the relevant advantages of each data source and reduce the relevant biases (see Ben-Akiva and Morikawa, 1990). Research into such an integrated data collection approach should address questions such as:

- What can be expected of data collected from travel simulators?
- What behavioral data should be collected from operational tests?
- How should such data collection be included in operational tests?
- How should data obtained from various sources be combined?

1.5 State-of-the-Art

This section briefly presents an overview of the modeling efforts that have been conducted by various researchers to study travelers' response to information provision (see Appendix A for a full exposition). It is concluded that these studies do not properly address all 5-stages presented above and are mostly limited to modeling only the travelers' trip decisions (ATIS Usage and Travel Response) and the effect of learning on trip decisions.

ATIS Usage

Current efforts have been limited to modeling the pre-trip and en-route information acquisition of radio traffic reports. The data used for the validation of the developed models has been restricted to RP data obtained from travel surveys [see, for example, Polydoropoulou *et al* (1993)].

Travel Response

The bulk of research conducted to date has focused on the ATIS travel response stage. The effect of information on both pre-trip decisions (such as mode, departure time, and route choices) and en-route decisions (such as route diversion and compliance with the provided advice) has been examined. Both RP data (from travel surveys) and SP data (from travel simulators and questionnaires) were used in estimating the models. No modeling effort has resorted yet to data from field tests.

Modeling Pre-Trip Choices - Models of the influence of pre-trip information on travelers' mode choice, departure time, route choice, and frequency of route changes have been developed by different researchers [see, for example, Cascetta and Biggiero (1992); Polak and Jones (1992); Polydoropoulou et al (1993)]. SP and RP data from travel surveys have been used in the model estimation procedures.

Modeling En-Route Choices - Various aspects of en-route traveler behavior in the presence of information have been the subject of modeling efforts [see, for example, Adler et al (1992a,b); Bonsall (1991); Jayakrishnan and Mahmassani (1991); Khattak et al (1992); Lotan and Koutsopoulos (1993)]. Models of travelers' perceptions, route switching behavior, diversion choices, and compliance decisions have been estimated using SP data from travel simulators as well as RP data.

Learning

Existing models try to capture the effects of learning only on the 4th stage of the modeling framework, namely, on the travel response to ATIS. Two different approaches have been used. whereby the first tries to examine the effects of learning on trip-to-trip adjustments while the second examines the updating of travelers' perceptions [see, for example, Cascetta and Biggiero

(1992); Hatcher and Mahmassani (1992); Iida et al (1992)].

1.6 Report Outline

This report represents a first step of an effort to assemble systematic knowledge about ATIS market demand and user response. The advancement of the state of the art of ATIS demand modeling and user behavior would entail model development and data collection efforts which are presented in the remaining chapters of this report.

The report consists of 5 chapters. Chapter 2 presents a modeling framework for travelers' decisions in an ATIS context. Chapter 3 summarizes the data needed to estimate the models proposed in Chapter 2. Chapter 4 provides an overall evaluation of data collection efforts to date though operational tests, travel simulators, and travel surveys and suggests enhancements that would allow the collection of the data needed to estimate and validate the proposed framework. Chapter 5 provides concluding remarks and suggestions for further research.

Appendix A includes a literature review of the modeling efforts that have been conducted by various researchers to study travelers' response to information provision. Appendix B, includes a short presentation of major issues discussed at a workshop hosted at MIT on October 1, 1993. The workshop's objective was to bring together simulator developers and those involved in operational tests to discuss research conducted on user response to ATIS products and services, and to determine the most fruitful direction in which to continue this research. The minutes of the workshop are also included.

2. Comprehensive Modeling Framework for ATIS

In Chapter 1 the need for a comprehensive modeling effort which presents a unified framework of traveler response to ATIS services was identified. The major elements of such a framework are presented in this Chapter. A discussion of data needs and data collection methodologies follows in Chapters 3 and 4, respectively.

2.1 Traveler Decisions in an ATIS Context

Hierarchy: Figure 1 presented the hierarchy of traveler decisions in an ATIS context. This hierarchy involves 5 basic stages: awareness of ATIS services, access to ATIS services, usage of ATIS services, travel response, and learning. ATIS awareness and access are considered to be system decisions, while ATIS usage and travel response can be labeled as trip decisions. After each trip, learning takes place affecting both system and trip decisions.

Time Frame: System decisions are made less frequently than trip decisions. ATIS awareness can be considered to be multi-level state with the individual traveler's level of awareness depending on his/her decisions to seek information about existing ATIS. On the other hand, the frequency of making ATIS access decisions depends on the type of ATIS service being considered. As such, the ATIS access decision may be associated with a vehicle purchase decision which is made every few years (as in the case of in-vehicle ATIS equipment), or may be a decision to subscribe to ATIS services (such as those provided over the phone) with more frequent opportunities for revision. Finally, ATIS usage and travel response are decisions made on a trip-by-trip basis, and as such a traveler might take several such decisions every day. After each trip, learning and updating of perceptions take place based on the experiences derived from system and trip decisions.

2.2 ATIS Awareness

During the first stage of system decisions, a traveler may make conscious decisions to develop an awareness of the availability of ATIS options, the services provided by ATIS (such as traffic information, guidance, etc.), and their attributes. This stage precedes and acts as a filter for the access stage and is very important in modeling travelers' system decisions since it helps define which ATIS systems belong to the travelers' consideration set[1], and contributes in understanding the choices made given the consideration set membership.

The ATIS level of awareness can be considered as the outcome of the travelers' acquisition of information about alternate existing ATIS. The knowledge about an ATIS has several components such as existence of ATIS alternatives, services provided by each alternative (such as congestion levels on alternate routes, incidents, route guidance, or parking information), and attributes of the systems (such as reliability and timeliness or cost of access and cost of usage of services provided).

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[1] For a comprehensive discussion of the influence of consideration sets on consumer decision making and choice, see Shocker et al (1991).

Given the availability of alternate ATIS in a certain area and the existing information sources through which travelers can be informed, the following factors affect travelers' decisions to acquire more information about existing ATIS and their choices among information sources (Figure 2):

Sources of Information

Information about ATIS products and services can be provided by a variety of sources, such as mass-media, (advertisements, magazines, etc.), word-of-mouth, or direct mail (pamphlets). Alternate information services are expected to have varying effects on travelers' level of awareness (detail of information acquired) and their perceptions about ATIS. For instance, it is known that a negative word-of-mouth comment from a friend about a system has much more effect on the travelers' predisposition towards the system than a positive TV commercial (Urban and Star, 1991). Furthermore, the effectiveness of publicity for ATIS depends strongly on the marketing plan for the ATIS services. If little publicity has been made about an existing system, it is less likely that travelers are aware of this system and its attributes.

Travel Information Needs

Depending on their specific travel needs, travelers may be encouraged (or even forced) to look for and investigate the availability of different information sources which may be of help in choosing the appropriate travel pattern for a specific trip. For instance, a commuter's decision to look for an ATIS is influenced by his/her trip time, the variability in trip time, the availability of routing alternatives, and the availability of departure time alternatives (arrival time flexibility). As such, a traveler whose commuting trip is widely variable from trip to trip due to congestion and who has a number of routing alternatives is likely to have higher travel information needs and to seek more actively sources of such information, with a resulting higher potential for awareness of ATIS options. A similar conclusion can be reached for a trip in an unfamiliar area whereby the traveler's information needs are significant.

Individual Characteristics

In addition to the travel information needs, certain personality factors affect the extent to which a traveler actively looks for travel information sources and go a long way towards determining the likelihood of his/her awareness of ATIS services (Kaysi, 1992). For instance, this likelihood is expected to be higher if the traveler is an "information seeker" in general (someone who likes to learn about different products and services) and if he/she interacts a lot with others both at work and socially (awareness by word-of-mouth).

The above factors affect travelers' decisions to increase their level of ATIS awareness and consult some of the available information sources. After consulting such sources, perceptions about ATIS services available in the market and their attributes are updated. Therefore, the level of travelers' ATIS awareness increases, and the consideration set from which the traveler will make his/her access decision gets formed. Following some trip decisions, a traveler might wish to

learn more detailed information about already known or new ATIS and therefore consult other sources of information. This implies a feedback loop from the learning stage (5th stage of our framework). The new information will update the travelers' perceptions about ATIS and increase their level of awareness.

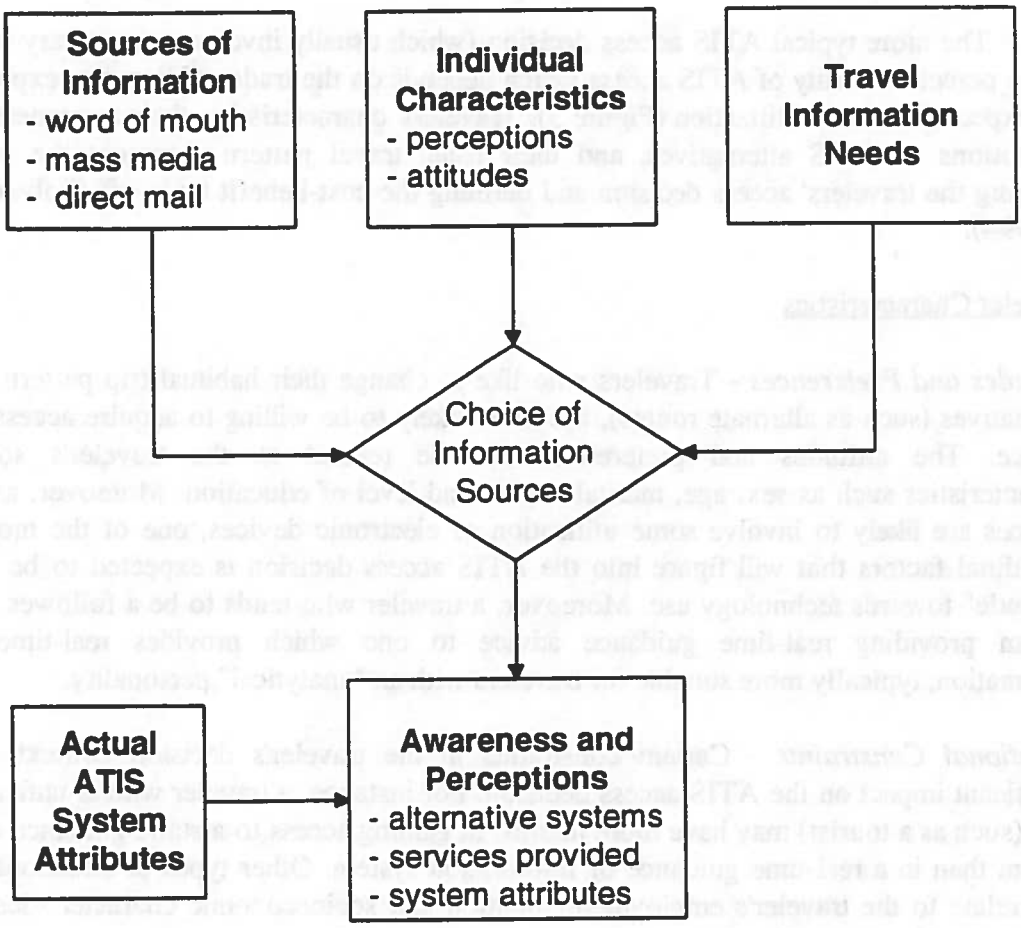

Figure 2: ATIS Awareness

2.3 Access to ATIS Services

From the bundle of ATIS services that travelers are aware of, only the ones that best satisfy their needs and expectations will be included in the consideration set from which the final access decision will be made. After a closer evaluation of the alternatives in the consideration set, and a potential trade-off between attributes of alternatives, a final decision to purchase ATIS equipment or to subscribe to information services will be made. For instance, "willingness to pay" for ATIS services is being incorporated in the evaluation of the SmartTraveler ATIS operational test being conducted in the Boston area (Multisystems, 1993) as well as evaluations of some of

the other tests currently in different areas of the U.S.

It should be noted that some ATIS configurations do not involve a traditional "access decision" such as paying to have the privilege to use the ATIS service. For instance, "access" to radio traffic reports is free and may only involve the act of being familiar with the radio station's frequency and the time traffic reports are provided.

The more typical ATIS access decision (which usually involves a monetary cost) is based on the perceived utility of ATIS access which depends on the trade off between expected benefits and expected costs of utilization (Figure 3). Travelers' characteristics, their awareness and current perceptions of ATIS alternatives, and their usual travel pattern represent the major factors affecting the travelers' access decision and defining the cost-benefit trade-off (Polydoropoulou et al, 1994).

Traveler Characteristics

Attitudes and Preferences - Travelers who like to change their habitual trip pattern and try new alternatives (such as alternate routes), are more likely to be willing to acquire access to an ATIS service. The attitudes and preferences can be related to the traveler's socioeconomic characteristics such as sex, age, marital status, and level of education. Moreover, as most ATIS services are likely to involve some utilization of electronic devices, one of the more important attitudinal factors that will figure into the ATIS access decision is expected to be the travelers "attitude" towards technology use. Moreover, a traveler who tends to be a follower may prefer a system providing real-time guidance advice to one which provides real-time congestion information, typically more suitable for travelers with an "analytical" personality.

Situational Constraints - Certain constraints in the traveler's decision context may have a significant impact on the ATIS access decision. For instance, a traveler who is unfamiliar with an area (such as a tourist) may have more interest in gaining access to a static guidance or navigation system than in a real-time guidance or information system. Other types of situational constraints may relate to the traveler's employment situation and socioeconomic characteristics such as the existence of income constraints.

Awareness and Perceptions about ATIS

The perceptions about ATIS are formed in the awareness stage. As discussed in section 2.2, such perceptions are likely to be influenced by two factors, namely: (1) the source from which the traveler acquired information about the existing ATIS, such as word of mouth, mass media, etc.; and, (2) the actual bundle of services provided by each ATIS and their attributes such as system type, reliability and accuracy, and relevance of information being transmitted. Whether the available system provides static guidance, real-time congestion information, route guidance, business services database, transportation databases (parking or public transit information) goes a long way towards influencing the access decision. Moreover, the availability of information relevant (or at least perceived to be so) to the traveler's typical trip pattern also has an impact to the expected benefit to be derived from accessing an ATIS.

Usual Travel Pattern

The usual travel pattern has a strong impact on the travelers' perceptions regarding the usefulness of an ATIS, as well as the expected level of usage of the system under consideration. The level of usage typically depends on certain attributes of the usual trip pattern adopted by the traveler and which render it likely to benefit from the availability of an information system, such as a commuting trip. The more important attributes include the usual trip time as well as the variability in this trip time. In other words, travelers who have to make longer trips with significant variability in travel time are likely to require more frequent access to ATIS services. Furthermore, the usefulness of an ATIS depends on the flexibility of the existing travel pattern with regard to the availability of routing alternatives (dependent on network), departure time alternatives (dependent on flexibility of arrival time at destination), as well as the availability of destination and modal alternatives or parking services in case ATIS provide relevant information on these choice dimensions. In other words, if several mode, departure time, and routing alternatives exist for the usual travel pattern, it becomes more likely that ATIS services can recommend a travel pattern which improves upon the usual pattern, on a trip-by-trip basis.

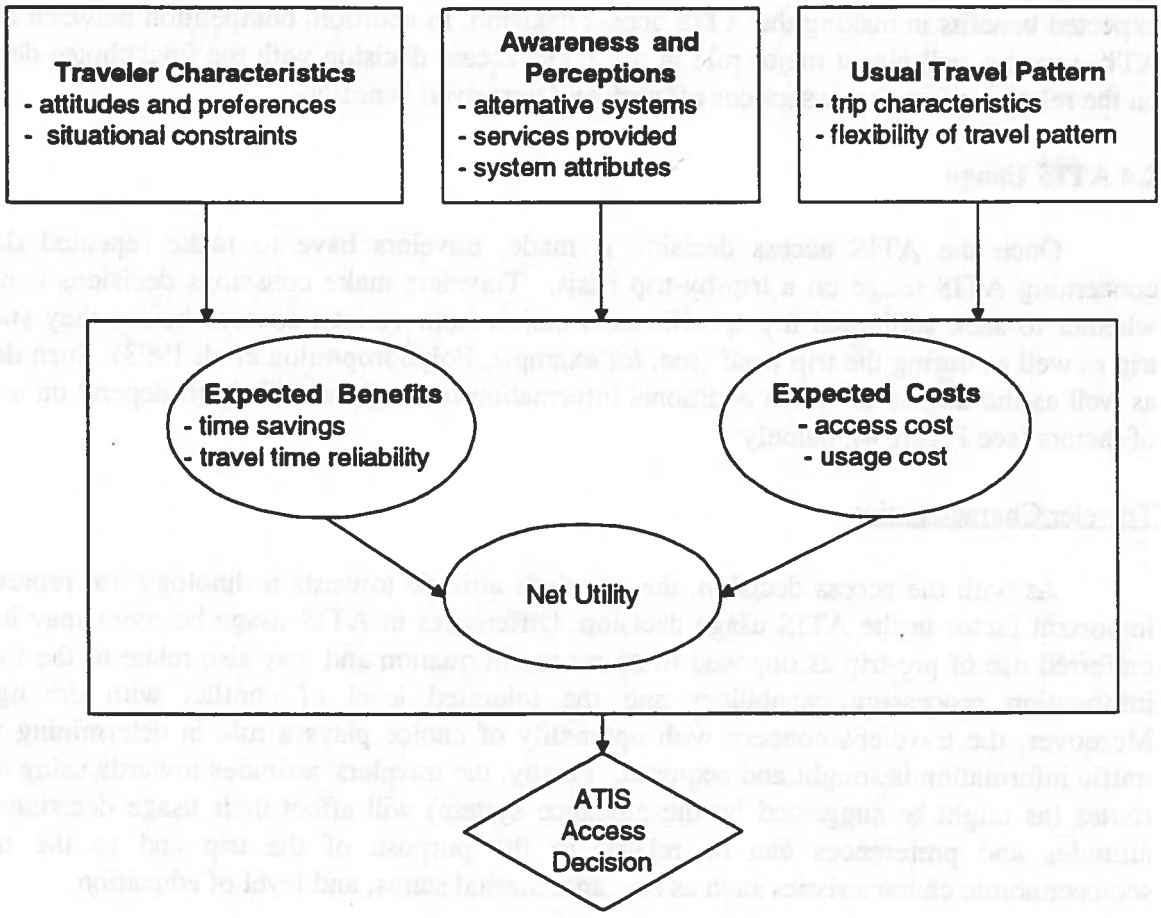

Figure 3: ATIS Access

Expected Benefits and Costs

The factors described above are expected to affect the development of perceptions regarding the potential benefits and costs of alternate ATIS services, as discussed next.

Expected Benefits - Benefits incurred from an ATIS would include travel time savings, trip uncertainty reduction, stress reduction, minimizing delay inconvenience due to incidents, etc.. The perceived benefits to be gained from the usage of an ATIS are very important for the overall decision to obtain access to ATIS services. However, the expected benefits are also a function of the accuracy and reliability of ATIS services. If such services are not successful in providing accurate information regarding the preferred travel alternative on a specific trip, benefits from usage will not materialize. The traveler's perceptions of such ATIS attributes will bear heavily on the decision of whether to purchase access to ATIS services or not.

Expected Costs - The costs affecting the access decisions could be a one-time price which is paid to purchase ATIS equipment or periodic charges for subscribing to ATIS services, or a combination of the two. Obviously, the access costs will be weighed by the traveler against the expected benefits in making the ATIS access decision. In addition, competition between alternate ATIS services will play a major role in the ATIS access decision with the final choice depending on the relative access cost, services offered, and perceived benefits.

2.4 ATIS Usage

Once the ATIS access decision is made, travelers have to make repeated decisions concerning ATIS usage on a trip-by-trip basis. Travelers make conscious decisions concerning whether to seek additional trip-specific information from various sources before they start their trip as well as during the trip itself (see, for example, Polydoropoulou et al, 1993). Such decisions as well as the degree to which additional information is sought are likely to depend on a number of factors (see Figure 4), namely:

Traveler Characteristics

As with the access decision, the traveler's attitude towards technology use represents an important factor in the ATIS usage decision. Differences in ATIS usage behavior may include a preferred use of pre-trip as opposed to en-route information and may also relate to the individual information processing capabilities and the tolerated level of conflict with driving tasks. Moreover, the traveler's concern with optimality of choice plays a role in determining whether traffic information is sought and acquired. Finally, the travelers' attitudes towards using alternate routes (as might be suggested by the guidance system) will affect their usage decisions. These attitudes and preferences can be related to the purpose of the trip and to the traveler's socioeconomic characteristics such as sex, age, marital status, and level of education.

In addition, other traveler characteristics affect the ATIS usage decision. For instance, a

driver who is familiar with the network may not use a guidance system as much as someone who is unfamiliar and is willing to try new routes. A related factor consists of the traveler's experience and familiarity with ATIS systems.

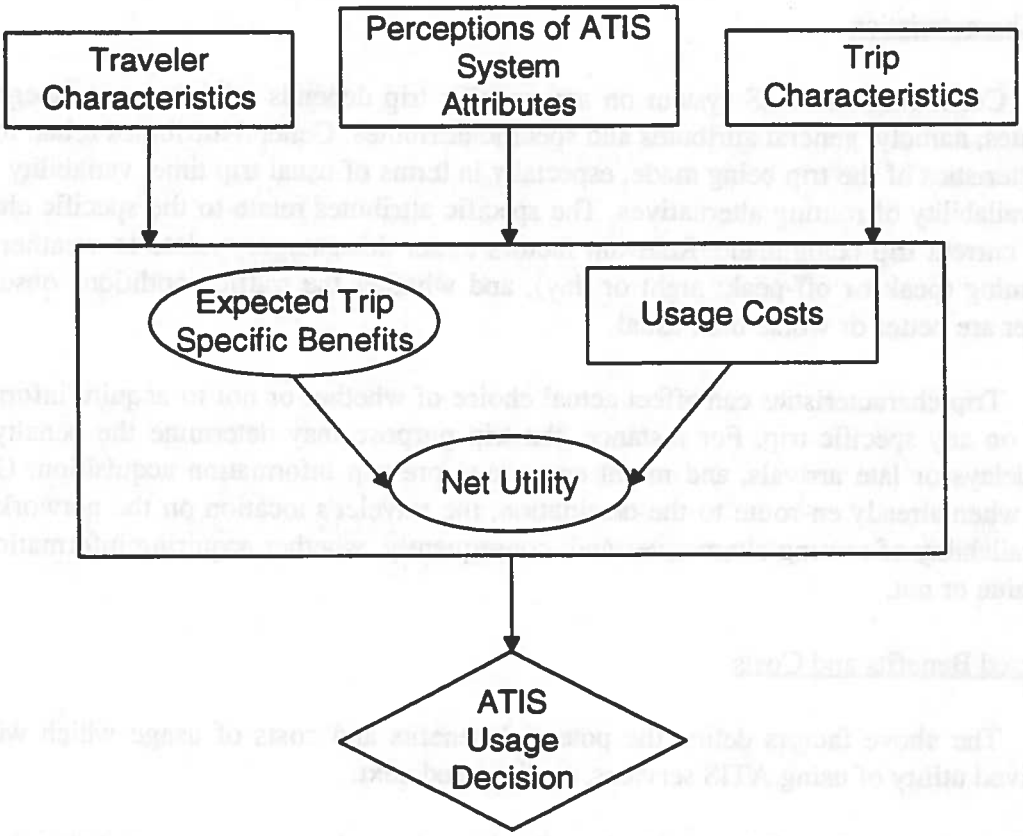

Figure 4: ATIS Usage

ATIS Attributes

Attributes of ATIS services likely to impact usage decisions include the perceived reliability of the information source and, consequently, the perceived value of information in helping to make travel choice as far as increased satisfaction with choice and psychological benefits are concerned. On the other hand, the perceived "costs" of obtaining information in terms of time, effort, money, decision delay, and psychological costs also impact the usage decision. Finally, if more than one information source is available, the specific source that will be consulted is expected to depend on perceived comparative benefits and costs, individual preferences, as well as the stage in the trip-making which may preclude the use of certain ATIS sources.

The (perceived) relevance and reliability of information being provided goes a long way

towards determining whether a usage decision will be made or not. It is also the case that the quality of the last piece of advice from the ATIS (on previous trip, for example) plays a significant role in the usage decision. As such, both long-term and short-term characteristics of the ATIS system, as perceived by the traveler, have an impact.

Trip Characteristics

Consulting an ATIS system on any specific trip depends on two basic categories of trip attributes, namely, general attributes and specific attributes. General attributes relate to the typical characteristics of the trip being made, especially in terms of usual trip time, variability in trip time, and availability of routing alternatives. The specific attributes relate to the specific characteristics of the current trip being made. Relevant factors under this category relate to weather conditions, trip timing (peak or off-peak; night or day), and whether the traffic conditions observed by the traveler are better or worse than usual.

Trip characteristics can affect actual choice of whether or not to acquire information from ATIS on any specific trip. For instance, the trip purpose may determine the penalty associated with delays or late arrivals, and might encourage pre-trip information acquisition. On the other hand, when already en-route to the destination, the traveler's location on the network determines the availability of routing alternatives and, consequently, whether acquiring information will be of any value or not.

Expected Benefits and Costs

The above factors define the potential benefits and costs of usage which will affect the perceived utility of using ATIS services, as discussed next.

Trip-Specific Benefits - Trip-specific benefits depend to a large extent on traveler characteristics, attributes of the ATIS system being used, and trip characteristics. The outcome of the trade-off between these benefits and costs (outlined below), will determine the travelers' decisions of whether to use ATIS for their pre-trip and en-route decision making.

Usage Costs - Certain ATIS configurations are likely to have a dollar cost per usage which will influence the usage decision. Other systems will not have a dollar cost per se, but will involve a certain time expenditure on part on the traveler. For instance, in an in-vehicle route guidance system, the driver will have to key in an intended destination and to observe the small screen or to be interrupted by audio messages to obtain routing advice.

2.5 Travel Response to ATIS

2.5.1 Travel Response Dimensions

The complexity of the potential travel responses to ATIS usage relates to the fact that such responses may include decisions related to whether to travel as well as destination, mode, departure time, route, and parking choices associated with the intended trip pattern [see, for

example, Bonsall (1991) and Lotan (1992)]. The exact choice dimensions open to a traveler depend on the phase in the trip process as well as the choice context (such as availability of modal alternatives). Next we discuss potential travel response in each of the pre-trip and en-route phases.

2.5.2 Travel Response Phases

Figure 5 describes the general framework of pre-trip and en-route ATIS usage and travel response [Kaysi (1992); Polydoropoulou (1993)].

Pre-Trip Phase

Before starting each trip a traveler decides whether or not to acquire information about the traffic conditions. Based on this information, travelers may decide not to travel, to choose a different destination, or may adjust their scheduled departure time, mode, route, and parking choices accordingly. If drivers decide not to acquire pre-trip information, they will rely on their historical perceptions and experiences and will therefore start their trip following the habitual route.

En-Route Phase

If en-route traffic information is acquired, travelers process this information according to their personal characteristics, attitudes and preferences, as well as the characteristics of the information provided to them. Travelers might then choose not to respond to the information or not to comply with the advice and follow their preselected pattern. Other choices open to travelers acquiring en-route information include route diversion and switching destination, mode, and/or parking choices.

2.5.3 Factors Determining Travel Response

Different factors which are likely to affect travel responses to ATIS were identified in research efforts conducted by various researchers [Adler et al (1992), Cascetta and Biggiero (1992), Jayakrishnan and Mahmassani (1991), Khattak et al (1992), Lotan and Koutsopoulos (1993), Polak and Jones (1992)]. These factors include the following:

ATIS Characteristics

Certain attributes of the consulted information system are significant as far as the travel response is concerned. The relevance of the obtained information to the planned trip, the indicated traffic conditions on alternative travel patterns (better or worse than usual), the reliability of the information source, and the quality of recent information provided by the ATIS service being used all have an impact on the traveler's response. The trip-specific information credibility depends on the existence of conflicting or corroborating evidence based on the traveler's own observations and the conditions indicated by the ATIS.

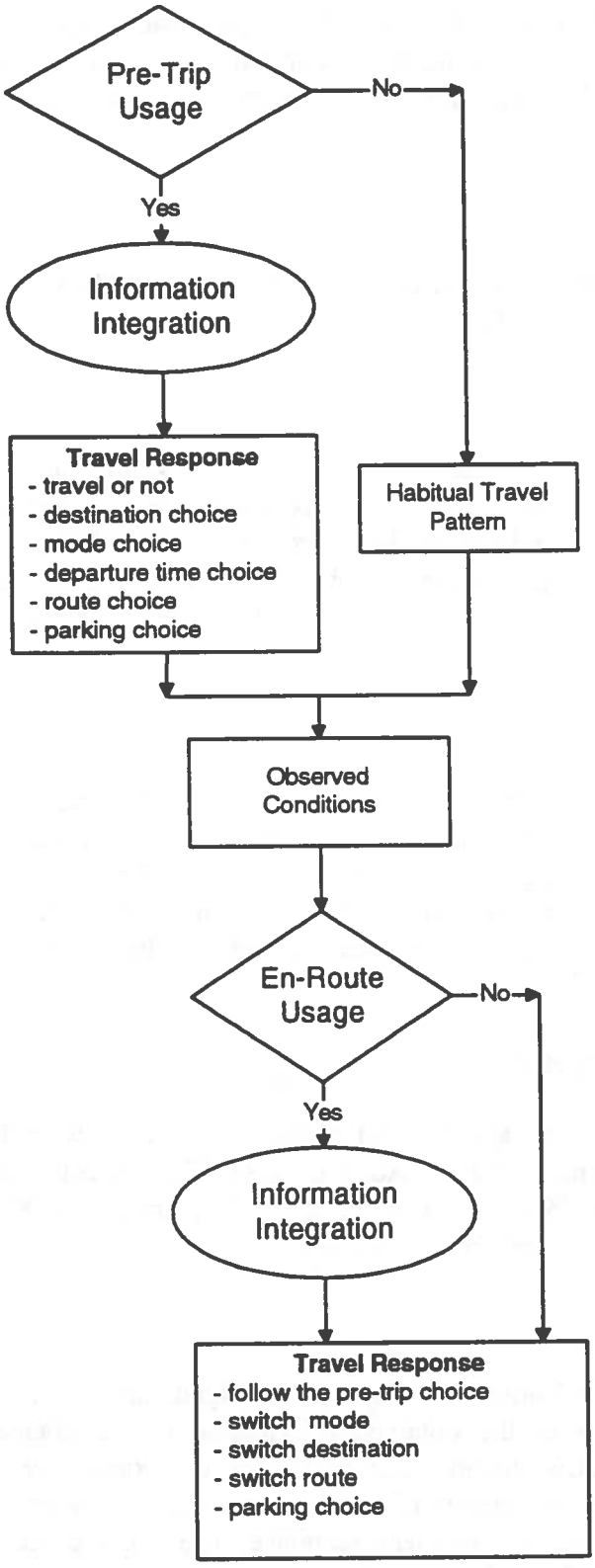

Figure 5: ATIS Usage and Travel Response

Traveler Characteristics

The choice of travel pattern depends on certain traveler characteristics including socioeconomic factors, personality factors, as well as an array of traveler attitudes and preferences. For instance, the traveler's previous route choice and the importance of choice inertia or habit in his/her decision-making process represent one such factor. Again, the traveler's attitude towards using alternate routes (as might be suggested by the ATIS service) will affect his/her compliance with the advice. This attitude can be related to the traveler's socioeconomic characteristics such as sex, age, marital status, and level of education. The travelers' familiarity with the network . The en-route response to information being provided by ATIS services will also depend on traveler attitudes towards route switching, risk of delay, and their bias level towards certain travel patterns such as freeway driving. Finally, the traveler network familiarity and experience with expected delays on alternate routes play important roles in determining the changes in the habitual travel pattern which may take place in response to the information provided.

Trip-Specific Characteristics

The response to ATIS advice could also be related to constraints imposed by specific trip characteristics such as the advice timing as it relates to the current trip. For instance, if advice is provided when the driver is already close to his/her destination, he/she would have a better ability to discriminate the quality of the advice and have a more informed travel response. Other constraints relate to whether the traveler was planning to make any stops on the intended route in which case he/she might not be able to switch to a suggested route in response to ATIS advice.

2.5.4 Choice Set Revision and Information Processing

Choice Set Revision

The choice set of travel patterns for a traveler includes all alternative patterns which are both feasible to the traveler and known during the choice process. One of the immediate impacts of information availability through ATIS services manifests itself in the revision of the choice set for travel patterns (Bovy and Stern, 1990; Kaysi, 1992). The formation of the choice set is usually dependent on individual characteristics as well as information attributes. Under the first category we have the individual's ability to process information, his/her expectation levels, and his/her choice inertia or habit. For instance, a traveler who has a strong inclination towards following a habitual route might not include an alternative route suggested by ATIS in his choice set. On the other hand, information attributes affecting choice set revision include informational constraints (learning under time and space restrictions), search costs, and existence and format of informational aids. In other words, a traveler is likely to revise his choice set and consider additional alternatives more easily if information on the existence of such alternatives is easy to obtain through ATIS with simplified user interfaces.

Information Processing

Although additional information is likely to have an impact on travel response, it should be kept in mind that travelers are characterized by having a limited processing capacity which leads many of them to use heuristics and other techniques to simplify their travel decision making. Therefore, the amount and complexity of information processing which travelers might be able to perform is not to be overestimated. In addition, the format in which driver information is presented influences the information processing (and acquisition) tasks performed by drivers.

Finally, individual differences in processing abilities as well as prior experiences play an important role in determining driver response to information (Kaysi, 1992; Van der Mede and Van Berkum, 1991). For example, some drivers may decide to acquire pre-trip information only since they can not perform en-route processing of information.

2.6 Learning

2.6.1 Learning Dimensions

Each trip made will enrich the travelers' experiences and perceptions regarding traffic conditions and the reliability and relevance of information provided by ATIS. Ben-Akiva et al (1991) proposed a framework for traveler trip choices and emphasized how such choices are influenced by historical perceptions as well as the provision of traffic information. The process through which perceptions are revised and learning takes place is also outlined. Next, trip and system learning aspects are briefly discussed.

Trip Conditions

After a specific travel pattern is adopted for a certain trip, the experienced travel time or cost is compared with the average or usual time or cost. The output from this comparison may be viewed as a "label" attached by the traveler to his/her short-term perceptions of that specific pattern. These short-term perceptions may simply indicate that the experienced travel pattern was worse than usual, as usual, or better than usual. These short term perceptions are expected to impact the short-term decision making process, and specifically the pattern chosen on the next trip. Obviously, some longer-term perceptions of the trip pattern would also affect the next choice and are also updated by experiences through a mechanism which is more complex than what is described above as it considers multiple experiences.

ATIS Reliability and Relevance

The content of the information provided and the actual travel response of the individuals play an important role in the development of perceptions related to ATIS usefulness. The discrepancies/agreement between the ATIS advice and the experienced traffic conditions (or travel times) will also affect the level of confidence on ATIS information.

2.6.2 Feedback to Trip and System Decisions

In general, the feedback from learning affects both system decisions and trip-to-trip decisions.

System Decisions

ATIS Awareness - After each trip made travelers update their perceptions about the traffic conditions encountered in their journey and the usefulness of ATIS. Based on the updated travel perceptions and actual level of ATIS awareness, the traveler might decide to acquire more information about existing systems and services (Figure 6)

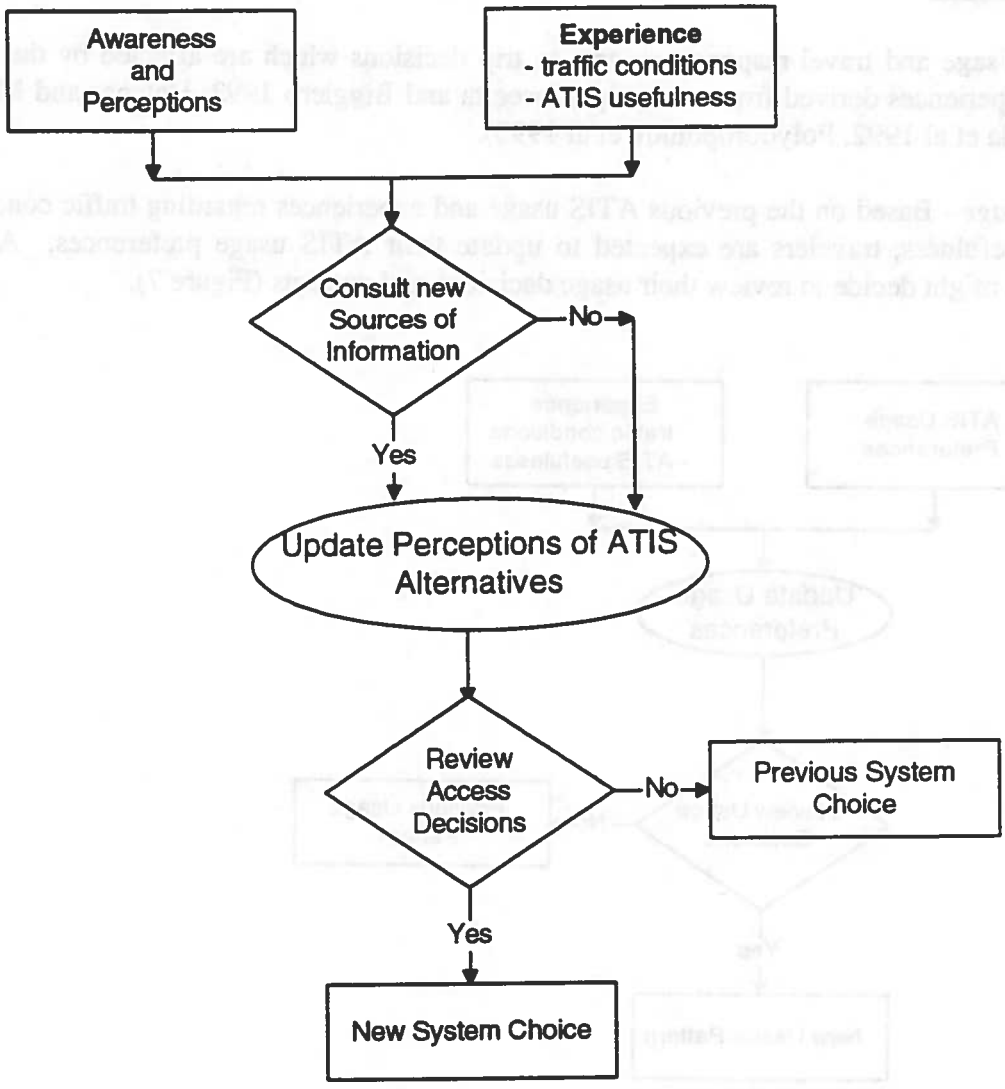

Figure 6: Effects of Learning on System Decisions

Consider the case where the experienced traffic conditions encountered are so bad that travelers decide to update their awareness about new ATIS that could provide them with useful information and assist them in their trips. Travelers might then decide to consult new sources of information and update their knowledge of ATIS alternatives. After updating their knowledge about ATIS services and attributes, travelers are expected to revise their consideration set.

ATIS Access - Once travelers revise their ATIS consideration set, they might decide to review their access decisions, and if they do so, they might come up with a new system choice (Figure 6). Otherwise, they will rely on the existing system choice.

Trip Decisions

Usage and travel response are trip to trip decisions which are affected by the travel and ATIS experiences derived from each trip (Cascetta and Biggiero 1992, Hatcher and Mahmassani 1992, Iida et al 1992, Polydoropoulou et al 1993).

ATIS Usage - Based on the previous ATIS usage and experiences regarding traffic conditions and ATIS usefulness, travelers are expected to update their ATIS usage preferences. As a result, travelers might decide to review their usage decisions and patterns (Figure 7).

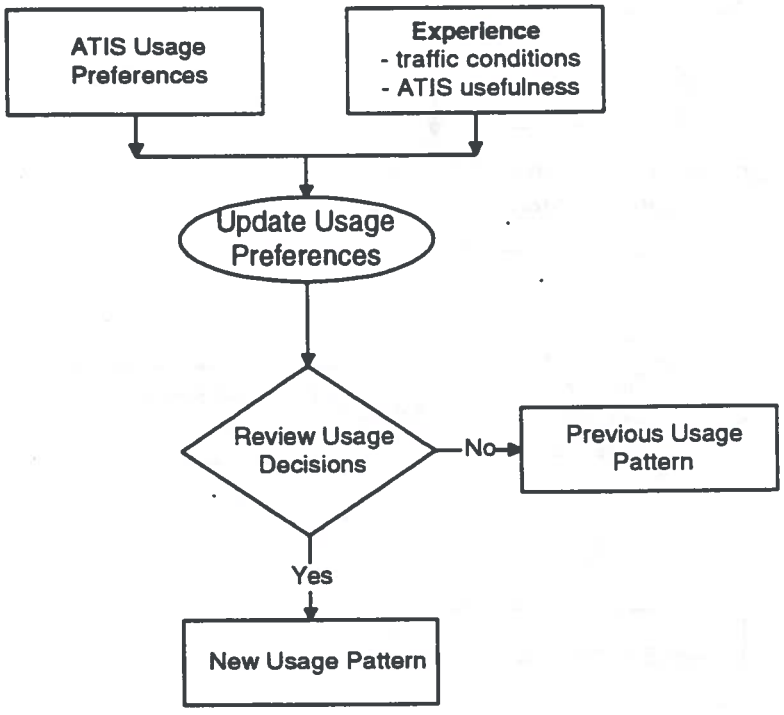

Figure 7: Effects of Learning on Usage Decisions

Travel Response - One way of looking at the effect of learning on the choice of travel pattern in response to traffic information is to consider the decision of whether or not to revise the previously chosen trip pattern (may be the "habitual" pattern) (see Figure 8). Every traveler has experiences with travel conditions on the alternative trip patterns he/she may choose to perform his/her typical trip. In the case of repetitive travel-making, a basic force behind a revision decision is a departure of travel conditions from expectations or experiences. It is expected that if the travel time experienced on the previous day had been significantly higher than the average experienced travel time for that alternative, the traveler will be unsatisfied with his/her previous day choice and will perceive a potential for high benefits if he/she revises that choice.

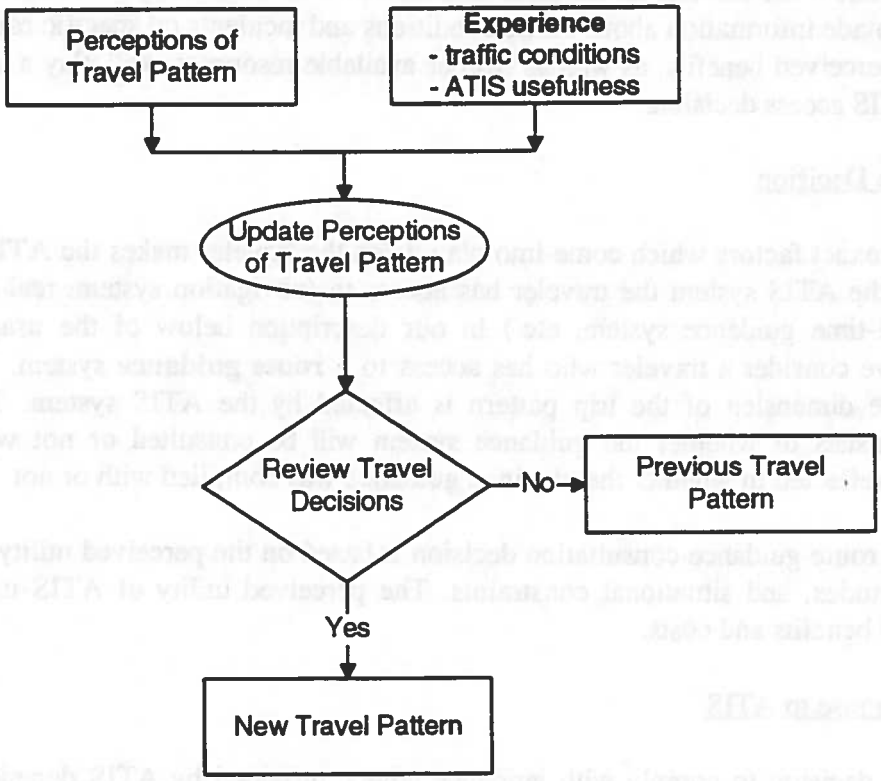

Figure 8: Effects of Learning on Travel Decisions

The decision to revise the travel pattern is also likely to depend on the traveler's attitude towards trying new alternatives. For instance, if a traveler's attitude inclines him strongly against trying new alternatives and towards adhering to his/her habitual travel choices, this factor will always involve negative perceived benefits from revising the travel pattern. Other causes for revisions may be what is referred to as "incidental learning" leading to the existence of conflicting pieces of information. In such cases, travelers have to decide whether current travel choices still make sense or must be revised.

2.7 Illustration

ATIS Access Decision

Consider the case of a traveler who considers purchasing a route-guidance system or to subscribe to a telephone service that provides traffic information. In the first case the access cost is high, but a larger bundle of services are provided to the traveler (such as next link to follow recommendations, map with alternative routes, congestion levels on the network, etc.), and no usage cost is required. In the second case, the cost of accessing the service is relatively low (subscription fee), usage costs are required (telephone call cost) as well as a potential purchase of a cellular phone if the traveler is willing to acquire en-route information. Furthermore, this service can only provide information about traffic conditions and incidents on specific routes. The traveler needs and perceived benefits, as well as his/her available resources, will play a significant role in the final ATIS access decision.

ATIS Usage Decision

The exact factors which come into play when the traveler makes the ATIS usage decision depend on the ATIS system the traveler has access to (navigation system, real-time information system, real-time guidance system, etc.) In our description below of the usage and response decisions, we consider a traveler who has access to a **route guidance** system. That is, only the route choice dimension of the trip pattern is affected by the ATIS system. The ATIS usage decision consists of whether the guidance system will be consulted or not while the traveler response is reflected in whether the obtained guidance was complied with or not.

The route guidance consultation decision is based on the perceived utility of ATIS advice, traveler attitudes, and situational constraints. The perceived utility of ATIS usage depends on trip-specific benefits and costs.

Travel Response to ATIS

The decision to comply with guidance advice provided by ATIS depends mainly on the perceived benefits from compliance, on traveler attitudes and preferences, and on situational constraints. The perceived benefits are a function of the credibility of the advice (both general and trip-specific) as well as the traveler's experience with traffic conditions on alternate routes.

However, the utility maximization rule described above, might not always take place. Experience using route guidance systems have shown that travelers, in relation to the manner in which they utilize ATIS services, can be classified into the following four categories: do not utilize at all, consult conditionally, consult regularly but follow selectively, and accept unconditionally (Polydoropoulou, 1990). By relating the usage pattern characteristic of each traveler to trip and information attributes as well as traveler characteristics, attitudes, and preferences, it becomes possible to predict the usage patterns associated with potential ATIS services and to tune these services in a way that encourages certain usage patterns.

Other scenarios of information provision lead to different models of the en-route response. Suppose that travelers receive en-route information regarding the remaining travel time on their current route as well as on their best alternative route. The travel time improvement offered by the alternate route would represent an important factor in the diversion decision. A diversion model may then relate the utility of the decision to divert to the improvement in travel time due to diversion relative to the remaining travel time on current route, the perceived reliability of information system providing guidance, the driver's attitude towards trying new alternatives, and other factors. That is, if the relative improvement is high, the driver will perceive that significant benefits are likely to materialize if he/she diverts. On the other hand, if the traveler distrusts the system, the factor related to the information system reliability will have the effect of substantially reducing the perceived benefits from a diversion. In such a case, the driver may not divert unless the reported benefits are quite substantial.

Learning

Referring again to the case of a route guidance system, the guidance provided on a certain trip may be evaluated by the traveler based on the experience he/she had while complying (or not complying) with the advice in terms of the discrepancy between acquired guidance and observed traffic conditions. The evaluation will lead to a short-term labeling of the guidance system as either reliable or unreliable. In some cases, the label could be "no opinion" if the travel experience did not afford the chance to evaluate the guidance quality. Again, the short term labels are likely to impact the next decision(s) concerning acquiring guidance as well as complying with it. A similar but more complicated process exists in the case of long term updating of perceptions regarding the guidance systems.

3. Data Needs

In order to estimate the proposed models dealing with traveler behavior in the context of ATIS services, extensive data is required.

The decision time frame of the 5 modeling stages should be carefully considered when addressing the data needs. ATIS awareness and access are longer term decisions of the travelers. However, data collection for the ATIS usage, the traveler response and the updating of perceptions involve data from trip-to-trip or daily behavior. Therefore, the data needs differ significantly from traditional efforts for two reasons:

1. No data has ever been obtained to model ATIS awareness and access decisions.
2. The data needs for the modeling of ATIS usage, travel response and updating perceptions and experiences, focus on the *dynamic* travel behavior dictating multiple observations over time.

Moreover, in order to capture the general environment within which each traveler makes his decisions, data relevant to the travelers' characteristics, trip and network characteristics, as well as the information characteristics is needed.

3.1 Dependent Variables

System Decisions

In order to model ATIS awareness it is necessary to identify whether individual travelers are aware of ATIS and to monitor and record actions through which they implement decisions to acquire information regarding alternate ATIS services. As far as access to ATIS services is concerned, data should be obtained regarding purchase/subscribe decisions which are made by travelers.

Trip Decisions

The information needed for modeling the ATIS usage decision includes when (pre-trip or en-route) and what type of ATIS information is requested (time schedules of alternate modes, traffic conditions on alternate routes, information provided at each intersection, navigation aid, etc.). On the other hand, data needed to monitor the travel response decision include destination, mode choice (alternate modes under consideration and final choice of mode), departure time choice, route choice decisions (preferably at each intersection), and parking choice.

Learning

To investigate the effect of experience on learning by and updating of traveler perceptions, post-trip evaluations about the traffic conditions encountered and the usefulness of information are needed. This information will be compared with the actual traffic conditions and the reliability and relevance of information provided in order to better understand the differences between

perceived and actual situations. Information regarding travelers' perceptions about chosen modes, routes taken and information usefulness at the end of each trip, provides the basis to investigate how the travelers' perceptions and preferences are updated after each trip made. Furthermore, there is a need to question drivers about their experienced travel time on their chosen travel pattern at the end of each trip. This will help identify the impact of travel experiences on subsequent travel decisions.

3.2 Explanatory Variables

Explanatory data relate to traveler, information system, trip, and transportation system characteristics. Data associated with each of these categories may be either general or trip-specific data. While trip-specific data changes from trip to trip, general data relate to longer-term attributes of the traveler, information system, or transportation system. Data associated with system decisions falls under the "general data" category whereas factors affecting trip decisions may fall under either the "general" or "trip-specific" category.

3.2.1. General Data

Traveler Characteristics

A. Socioeconomic characteristics, such as age, gender, income, education, marital status and profession.

B. Cognition, of *transportation network*, such as familiarity with alternative modes and routes (known and used alternatives), traffic conditions on alternate routes. This data collection should refer to a typical trip (working, shopping and recreational).

C. Stated attitudes, perceptions and preferences, towards:

- *Travel decisions*, such as importance given to alternate factors for mode, departure time and route choice, i.e. risk of delay, preferences of using alternate routes, habit following, etc.
- *Traffic information*, such as perceived importance, reliability and relevance of traffic information, ATIS access decisions and use of technology (when and where).

Information System Characteristics

Alternate ATIS are expected to have different effects on travelers' behavior. The following is a list of data related to actual characteristics of ATIS, that should be collected:

- ATIS availability, such as highway advisory radio, radio traffic reports, VMS, in-vehicle information, in-vehicle guidance
- type of information provided, such as static vs. dynamic; qualitative vs. quantitative; prescriptive vs. descriptive
- format and user interface (maps; messages; with explanation)
- price: access costs, costs per usage

- accuracy and reliability of information provided factors that depend on update frequency, level of detail of network representation, etc.
- source of learning about ATIS (advertisements, etc.)

Trip and Transportation System Characteristics

Travel related characteristics that should be collected are the following:

- usual travel times and costs on alternate modes and routes, variability of travel times
- usual traffic conditions on alternate routes:
- availability of routing alternatives depending on network structure
- availability of departure time alternatives/flexibility in arrival time for alternate trip purposes

The revealed discrepancies between travelers cognition/perceptions of transportation facilities and ATIS attributes and actual situations/characteristics, are expected to provide a further insight in travelers' decision making.

3.2.2 Trip Specific Data

In order to capture the dynamic character of travelers' decision making it is important to collect trip-to-trip data. Since at the end of the trip each traveler reevaluates his/her decisions, for each specific trip the following data should be collected:

Trip and Transportation System Characteristics

Trip data includes flexibility of departure time and known and preferred number of alternative routes, trip purpose (e.g. commuting, tourist, etc.), stops made en-route, peak vs. off-peak travel, weather conditions, and day vs. night.

Network characteristics such as actual traffic conditions, link travel times and incidents occurred should be collected. etc. The collection of information regarding *actual* traffic conditions experienced by drivers during their trips is necessary since it provides a means of understanding how observed traffic conditions impact travel decisions and how they are weighed against information provided by ATIS services, in case of conflict. However, this data may be difficult to get hold of at the present time since the technology is not yet in place to monitor traffic conditions continuously on a large scale basis. This could leave one with the inferior option of relying on travel times as reported by drivers themselves, and the analyst would have to take into account the potential problems with these values (bias, cognitive dissonance). However, an indirect measure of traffic conditions, that could be used is the actual velocity of the vehicle, between each intersection. Moreover, accidents occurrence and clearance times should also be recorded, in order to be able to test the reliability of the information provided. In this case the advantage of conducting driving simulator experiments, instead of field experiments is that traffic conditions, link travel times and incidents are controlled by the researcher.

Information System Characteristics

The following information should be collected:

- Where and when was information provided?
- What was the content of information provided (indicated traffic conditions, guidance advice, etc.)?

The collection of the above information allows the testing of the relevance, reliability and timeliness of the information provided through ATIS, based on the discrepancies/agreement of the content of information provided and the actual traffic conditions.

The sources of information available to the driver and which should be monitored include trip-specific pre-trip information or guidance as well as trip-specific en-route information. If a survey is to be conducted to obtain such information, it should include explicit questions concerning the traveler's access to such information sources, whether the sources were consulted (i.e. ATIS usage decisions), and the specific information that was relayed by these sources.

Under some information provision technologies, it may be possible to keep track of the information that was relayed to drivers in which case it would not be necessary to question drivers concerning information received. This would be desirable since a possible source of error due to incorrect reporting by drivers of information received would be eliminated. Such data could be obtained from demonstration projects or travel simulators.

4. Evaluation of and Proposed Enhancements to Data Collection Methodologies

In this chapter data from: 1) travel surveys, 2) travel simulators, and 3) field experiments are discussed. The discussion regarding travel simulator data and field experiments is based on two reports (named Volume 2 and 3, respectively) that are briefly described below.

Volume 2 (Koutsopoulos *et al*, 1993a) reviews existing travel simulators and provides an overall evaluation of the use of such simulators to obtain data on traveler response to ATIS. The report focuses on the objectives and primary uses of simulators, the experience to date with data collected by simulators, associated model development, and the biases introduced by the travel simulator design and the form of conducted experiments. Volume 3 (Whitworth, 1993b) reviews IVHS operational tests and provides an overall evaluation of behavioral data which may be obtained from such tests.

A discussion of how the three data sources address specific data requirements for each of the five stages of user response to ATIS is presented below. The discussion involves awareness, access, usage, travel response, and learning as well as important components of these categories. Usage includes a discussion of pre-trip and en-route usage. Travel response includes a discussion of changes of departure time, changes of mode, and route choice. Finally, learning has been divided into trip-to-trip learning and long term learning regarding access choices (referred to as system learning).

Section 4.1 presents an overview of the three data sources. The following three sections present and provide an assessment of current data collection efforts, and suggest enhancements for each of the three data collection sources. Finally, section 4.4 proposes an integrated data collection effort which is intended to support the modeling framework presented in Chapter 2.

4.1 Data Sources

Revealed Preferences Data (RP) and Stated Preferences Data (SP) are the two types of data that can be collected in order to study travelers' response to ATIS products and services. RP data represents the actual behavior of travelers and can be obtained through travel surveys and field experiments. SP data represents the behavior of the travelers in hypothetical situations. Such data can be obtained through stated preferences surveys and travel simulators.

Travel Surveys

Surveys represent the traditional and easiest method of obtaining data regarding travelers' behavior. Both RP and SP data can be obtained through travel surveys. RP data can be obtained through travel diaries or logs that are filled over a number of days. Such data can help understand how travelers modify their behavior with time in response to specific experiences and information acquisition. Surveys may also be used to collect SP data which indicates the drivers' weighing of various choice factors. The power of stated preference data lies in its ability

to provide insights into new alternatives which have not been implemented yet, as well as potential driver choices in cases for which revealed preference data is limited.

Travel simulators

Data obtained from travel simulators is SP data and indicates how drivers behave in hypothetical scenarios. A number of recent studies have focused on the use of travel simulators to analyze driver behavior under various scenarios of information provision. These studies put travelers in simulated travel circumstances and observe their reactions and travel behavior. The simulator would "observe" driver decisions and store such information for later analysis. Simulators enable the creation of a wide range of travel situations under laboratory conditions (controlled environment) and the collection of relatively inexpensive data.

Field Experiments

In field experiments travelers use actual ATIS when making their travel decisions. RP data is collected by observing travel decisions taken by individuals in their normal daily lives. This is the most expensive data collection methodology but provides more reliable data than the SP experiments.

4.2 Travel Surveys

This section presents a brief evaluation of data collected through existing travel surveys and a discussion of the possible enhancements that could be introduced in order to collect data with minimum possible bias while addressing the 5 modeling stages of the framework presented in this study.

4.2.1 Data Collected from Existing Travel Surveys

In addition to the more typical uses of surveys to collect information about respondents' socioeconomic background and choice context, surveys used to collect data on user response to ATIS can be broken down into two main categories according to the target population.

A. General Traveler Population Surveys

This first category includes surveys which target the general traveler population and which focus on the following two objectives:

1. *To capture user response to commercially available traffic information services.* All surveys conducted so far and falling in this domain have only addressed the acquisition of radio traffic reports and the influence of such information on drivers' route choice behavior (Khattak *et al*, 1991; Mahmassani *et al,* 1989 and 1991). Some surveys have asked interviewees to recall an incident induced travel delay and the effect of information on their route choice decisions while others have obtained detailed diaries of daily trip behavior and information acquisition and usage for a designated period of time. The latter type of surveys consisted of identical questionnaires

to be filled in subsequent weekdays, with each questionnaire being related to that day's commuting trip. The questions asked related to pre-trip and en-route traffic information acquisition, their influence on the travelers' decisions, and the updating of perceptions for system and trip characteristics. A prototypical survey of this type was conducted at MIT in 1991 (see Kaysi 1992 and Lotan 1992 for survey design considerations and Polydoropoulou *et al,* 1993 for data analysis and modeling using survey data). Other surveys have focused on the influence of transit schedule and parking information on travelers' decisions. In all cases, no data on the access decision may be obtained as such simple traffic information services do not pose a typical purchase/no purchase situation since no monetary cost is involved.

2. *To address user response to unimplemented ATIS services.* In the case of unimplemented ATIS services, the survey has to be restricted to the user response dimension of access and some of the trip decisions. Polydoropoulou (1993b) conducted a pilot survey to investigate the willingness to pay for ATIS. Respondents were set in a hypothetical situation where alternate ATIS are available. They were presented with different scenarios with two alternative ATIS: a route guidance system and a telephone service. Six major attributes of the ATIS were evaluated: price, method of payment (purchase vs. usage charges), accuracy of information provided, portability of route guidance systems, provision of traffic information such as bus and train schedules and availability of parking at destination. Respondents were asked to choose their preferred system and to state the likelihood of acquisition and usage of the system. A nationwide ATIS-related survey was conducted at University of Washington (Ng *et al*, 1993). The sample population was subdivided into 3 categories: 1) private motorists, 2) commercial drivers, and 3) commercial system operators. The questions relate to the travel characteristics of travelers as well as their willingness to use ATIS and their willingness to pay for such a system. Khattak *et al* (1993) conducted a large scale commuters mail back survey, to identify auto commuters' propensity to switch to public transportation when a pre-trip ATIS device is available.

However, in such surveys, questions related to willingness to pay for traffic information are usually vague since no actual ATIS system is referenced. This fact could introduce bias to the data collected due to lack of familiarity with the ATIS service in question and/or due to possible misunderstanding of the choice situation by respondents. Obviously, surveys by themselves cannot be used to monitor all aspects of the response of the general traveling population to more innovative ATIS services since such services are not familiar to this population and any data collected in this manner would be unreliable. To inquire about the full user response dimensions associated with new ATIS services necessitates moving to a subpopulation which is familiar with such services, as discussed next.

B. Surveys Targeting Operational Test and Simulation Experiment Subjects

This second category of travel surveys includes:

1. *Surveys conducted in conjunction with actual field experiments.* These surveys provide the opportunity to investigate awareness and access decisions related to actual ATIS systems, and are expected to be more realistic than surveys of willingness to pay for unimplemented ATIS

products similar to the ones described above. Such surveys are also helpful in collecting information regarding trip decisions (ATIS usage and travel response), perceptions of information quality, and learning effects. Within this context, ATIS-related surveys are being conducted in association with the SmartTraveler system but no results are available yet. (Multisystems, 1993). Kantowitz *et al* (1993) presented a focus groups study conducted to investigate consumer evaluation of the TravTek ATIS. The experiments used videotapes made in Orlando with a TravTek vehicle. A split screen showed the road out the window and the TravTek display. Participants were shown series of structured questions related to the product. The experiment aims to investigate product characteristics such as communicability, complexity, cost etc. as well as the effect of personal characteristics such as age, education, income etc. on consumers behavior towards ATIS.

2. *Surveys conducted together with travel simulator experiments*. These surveys are expected to provide information similar to that collected from field experiment subjects; however, such data would relate to the simulated ATIS scheme rather than to an ATIS service experienced in actual driving situations.

4.2.2 Assessment and Limitations

From the above analysis it can be concluded that using surveys to collect data on user response to ATIS necessitates a compromise in either of the following dimensions:

- referring to available traffic information services vs. unimplemented innovative services
- capturing only certain dimensions of user response vs. full array of user response
- targeting a subpopulation (operational test or simulation experiment subjects) vs. general traveler population

As a result, existing travel surveys of the general population have been limited to addressing travel responses to information provided (A.1) and travelers' willingness to pay decisions (A.2).

On the other hand, the sampling frame used in most of the existing general population surveys is not representative of the whole population, since such surveys targeted either morning commuters traveling in a corridor (Khattak et al, 1991, Mahmassani *et al*, 1991) or employees at a specific location (Lotan, 1992).

Finally, it should be noted that although data acquired through surveys might in general suffer from bias, this data is useful at the initial stages of introduction of new ATIS services in obtaining indications of user intentions and attitudes (surveys of type A.2).

4.2.3 Enhancements of Travel Survey Data

<u>Minimizing Potential Biases</u>

It is widely recognized that surveys, in particular those dealing with new products and services (type A.2), have a number of potential biases including non-response biases that may arise from low response rate and response biases that stem from poorly worded questions, respondent fatigue, and a variety of psychological factors that affect the validity of statements about attitudes and behavioral intentions. Therefore, it is very important to try to reduce these types of biases as much as possible. Some useful hints for achieving this goal include the following:

1. Reduce non-response bias by using incentives for answering the survey. To be able to model non-response bias, a separate survey to capture a small sample of non-respondents can be conducted.
2. Try to minimize the fatigue that complicated nested questions can cause to the respondents.
3. Provide respondents with a set of realistic, well-explained situations from which the decision maker has to choose.

Collection of User Response Data

Travel surveys can provide the following data for the modeling needs of the 5 stages:

Awareness - Data collection regarding awareness can only be conducted using a travel survey relating to existing ATIS services which are generally available to the public (survey type A.1) and not to a select group of subjects as in a regular field experiment. Note that if a field experiment is being offered as a test market (such as SmartTraveler), it will be considered to be an "existing" ATIS in which case a general population survey of type A.1 would be feasible. For these surveys, the following questions should be addressed:

- Which traveler information services are you aware of?
- How did you learn about these services?
- Which traveler information services do you consider to be useful for your needs?
- When, where, and under what conditions would you use a traveler information service?
- Are you familiar with the cost of alternative information services?
- What information sources would you consider seeking to obtain more information about existing traveler information services?

Access - Data collected here would help investigate decisions to subscribe to or purchase different ATIS services. In order to identify the travelers' access decisions, willingness to pay data can be collected regarding new, unimplemented ATIS services (survey type A.2), especially if alternatives are described in detail. Such a survey should combine alternate scenarios of the following components:

- alternative ATIS
- alternative services provided (such as traffic information, route guidance, etc.)
- alternative pricing strategies (for access and usage costs)
- alternative information characteristics (such as reliability, timeliness etc.)

Related questions would be: Are you considering purchasing or subscribing to a traveler information services? For what reasons would you considering acquiring means to a traveler information service? etc.

Access data can also be collected for existing ATIS services (survey type A.1) if such services have real costs. Finally, subjects participating in field experiments or travel simulators may also provide data on access decisions (survey type B.1 and B.2); however, such data will be limited to the ATIS service they have experienced either in reality or through the simulator.

Usage - Data from travel surveys is needed to identify traveler decisions regarding when to use the ATIS services. Pre-trip and En-route scenarios will help investigate the usage decisions. Surveys of types A.1, B.1, and B.2 may be utilized for this purpose.

Travel Response - Travel diaries are the most appropriate means to capture travelers trip-to-trip decisions in which case trip chaining activities can also be recorded and studied. It should be noted that previous ATIS diary-type surveys have been limited to commuting trips while for the purposes of documenting travel response to ATIS recording all types of trips would be necessary. Moreover, SP data can be collected with respect to alternate scenarios of departure time choice (based on expected delays, arrival time flexibility, etc.), mode choice (with the availability of bus and train schedules), route choice (in conjunction with the provision of traffic information), and parking choice (depending on the availability of parking facilities). Again, surveys of types A.1, B.1, and B.2 may be resorted to for this purpose.

Learning - Two different types of learning are of interest, one related to system decisions and the other to trip decisions. Individuals who have access to an ATIS service could be asked as part of a travel log to report their perceptions towards ATIS characteristics and usefulness, as well as trip characteristics. To measure perceptions and awareness, a semantic scale can be used and statements such as: Traffic conditions today were better than usual, I am satisfied with my route choice today, and Traffic information received today was useful, can be included. Learning about trip attributes as well as system attributes can be obtained by surveys of types A.1, B.1, or B.2. However, a revision of the access decision which reflects system learning cannot be obtained from surveys of types B.1 and B.2, and can only be obtained for surveys of type A.1 if an distinguishable access decision exists.

Table 1 summarizes the discussion presented above regarding potential uses of surveys for collecting data on the 5 stages of user response to ATIS.

Table 1 Travel Survey Data for User Response to ATIS

	General Population Survey - Existing ATIS (A.1)	General Population Survey - Hypothetical ATIS (A.2)	Survey of Field Experiment Subjects (B.1)	Survey of Driving Simulator Subjects (B.2)
Awareness	√			
Access	if real cost	√	some	some
Usage	√		√	√
Travel Response	√		√	√
Learning System Trip	some √		some √	some √

Collection of Traveler Characteristics Data

The general data related to travelers' socioeconomic, attitudinal, and cognition characteristics discussed in Chapter 3 can be collected by using a questionnaire which may be administered to a general population sample and to the subjects of an experiment (either travel simulator or field test) at the beginning of the experiments to be conducted . This questionnaire should contain three groups of questions involving queries about the travelers' socioeconomic characteristics, travelers' attitudes and preferences towards information and travel conditions, and the usual trip patterns.

Socioeconomic Data - The first group of questions, related to the socioeconomic characteristics, should inquire about the drivers' sex, marital status, education, income, employment, profession, time at current dwelling unit, and time at current job.

Attitudes and Preferences - The second group of questions should be related to the attitudes and preferences of travelers. A semantic scale can be used to indicate the level of agreement with several statements that reflect attitudinal factors. These statements could be classified into two major categories: statements that reflect general attitudes towards modifying trip patterns and statements that reveal the perceptions of the drivers towards the validity and effectiveness of available information sources.

To better understand the travelers' weighing of alternate travel choice attributes, a group of questions that indicate the importance of several factors in choosing a travel pattern can also be included. For instance, in the case of route choice behavior, a semantic scale can be used to indicate the perceptions of drivers related to relevant route choice factors such as time of day, commuting time, habit, traffic reports, risk of delay and weather conditions.

Usual Trip Pattern - The third group of questions should inquire about the travelers' cognition of the transportation network and their usual trip patterns. It should involve questions concerning usual departure and arrival time, flexibility in the arrival time, availability of alternate

travel modes and parking, traffic conditions encountered, number of alternative routes used, and duration and purpose of stops made. These questions should be asked for typical trips associated with various trip purposes.

Note that network characteristics, such as availability of alternative routes and usual traffic conditions can be obtained through maps and traffic information of the network under consideration. Moreover, transit availability and schedules and parking availability and cost could be obtained. However, travel information attributes associated with alternate ATIS services such as actual reliability and relevance of information being provided are more difficult to obtain.

4.3 Travel Simulators

In this section an overall assessment of data obtained by existing simulators is presented. Furthermore, enhancements for future data collection are proposed. Two major issues will be addressed, namely, the quality of data collected through travel simulators and the collection of data for modeling the 5-stages of the proposed framework.

4.3.1 Data Collected Through Existing Travel Simulators

In all travel simulator experiments the subjects are seated in front of a PC or (in more elaborate travel simulators) in car mock-ups, and are asked to drive from a specific origin to a destination. Maps, VMS, and/or route guidance advice are provided to participants in order to assist them in their route choice. The advice given and the actual choices are recorded by the simulators and therefore data on travelers behavior is collected.

Table 2 presents the categories of data that have been collected so far based on travel simulators developed by various research teams. The names or affiliations of these teams appear in the first row of the table. The table is based on the available reports and informal communication with developers of these simulators described in Koutsopoulos et al (1993a). The check marks in the horizontal categories relate the collected data to the 5 stages of the modeling framework developed in Chapter 2.

From this table it is obvious that not all existing simulators collect the same user response data. The simulator design sometimes limits the data collection, while in other instances the limitation on the data which may be collected relates to the experimental set-up (for further discussion see section 4.3.2).

Table 2 Driving Simulator Data for User Response to ATIS

Modeling Stages	Kyoto Univ.	MIT	Systems Technol.	TNO	UC Davis	UC Irvine	Univ. of Leeds	UT Austin	Polak & Jones	IA Simulator
Awareness										√
Access										√
Usage										
Pre-Trip/R		√			√	√	√	√		
Pre-Trip/NR	√		√	√						
En-Route/R		√				√	√	√		
En-Route/NR			√	√						
Travel Response										
Mode Choice								√	√	
Dept. Time	√	√					√	√	√	
Route Choice										
Pre-trip	√	√	√	√	√	√	√	√	√	
En-Route		√	√	√		√	√	√		
Learning System										
Trip	√	√	√	√	√	√	√	√		

Awareness and Access Decisions - Since travel simulators generally simulate a specific type of ATIS service and do not involve any action on the part of participants to purchase or subscribe to such service, these experiments can not collect data on the awareness and access decisions of the travelers. Only a simulator which is enhanced to include information acceleration concepts [similar to the one developed by Hauser et al (1992) and discussed below] can collect such type of data.

Usage Decisions - As far as providing data related to ATIS usage decisions, existing travel simulators fall into two categories. The first category includes those simulators whereby information about traffic conditions is provided to the travelers throughout the whole experiment (non-user-requested information provision - NR). Simulators providing information only in case the user requests it (R) constitute the second category. Simulators that belong to the first category *can not* collect data about usage decisions. Furthermore, usage decisions can be broken into between pre-trip and en-route decisions. Pre-trip decisions are taken at the beginning of the trip, while en-route decisions are taken during the trip.

Travel Response - Data collected regarding traveler response to ATIS may relate to mode, departure time, route, and parking choices. Very little data has been collected by travel simulators regarding mode choice as one dimension of travel response to ATIS. Only Polak and Jones (1992) have developed a simulated game (hypothetical scenarios with alternate transit schedules) that can capture travelers' mode choice behavior. In addition, the simulator developed at UT Austin provides transit schedules to travelers. Data for departure time choice has been collected more frequently.

Travel simulators have been mainly developed to collect data on the route choice behavior of travelers. While pre-trip and en-route choices can be monitored, some simulators are limited to collecting data on pre-trip choices only. This is the case for simulators where the network consists of two alternate routes between an origin and a destination, so subjects have to make their route choice at the beginning of the trip. Finally, no parking choice data has been collected through travel simulators.

Learning - Data on the effect of learning on travelers' revision of trip decisions can be collected in conjunction with all travel simulators since repetitive trips are usually conducted by the same subject. The provision by most simulators of post trip information represents one input into the trip learning behavior. Although it is not clear which simulators collect such data, a check mark has been introduced to all existing travel simulators in relation to the trip learning behavior.

To summarize, from Table 2 it is obvious that existing travel simulators have been utilized to collect data only for stages 3 (usage), 4 (Travel Response), and 5 (Updating of Perceptions) of the modeling framework. For more detailed descriptions of the capabilities of the different travel simulators, see the report by Koutsopoulos *et al* (1993a).

4.3.2 Assessment and Limitations

In general, an important concern in the use of simulators as a data source is the ability to elicit valid behavior. In general, *validity* of a simulator refers to the correspondence between the results acquired by using the simulator and a set of outcomes that are needed or desired and constitute the objectives of its use. In this case, the correspondence relates to the drivers' behavior under ATIS in the simulation and their actual behavior in real situations. The validity of a simulator is a function of its fidelity. *Fidelity* refers to the accuracy of the correspondence between the simulator and the operating environment (in our case, the driving and informational environment). In general the validity of the data collected through a driving simulator depends on the design of simulators and the experimental set-up.

The following discussion refers to the potential biases that may be caused by the design of the simulators and the experimental set-up. Ways to reduce these biases are presented in section 4.3.3.

Design of Simulators

The design of simulators relates mainly to the driving environment, the network representation, and the information environment.

Driving Environment - Regarding the driving environment, two different types of simulators have been developed:

- Simulators that utilize exclusively the computer terminal and the keyboard (or keypad) to input information.
- Simulators that use a combination of seat, steering wheel, foot controls, and a computer.

It is not clear how much the degree of sophistication affects the experimental results. To enhance the realism of the simulated travel environment, some of the simulators in the first group use special features to maintain the attention of the subject on the travel task.

On the other hand, the dimensionally of simulators' graphical displays, such as 2-dimensional or 3-dimensional, plays a major role in the realistic representation of the travel environment. Moreover, some simulators also provide auditory feedback of engine, road and wind sounds consistent with the speed of the subjects' car. The better the visual and auditory stimuli, the more the subjects are expected to use the same behavior pattern as in real life. However, Bonsall (1993) states that more sophisticated simulators might reinforce the subjects' perceptions of simulators as "games" and therefore the results obtained might not reflect their actual decision making.

Network Representation - According to the network representation, three different types of simulators have been developed:

- Simulators in which traffic characteristics are exogeneously defined and follow some statistical distributions.
- Simulators which use animated representation of real networks and traffic conditions illustrated through photographs.
- Simulators that interact with a traffic simulation model, so that traffic conditions are the results of the interactions among the subjects and the other vehicles in the simulation model.

The advantage of the first type of simulators is the flexibility they have to control all types of traffic conditions and information characteristics. However the traffic conditions might not be as realistic since it is difficult to have the appropriate distributions (correlation, etc.). The second type of simulators are more realistic but the network characteristics are fixed. Simulators belonging to the third category are more systematic and realistic but not as flexible as the simulators belonging to the first category.

Information Provision - The information provided is a major factor affecting subjects' travel behavior. Two issues need to be considered. The first is how realistically the ATIS options are represented. We can identify two types of simulators, based on the information provided:

- Simulators which display messages on the PC screen in order to simulate Variable Message Signs (VMS), represent traffic conditions on the links with specific colors (on maps displayed), present the shortest path with special link color, and display route guidance recommendations in the form of flashing arrows to indicate turns at intersections.
- Simulators that project the actual network with slides and use both a PC for route guidance and shortest path recommendations and the projection screen for VMS. Subjects read actual signs while driving and pay attention to the route guidance system.

The second information provision issue concerns the familiarity of drivers with actual ATIS systems, and differences between the real world decision making environment and the simulated environment. The results obtained may be biased if subjects can not make direct associations with actual travel experiences and information services.

Experimental Set-Up

The experimental set-up for a travel simulator experiment relates to factors such as the sample drawn for the experiment, incentives given to participants, etc. From the review of the experiments conducted it was found that the experimental set-up might strongly affect the results obtained. Major biases may be caused by the indifference of subjects to the experimental tasks or by the omission of situational constraints (see also Koutsopoulos *et al,* 1993a).

4.3.3 Enhancements and Recommendations

It is expected that the more realistic the design of the simulator is, the more likely travelers are to apply the same decision-making behavior they exhibit in real-life. Therefore, the design of the simulator and the experimental set-up should be context-specific so that the subjects respond in a familiar environment, in which case more reliable results are likely to be obtained.

Reduction of Potential Biases

Design of the Simulator - The following are some suggestions to reduce potential biases introduced by the design of the simulator:

- Efforts should be made to achieve a realistic simulator environment. Therefore, special features should be incorporated and alternative configurations of each simulator should be tested. For instance, if the simulator has the capability to display day-time and night-time road scenes and weather conditions such as snow and rain, the description of alternative driving scenarios will be more realistic.

- The simulator must be capable of generating a real network and the network representation should be general (freeways, arterials, etc.). In that case, the familiarity of subjects with the network and the information provided could be tested since subjects could relate their choices with their actual trips.

- Special attention should be given to the design of simulators from a human factors point of view, such as good visibility or limited provision of information to avoid overloading of the subjects' short-term memory.

Experimental Set-Up - The following are some suggestions that may be used to reduce the biases caused by the experimental design:

- There is a need to provide real world factors that influence decision making, such as time penalties, risk and cost of accidents, tickets, rewards etc. These will reduce probable prominence hypothesis biases[1] and preference inertia[2].

- The simulated experiment should capture traveler behavior which is sensitive to different trip purposes, such as work or recreation trips.

- A representative sample of the driving population should be used. In most experiments to date, convenient samples of students have been used. However, alternate sampling schemes capturing various categories of gender, age, income, profession, etc. should provide more useful results.

The Information Acceleration Concept

Existing travel simulators provide data related to the trip decisions associated with the overall response to ATIS while system decisions consisting of the awareness and access stages cannot be modeled by data acquired from such simulators. In order to model these decisions,

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[1] An example of prominence hypothesis bias can be observed when subjects consistently decide to follow the advice provided by the ATIS without any concern for the quality of information provided.

[2] Preference inertia can be observed in the case of subjects who, after an initial choice which satisfies their criteria, continue to use that choice without considering any alternatives.

existing travel simulators have to be enhanced and modified to include information acceleration capabilities which can be of great assistance.

The concept of "information acceleration" (IA) represents a new methodology for developing preproduction forecasts for durable goods [see Hauser et al (1992) and Weinberg (1993) for details]. Information acceleration facilitates simulation of: 1) a future new durable good, 2) the availability of information on the new durable good before and after market launch, 3) the existence of competition, 4) consumer information search and interaction with the new durable good and competitive products, and 5) critical consumer information search behavior and consideration of the new durable good.

Recently, IA simulators have been used for conducting applied market research aimed at examining consumer behavior when evaluating new products or services which are not currently in their consideration set. In an IA experiment, subjects can acquire information about products they are interested in by interacting with a computer system featuring multi-media applications and which simulates a future market. Alternative sources of information are available. Subjects can contact any sources they like such as word of mouth (listening to the voice of a friend), consult articles in magazines, see advertisements, or even simulate a visit to a retail outlet where they can examine closely the product under consideration and listen to the salesman's descriptions. The different sources which are consulted and the time spent seeking information are recorded, and therefore data on the impact of these factors on subjects' awareness of the product can be collected. Furthermore, data about subjects' shopping and buying decisions and willingness to pay for specific products is collected. Note that this data is expected to have a high degree of reliability since the subjects have a concrete image about the products under consideration.

An IA simulator could be a powerful tool to provide data addressing user response under the provision of "market" information about alternate ATIS services. Such a simulator would assist analysts identify:

- the effects of different information sources, such as advertisements, magazines, and word of mouth on travelers' awareness and willingness to acquire information about alternative ATIS products and services, and
- the travelers' market response to ATIS services and their willingness to pay for such services.

Collection of User Response Data

Awareness - By incorporating IA concepts, an extended travel simulator should be able to provide alternate information sources concerning ATIS services. As such, subjects participating in the experiment would be able to choose the information sources they are interested in consulting and the time they allocate to each. The benefits of such an approach include:

- A choice of multiple sources of information (such as advertisements, retail outlet, word of mouth, etc.) for each ATIS would be available.
- The travelers' decisions will enable an identification of the effects of ATIS publicity.

- Data about time allocated to information search would enable a study of "value of time" allocated to seeking information by different customers.
- Moreover, variations in time allocated to information search among travelers would provide a basis for segmentation of travelers before making their ATIS access decision.
- Finally, data on the amount of information subjects want to acquire about each ATIS is of interest and will provide some preliminary insights into their willingness to access the ATIS, since the more information subjects acquire about a specific ATIS the more likely they are to acquire access to it.

Access - Data collected regarding the willingness to pay for alternate ATIS services should distinguish between acquisition costs and usage costs. Investigation of the importance of different services provided by ATIS (such as traffic information, route guidance, transit schedules, parking information, etc.) on travelers' access decisions is also important. Information on the attractiveness of alternate services provided by the ATIS should also be collected.

Usage - Traditional travel simulators can easily provide data concerning usage decisions . The only modification that should be implemented to existing travel simulators is to provide information or guidance only if the user requests it, and not force it on the subject as most existing simulators do. This way the decision of subjects to use information in their pre-trip and en-route travel choices will be examined.

Travel Response - Data relating to the major travel decisions which could be made in response to travel information should be collected. For instance, none of the existing travel simulators has been used to examine the impact of ATIS on mode choice. The only simulator which comes close is the one developed by Polak and Jones (1992). However, this simulator could be characterized as a stated preferences survey rather than a simulator. Other travel dimensions for which data needs to be collected include departure time, route, and parking choices.

Learning - Simulators can assist in the collection of data for the 5th stage of the modeling framework regarding updating travelers' perceptions of ATIS and trip attributes. Each subject should perform several trips, following which his/her reactions would be recorded in order to impute the learning behavior.

Conclusions

Although existing travel simulators are valuable in investigating the influence of ATIS on travelers' trip behavior, their contribution towards this ultimate goal is incomplete without further enhancements as discussed in previous sections. Depending on their configuration, the purpose for which they were developed, and the experimental design used, all simulators to some degree fail to replicate actual behavior. However, due to lack of RP data, the degree of inconsistency has not yet been quantified.

Furthermore, existing simulators have been developed independently of each other. Consequently, the experiments conducted cannot be directly compared. Although simulators

represent a wide range of designs (from simple to very elaborate), the results cannot be compared in order to draw conclusions as to which design is most appropriate. Further investigation is required in order to specify the "best design" or a set of "acceptable" designs. For example, a comparison of different simulator performance measures with the same subjects and tasks could provide a more accurate approach to identify the impacts of different simulator designs on the experimental results. Note that a simulator has been developed at University of Leeds (Firmin, 1993) to be used explicitly as a tool to examine the effects of simulator design on subjects' responses.

To conclude, the most useful simulator would be the one that allows collection of data for estimating all five stages of the modeling framework. This travel simulator should have information acceleration capabilities and be as realistic as possible. The issues of fidelity and validity of travel simulators remain of utmost importance. Since driving simulators closer represent the actual driving environment, they will be useful in collecting data on travel behavior. As Sherman (1993) notes: "Driving simulators should be linked with the traveler behavior simulators to provide an effective evaluation for new ATIS products." The comparison of the behavioral responses obtained when different types of simulators are used will lead us to the optimal design of a travel simulator that is as simple as possible and provides valid results.

4.4 Data from Demonstration Projects

This data source involves documenting the behavior of drivers participating in demonstration projects and relating that to prevailing traffic conditions and guidance being provided, among other factors. A comprehensive review of the role of operational tests in understanding user response to ATIS is presented by Whitworth (1993b).

4.4.1 Evaluation of Existing Operational Test Data

This section outlines what role each operational test is playing or is likely to play in the collection of data on user response to ATIS. Table 3 shows how the various U.S. ATIS operational tests provide data supporting the various stages of user response to ATIS. It is primarily based on the evaluation plans that have been developed for these operational tests Check marks indicate that the operational test will provide needed data concerning the user response stage. "Some" indicates that the user response stage is only partially covered by data obtained from the operational test. From this table it is evident that while the ATIS usage stage and route choice dimension of the travel response stage are covered quite well by the operational tests, little or no data is expected to come out of these tests regarding the awareness or access stages. On the other hand, some data relevant to the learning stage and dimensions other than route choice in the travel response stage will become available.

Table 3 Operational Test Data for User Response to ATIS

Test	Smart Traveler	DIRECT	Advance	Fast-Trac	Pathfinder	TravTek	H.S.C.	Genesis	SMART Corridor
Expected Completion	1994	1995	1996	1994	Done	March 1994	1995	1995	1993
Awareness	√								√
Access	some	√	√	√	√	√	√	√	some
Usage									
Pre-Trip	√	some					√	√	√
En-Route	some	√	√	√	√	√		√	√
User Response									
Mode	√						√	√	
Time	√						√	√	√
Route Choice	√	√	√	√	√	√	√	√	√
Learning									
System	√		√	√			√	√	√
Trip		√	√	√	√	√		√	

4.4.2 Recommendations and Enhancements

Collection of User Response Data

In this section a discussion of RP data which may be collected from operational tests for modeling the 5-stages of the modeling framework is presented.

Awareness - Data on awareness can be obtained from surveys of users of ATIS and the general public in a market where ATIS service is commercially available. Operational tests which most closely simulate the marketplace for ATIS will provide the best data on ATIS system decisions. 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 a market situation. Operational tests where an access cost is involved (a sign up fee, or equipment purchase cost) could provide RP data on access. However, operational tests which have an access cost are very limited. Instead, we can get data by surveying test subjects about their opinions of their willingness to pay for access to a set of specific ATIS services.

Usage - Usage should be considered in two parts, namely, 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 resorted to 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 logs as was discussed regarding usage. There are four types of user response which we are concerned with: mode shift, departure time shift, route choice and parking choice.

Mode: To collect data on mode choice, the operational test should provide travelers with information on several mode options. It is essential that an operational test area includes multiple modes if mode choice is to be examined. Such a choice context provides the opportunity to observe any en-route mode switching in which case subjects might decide to head for a park-and-ride facility. 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. 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.

Parking Choice: Parking choice information could be collected only through a natural use study. Parking choices could take place pre-trip and en-route. ATIS should provide information for parking availability and data collection should include the requested information, the information provided, and the travelers' parking decisions.

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 may also be afforded the option of modifying their ATIS access so that learning impacts on the access decision can be observed directly rather than estimated based on subjects' 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 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.

Conclusions

After analyzing the use of operational tests as a potential data source for user response to ATIS, 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 data collection strategy should be developed. Once this strategy is developed operational tests can be designed to fulfill specific information needs.

2. A market environment is required to collect good quality user response data, especially regarding awareness and access. Therefore, operational tests should be structured to simulate a market environment.

3. In order to compare differing ATIS technologies they need to be tested under the same conditions. Operational tests should test multiple and significantly different technologies, preferably in a market type setting.

4. To fully understand changes in behavior due to the introduction of ATIS, control groups are required. 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 mode shifting is to be properly represented.

4.5 Integrated Data Collection

Analysis and Modeling Considerations

Regarding analysis and modeling considerations, alternative data sources have different levels of accuracy and contain various types of biases. The combination of different data sources seems appropriate in order to exploit their relative advantages and obtain more reliable estimates than those of a single data source. Within this context, the combination of travel simulator experiments with selective field validation is expected to be a step forward in the investigation of the impacts of ATIS on travelers' behavior and development of models that accurately capture this behavior.

Role of RP Data

RP data represents the actual behavior of travelers. However, such data might not contain sufficient information to identify the underlying preferences of travelers. In particular, RP data can not provide direct information about drivers' behavior on new-non existing alternatives, such as the introduction of new ATIS services with different levels of reliability.

Moreover, RP data obtained from field experiments featuring different ATIS services may not be directly comparable in terms of explaining user response to ATIS. For example, travel information acquired from a system similar to Smart Traveler is expected to have a different impact on traveler response than a route guidance system. A comprehensive data collection program would involve multiple locations and ATIS services and would identify the commonalties and differences between these sources.

Role of SP Data

Travel simulator experiments providing SP data enable the collection of traveler behavior data in a systematic manner. They facilitate the collection of data on travelers' behavior under different scenarios with systematic variation in road, traffic conditions, and information provided. This data is difficult or very expensive to obtain in real world experiments. Moreover, stated preferences can capture some aspects of latent preferences and therefore could help in the identification and estimation of the preferences that determine actual behavior. Therefore, the use of travel simulators to obtain stated preferences data about the behavior of drivers under ATIS has significant advantages.

However, it is obvious that even though stated preferences are related to the underlying preferences of the drivers, they do not necessarily replicate their actual behavior. Depending on the nature of the simulator and the experiment performed, stated preferences could be governed by a different decision making protocol than revealed preferences.

Combination of SP and RP Data

While SP data is cheaper to collect than RP data, subjects often misunderstand situations or can not correctly predict their actions due to a lack of familiarity with the experimental setting or the object of a questionnaire. Since ATIS is a completely new product, it is difficult for subjects to respond and it is useful to provide users with realistic information about what is being asked. In this respect, operational test participants make ideal subjects for collecting SP data as these subjects are more familiar with ATIS than those who have not been involved in an ATIS test.

Moreover, in order to validate the data acquired by travel simulators, it is important to investigate how people behave under the provision of traffic information through advanced traveler information systems in real-life. Field experiments would provide this type of data. The comparison of the revealed preference data to stated preference data will allow the enhancement of the design of the simulators. For example, as was noted before, the use of the same subjects in both field studies and simulation experiments can provide the means to identify biases introduced by travel simulators. It will also reduce the expected biases caused by the nature of the SP experiments. Moreover, discrepancies between the actual behavior and travelers' decisions while driving the simulator will allow the identification of the differences between the two data sources.

Finally, field experiments should also include travel surveys in order to capture the effect of trip learning on trip and system decisions.

Data Collection Environment

The ideal data gathering environment should closely resemble a marketplace setting but with data available on users attitudes, perceptions, and actions. Ideally, subjects should not know that they are participating in an experiment. Smart Traveler provides an example where subjects are unaware that they are participating in an experiment. Subjects should be provided with the ability to choose 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 Instruments

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 user response; surveys would record changes in attitudes including awareness and learning about ATIS.

Electronic log keeping by the system would provide the best data, followed by a diary kept by the user. The electronic log can be used to record more information than it is reasonable to ask a human to record; also, individuals might forget to record their trip information. On the other hand, an advantage of a written diary is that it allows subjects to record any special circumstances which may occur.

Surveys which ask users to recall how they behaved are not as good as logs since users are asked to recall their behavior from one or two days earlier. Surveys are the only way to collect information about users' perceptions of the system and how they change over time. Surveys of attitudes should also be distributed at regular intervals. Daily surveying is required to understand trip learning while surveys distributed over the course of the project provide data on system learning.

5. Conclusions and Future Research

5.1 Research Objectives

The overall objective of this research is to propose a comprehensive and coordinated approach to develop models of the user response to ATIS products and services and to collect relevant data from travel surveys, demonstration projects, and travel simulators. The models to be developed will provide a key input to a meaningful analysis of the market response to such services and of traveler behavior in the presence of traffic information. In addition, these models will supply the means to properly evaluate the expected benefits from and effectiveness of future ATIS implementations and to guide future designs of ATIS products and services.

5.2 Interim Findings

In research completed to date, reviews of behavioral data collection from existing travel simulators and ongoing field experiments were conducted. These reviews have indicated that the data collection efforts so far have been uncoordinated and incomplete. Moreover, all modeling efforts have been limited to part of the overall scope of user response in an ATIS environment. Based on these reviews a modeling framework for traveler behavior in an information rich environment was developed and elements of a data collection strategy that supports the estimation and validation of the modeling framework were identified.

It should be noted that the focus of research to date has been on characterizing the data which may be obtained from various sources and which can be utilized in estimating and validating models associated with the proposed framework of user response to ATIS. No attempt was made to make statements regarding the user response itself; this has to await the preparation of a coordinated database from travel simulators and operational tests and the operationalization of the ATIS user response framework and its component models.

Role of Travel Surveys

Existing travel surveys of the general population have addressed the following data needs:

- travel responses to information provided in existing ATIS services, and
- travelers' willingness to pay for unimplemented ATIS services.

Data acquired through surveys was found to be useful at the initial stages of introduction of new ATIS services in obtaining indications of user intentions and attitudes. Data about awareness of existing ATIS services, however, has not been collected by such surveys and needs to be included in the future.

Moreover, surveys by themselves could not be used to monitor travel response of the general traveler population to innovative, unimplemented ATIS services since such services are not familiar to this population and any data collected in this manner would be unreliable. To inquire about the travel response dimensions associated with new ATIS services necessitated

resorting to travel simulators or moving to a subpopulation which has experience with such services, such as operational test subjects.

Role of Travel Simulators

Existing travel simulators have been utilized to collect the following data regarding user response to unimplemented ATIS services:

- good coverage: travel response stage (route choice dimension)
- some relevant data: ATIS usage stage; travel response stage (dimensions other that route choice); trip learning stage
- little or no data: awareness or access stages

It should be noted that travel simulators represent the *only* means through which any data on unimplemented ATIS services may be obtained.

Role of Operational Tests

Research to date has indicated that data obtained from operational tests provides the following coverage of user response to experimental ATIS services:

- good coverage: ATIS usage stage; travel response stage (route choice dimension)
- some relevant data: trip learning stage; travel response stage (dimensions other than route choice)
- little or no data: awareness or access stages

Summary

Table 4 presents a summary of how the data currently available from the three sources described above covers the different stages of user response to existing, experimental, or unimplemented ATIS services.

A source which is included in brackets indicates that it currently either partially covers the cell or provides data of insufficient quality. The table indicates that data relating to system decisions (awareness, access, and system learning) is almost lacking. Existing simulators and operational tests play an important role in providing data regarding trip decisions associated with experimental or unimplemented ATIS services, based on a subpopulation of participating subjects.

Table 4 Existing Data for User Response to ATIS

	General Population		Subjects of Operational Tests
	Existing ATIS	Unimplemented ATIS	Experimental ATIS
Awareness			
Access	(survey)	(survey)	
Usage	survey	(trav. simul./survey)	travel log
Travel Response	survey	trav. simul./survey	travel log
Learning System Trip	(survey)	(trav. simul.)	(survey)

5.3 Recommendations

Continuing research in this domain is likely to require assembling and making available to researchers a coordinated database on user response to ATIS as well as developing a comprehensive model system for evaluation of ATIS impacts and potential benefits. Thus, it is viewed that future research should include further development of the methodology proposed here together with an empirical demonstration of its applicability. It is expected that the proposed future work would enable researchers to identify:

- The factors that affect the acquisition and usage of ATIS products and services;
- The learning behavior of potential users; and
- The ways in which different ATIS products and services affect travel behavior.

In general, user behavior analysis methods of this nature consist of two components, namely, data collection, and data analysis and modeling. Data collection recommendations will be briefly discussed in section 5.3.1 while suggested enhancements to data analysis and modeling techniques will be presented in section 5.3.2. Finally, section 5.4 outlines the tasks associated with the work program required to implement the recommendations of this report.

5.3.1 Data Collection

Data on user response to ATIS needs to be collected using a combination of approaches including travel simulator experiments, field operational tests, and travel surveys.

Travel Surveys

Travel surveys provide a relatively easy and low cost way of collecting both revealed and stated preferences data. A large scale survey, combining both reported behavior (weekly diaries) of travelers and their stated preferences towards alternate ATIS services, would adequately

support quantitative modeling and forecasting. A number of recommendations were made earlier in this report to improve the quality of data obtained from travel surveys. These included:

- the need to minimize bias by enhancing the realism of choice situations and describing alternatives in detail
- the need for surveys to monitor traveler behavior over extended periods of time and to keep daily logs of trip behavior and relevant perceptions in order to observe observing system and trip learning
- the need to collect data regarding traveler attitudes and cognition of trip and information system characteristics.

Finally, the report identified the stages in user response for which data may best be collected either by a survey of the general population or by targeting subjects participating in travel simulator or operational test experiments.

Travel Simulator Experiments

In order to collect data appropriate for implementation of the modeling framework proposed in this report, it is necessary to enhance the existing travel simulators based on the recommendations presented in the report by Koutsopoulos et al (1993a) and summarized earlier in this report. To perform this task, basic validity and fidelity considerations should be enhanced in existing simulators or others which are likely to be developed. In addition, improvements should address issues regarding the experimental set-up and design.

Moreover, since existing travel simulators only allow the collection of data regarding the travel responses to information provision, a modified information acceleration (IA) simulator is needed. The IA approach (discussed earlier in this report) is a powerful tool to collect data for all stages of the proposed modeling framework. Such a simulator will provide both "behavioral" and "market" information related to alternate ATIS designs, and would help identify the effects of different information sources (such as advertisements, magazines, word of mouth, or visit to an outlet selling route-guidance systems) on drivers' awareness of alternate ATIS and willingness to pay for these systems. Such a simulator would also be useful to ATIS developers and to transportation agencies, since it would provide a better representation of the market place, would give estimates of the demand for such systems from purchase intentions, and enable a forecast of ATIS usage under alternative future scenarios. Thus, the "voice" of customers would be heard in the ATIS design process, as well as their reactions to prototype applications of ATIS.

An IA simulator attempts to capture the market environment in which users make ATIS decisions. As such, the existing travel simulators will be embedded in the IA simulator to represent alternative ATIS products and services. Once a subject decides to acquire access to an ATIS service, he/she can then be presented with a driving task and traffic information associated with the chosen service so that his/her travel behavior may be monitored in an ATIS context.

Field Operational Tests

Field experiments provide data which is representative of actual behavior of drivers in a real traffic and information environment. Research to date, presented in the report by Whitworth (1993b), has provided an insight on which operational tests have collected or are planning to collect behavioral data on drivers' interest in ATIS and their response to the advice provided by the ATIS under development and testing. Several enhancements that will improve the coverage and quality of such data have been proposed in this report and include:

- the eventual need for multiple product offerings to compare user response to and impact of different ATIS technologies
- a test market is a necessity in order to provide reliable data on system decisions
- the need for control groups
- the need for the test area to include multiple modes to observe potential mode switching

Finally, assembling the data acquired from ATIS field tests in order to be used for modeling purposes is expected to be a major task

Summary

Table 5 presents a summary of the major recommendations regarding the role of alternate data collection sources in providing necessary information on the different stages of user response to existing, experimental, or unimplemented ATIS services. Bold entries indicate enhancements over the current data collection procedures.

Table 5 Recommended Data Collection for User Response to ATIS

	General Population		Subjects of Operational Tests
	Existing ATIS	Unimplemented ATIS	Experimental ATIS
Awareness	**survey**	**IA simul.**	**IA simul.**
Access	**survey**	**IA simul./survey**	**IA simulator**
Usage	survey	trav. simul./survey	travel log & **trav. simul.**
Travel Response	survey	trav. simul./survey	travel log & **trav. simul.**
Learning System Trip	 **survey** **survey**	**trav. simul. & IA simul.** **trav. simul.**	 **survey** **survey**

The above table highlights the following basic recommendations:

- Introducing information acceleration (IA) capabilities to existing simulators would enable data collection regarding system decisions for experimental or unimplemented ATIS services. This renders the use of surveys for obtaining data on access decisions to such services unnecessary since data quality would be substantially improved using the IA simulator.
- IA and travel simulators may be used with subjects participating in operational tests representing experimental ATIS services to obtain data on user response in various choice contexts which might not be captured by travel logs and to compare traveler behavior in real life to that in a simulator context. While not noted in the table above, simulators may be used for similar purposes in conjunction with existing ATIS services.
- Simulator and operational test experiments, in conjunction with focused surveys, are to be planned for obtaining data on system learning.
- Surveys targeting the general population for which existing ATIS services are available should be planned in a way that data on system decisions and system learning may be collected. This is expected to become a simpler but more important task with the introduction of several commercially available ATIS services which are bound to generate a market context, possibly with multiple offerings, and enabling a monitoring of system behavior.

5.3.2 Data Analysis and Modeling

Methods for the analysis of data to be collected are expected to range from simple exploratory data analyses to obtain descriptive statistics to advanced statistical methods for analyzing user behavior. For example, future research is likely to consider the possibility of combining revealed and stated preferences data in order to profit from the relevant advantages of each data type and obtain more reliable estimates of model parameters. In what follows we present some thoughts regarding directions for the forthcoming research into data analysis and modeling.

Modeling Techniques

In the discussion of the modeling framework it was suggested that the traveler compares expected costs and benefits and tries to maximize his perceived utility through his system and trip decisions (that is, minimize his travel time, stress etc.). Therefore, random utility models and discrete choice modeling techniques represent a strong option for the operationalization of the 5-stage framework.

Travelers' responses might be binomial (yes or no responses, such as comply or not comply with the ATIS instructions) or multinomial responses which might be naturally ordered (number of alternative routes used by each subject) or unordered (ATIS alternatives, such as telephone service, in-vehicle device, etc.). The most common discrete choice models are logit (binomial and multinomial) and probit models (binomial and multinomial) (see Ben-Akiva and Lerman, 1985, for details). For example, the following decisions can be represented by binomial models:

- Aware - not aware
- Use - not use
- Access - not access
- Comply - not comply

If we assume some dependence between the system decisions or between the trip decisions then nested models or multinomial models need to be used. Moreover, if the dependent variable is in an ordered scale, which is usually the format of answering in questionnaires, ordered discrete choice models can be used.

Choice Set and Choice Dynamics

The dynamic nature of the choices in an information-rich environment dictates the development of tools and techniques to incorporate these unique aspects. In an ATIS environment, changes in the choice context resulting from information availability affect both the individual choice set and the attributes of the alternatives. Due to variations across the population of the effects of the information environment, it is unlikely to be appropriate to impute the choice set deterministically from situational constraints. Hence, a probabilistic choice set model might be necessary. Previous work in probabilistic choice set models (Ben-Akiva, 1977; Swait, 1984; Swait and Ben-Akiva, 1987; Boccara, 1989) has addressed this issue by focusing on the existence of random constraints that imply the unavailability of certain alternatives.

The effects of informational constraints on choice set formation can be modeled by studying the problem of how individuals learn about alternatives under space and time constraints. Also, there are search costs (costs of information, etc.) associated with each alternative incorporated in an individual's choice set. For example, in the context of pre-trip choices situations, it is unlikely that an individual driver is really aware of the potentially large number of alternatives (e.g., travel mode, departure time, and route choices). Information aids in the inclusion and elimination of some alternatives from the choice set. Previous work by Hauser et al (1992) has demonstrated how the availability of various information sources can increase a consumer's awareness of choice alternatives.

For modeling the effects of learning on system (awareness and access) and trip decisions (usage and travel response), observations over time should be available. Therefore, a combination of cross-sectional and time-series data will be needed. The model under consideration may then have components of variance structure with individual effects (population heterogeneity), autocorrelation, and dependence on lagged values of latent or indicator variables (state dependence) (see Greene, 1993 for definitions). Most dynamic applications have used multinomial probit choice probabilities so that the latent variable model may have a linear structure (Mc Fadden, 1984).

Data Combination Methods

More advanced techniques that are likely to be needed for implementing the modeling framework include estimation of choice models from multiple data sources (Ben-Akiva and Morikawa, 1990). Combining SP and RP data is one such application. In order to estimate these

models two estimation methods have been developed: 1) joint MLE, using SP data and PR data simultaneously, and 2) sequential MLE, using RP and SP data one after the other.

Accuracy of parameter estimates in the RP model could be gained by sharing some of its parameters with the SP model, while potential biases and errors specific to SP data are explicitly considered in the SP model. Further, SP models could be used with the RP data to test the validity of SP models.

Use of Psychometric Data

Another advanced technique involves incorporation of attitudes and perceptions in discrete choice models (Ben-Akiva, 1992). These factors play a critical role in all stages of the ATIS user behavior framework.. Note that attitudinal and perception factors are latent factors that can not be directly observed but we can obtain indicators for them through the surveys to be conducted (as described in Chapter 4).

5.4 Further Research

To implement the recommendations of this research, a detailed work program has to be identified. The following list presents some of the more significant tasks associated with the future work program for ongoing research in this area:

1. Develop a detailed design of a comprehensive data collection strategy based on travel surveys, travel simulators, and operational tests and which covers all aspects of the 5 stages of user response to ATIS.

2. Assemble, and make available to researchers, a database for model development from various sources. In specific:
   - further develop and apply ATIS simulators in order to collect stated preferences data. In addition, develop and collect data from the IA simulator.
   - assemble revealed preferences data from conducted field tests.
   - assemble revealed and stated preferences data from travel surveys.

3. Develop, estimate, and test alternative models of user response to ATIS products and services. It is anticipated that it will be necessary to resort to the data analysis and modeling techniques suggested in section 5.3 above.

4. Validate the proposed data collection methodology and the proposed modeling framework for user behavior in the presence of information.

5. Conduct prototypical analyses of a number of ATIS strategies. Such analyses should demonstrate the capacity of the proposed modeling framework to provide insights into the following issues:

- what role can ATIS play in alleviating traffic congestion?
- what impact can ATIS have on encouraging modal shifts?
- what impact can ATIS have on departure time and parking choices?
- what user and system benefits may be anticipated from various ATIS schemes?
- how much are users willing to pay to gain access to different ATIS services?
- how do users value different ATIS features?

6. Based on the modeling and data analysis results, provide guidelines to further enhance the design of travel simulators and future operational tests with respect to their ability to collect reliable data on user behavior.

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APPENDIX A - Literature Review: Modeling Traveler Behavior in an ATIS Context

A review of various models of traveler behavior in an ATIS context which have been proposed is presented here. These models include different aspects of traveler behavior which are likely to be impacted by the availability of ATIS. Existing modeling approaches relate to the following 3 stages:

1. ATIS Usage
2. Travel Response
    a. Models of pre-trip choices
    b. Models of en-route adjustment/diversion
3. Learning
    a. Models of trip-to-trip adjustment
    b. Models for updating perceptions

1. ATIS Usage

Polydoropoulou *et al* (1993) proposed a modeling framework for pre-trip and en-route information acquisition, and the influence of the acquired information on drivers' route choice and route switching. The modeling framework was validated with revealed preference data, obtained by a travel survey conducted at MIT in 1991. Each driver had to fill out a travel diary and to answer questions regarding the acquisition of pre-trip and en-route information through radio, and the influence of this information on their decisions. The following travel decisions were analyzed:

- Acquisition of pre-trip traffic information;
- Influence of pre-trip traffic information on commuters' decisions;
- Acquisition of en-route traffic information; and
- Drivers' switching behavior.

The framework assumed that travel decisions, are the outcome of latent behavioral factors, the trip characteristics and the information characteristics. A two-stage modeling approach was used. Ordered probit models were used to analyze the stated drivers' attitudes and perceptions. The fitted values of these attitudes and perceptions were used as explanatory variables in binary logit models regarding the influence of information in route choice and route switching decisions. The results indicated that information acquisition decisions are primarily influenced by the drivers perceptions about the quality of information provided and the attitudes towards risk and discovery. Furthermore, route switching is affected by the content of the information acquired as well as the en-route observed traffic conditions. Moreover, the drivers' willingness to pay for more useful information was modeled. This model indicate that drivers with higher income with potential for travel time savings are more willing to pay for more useful information.

2. Travel Response

a) Models of Pre-Trip Choices

Cascetta and Biggiero (1992) estimated logit models for departure time and path choice for home to work trips, based on a revealed preferences survey carried out in the city of Turin. The survey was done on a sample of workers in a single industrial plant. Their experimental analysis consisted of two stages. In a first stage, the route choice model was specified and calibrated to define
generalized route cost functions. In the second stage, the departure time and route choice employment qualification. The analysis yielded the following results: travel time spent on secondary roads played an important role in route choice. Therefore travel times spent on primary and secondary roads should be used separately. Safety and comfort variables were found to be significant. Finally, early/late arrival penalties were perceived differently by the subjects.

Polak and Jones (1992) studied the impact of in-home pre-trip traffic information. The study was carried out using a microcomputer based simulation. An in-home pre-trip information system, offered information on travel times from home to City Center, by bus and car at different times of day. The respondents had also the ability to generate their own choice set of alternatives through the process of information acquisition. Surveys were undertaken in parallel, in Birmingham and Athens, allowing a comparison between the cities. The results showed that even amongst regular car users, there is a requirement for multi-modal pre-trip information. Moreover, the quantity and the type of pre-trip traffic information requested by travelers depends on a range of personal, journey related contextual and national factors. Finally, two important findings are that travelers are selective in the amount and type of information they request, and that the process of information acquisition is structured according to the travel preferences.

b) Models of En-Route Adjustment/Diversion

Jayakrishnan and Mahmassani (1991) presented a model of the path selection decisions of individual motorists along their journey in response to supplied information. It is assumed that an on-board computer receives and analyzes information on prevailing traffic conditions and provides the relevant data to the driver. The commuter route choice is assumed to follow boundedly-rational behavior whereby a motorist switches from his current path only if the improvement in remaining travel time exceeds some threshold level (or indifference band). The driver behavior can then be operationalized using a satisfying decision rule. In this model the indifference band is expressed as a percent improvement in remaining trip time over the current path, while an absolute minimum level is maintained to avoid switching as the driver nears the destination.

Khattak *et al.* (1991) investigated short term driver diversion response to incident-induced congestion delay and evaluated the ways in which drivers use real-time traffic information. Work trip drivers destined to the central business district in the Chicago area were intercepted at downtown parking garages during the AM rush hours. The survey data on

respondents' reported experience in the face of a recent delay was used to estimate a multinomial logit diversion choice model. The alternatives in this diversion decision were either to stay on the usual route or to divert to an alternative route. Several models were estimated and they included the following variables:

- Characteristics of the delay experience (weather, trip direction, length of delay, information source on delay)
- Attributes of "usual" and alternate routes (travel time, congestion, scenery, reliability, neighborhood safety, stress experienced while driving, traffic stops, overall rating)
- Trip characteristics (reported travel time on usual and alternate route, length of time usual route has been used)
- Socioeconomic attributes (age, gender, income, location of residence, personality factors)

Multinomial logit models were used to estimate drivers' diversion choices. The final model selected indicated that there exists a preference for staying on the usual route and that *information* has a greater impact on the decision to divert than direct observation. The reason for this could be the fact that drivers have more options to divert at the time they get traffic information on incident-induced congestion than when they observe congestion themselves. Moreover, delay is observed in increments whereas traffic reports provide a more comprehensive view of congestion. Mahmassani *et. al.* (1991) also found that drivers who listen to radio traffic reports are more likely to divert.

The model also indicated a tendency to divert as length of delay and travel time increase. As was expected, a strong perception of congestion on the alternate routes reduces the diversion tendency while the number of alternative routes used has the opposite effect. A *Stated Preference Index* which indicates a driver's inherent tendency to divert as well as an "adventure and discovery" personality index were found to be significant in modeling drivers' diversion decisions. Finally, suburban residents were found to be less likely to divert.

Khattak *et al* (1992) used stated preference data to evaluate the effects of real-time traffic information, along with driver attributes, roadway characteristics and situational factors on drivers' willingness to divert. The empirical aspects of the study focused on a survey of downtown Chicago automobile commuters. A five-point scale ranking from "definitely take usual route" to "definitely take alternate route" was used to access diversion propensity. Ordered probit models were used to model users diversion decisions. Drivers expressed a higher willingness to divert as expected delays on their usual route increased. Further, they were more willing to divert when the congestion was incident-induced, as opposed to recurring. Information for delay was received from radio traffic reports and compared with observed congestion. Trip direction was home-to-work rather than work-to-home. Respondents were less willing to divert if the alternate route was unfamiliar, unsafe or had several traffic stops. Drivers who normally experienced longer travel times were more likely to divert. Socioeconomic characteristics were also significant in predicting willingness to divert.

Bonsall and Parry (1991) developed an interactive route-choice simulator (IGOR - interactive guidance on routes) to investigate drivers' compliance to route guidance advice. In this experiment, each user was invited to make a series of journeys through hypothetical networks from one junction to the next on the way to their destination. Conditions in the network varied from day to day and differed according to the time of the day at which the journey was made. Regression models were estimated having as dependent variable the probability of acceptance the route guidance advice. The independent variables were an index of quality based on actual travel times or an index of quality based on free flow travel times. The results showed that the acceptance of an advice varies with the objective quality of the advice and with the quality of the previous received advice. The influence of the drivers' knowledge of the network and of the existence of corroborating or conflicting evidence is also demonstrated. The acceptance of an advice was depending on its credibility and this was a function of past experience, local conditions and psychological factors.

Lotan (1992) modeled the route choice process and the drivers perceptions in the presence of information by using concepts from fuzzy sets theory, approximate reasoning and fuzzy control. Empirical results were obtained by using a driving simulator developed at MIT. Ten subjects participated in the experiment, and each performed 20 trips under various traffic conditions (congestion levels, incidents, etc.). The data collected included prior perceptions (based on interviews), observed traffic conditions while driving, the available pre-trip and en-route information and the resulted choices made. In the case study presented, the underlying simplicity of the human reasoning concerning route choice was demonstrated. This agreed with the prior expectation that "a man, viewed as a behaving system, is quite simple. The apparent complexity of his behavior over time is largely a reflection of the complexity of the environment in which he finds himself".

Adler *et al* (1992a, 1992b, 1993) used a driving simulator named FASTCARS to collect data for estimation and calibration of predictive models of driver behavior under the influence of real-time information. Each driver was presented with 5 different travel objectives and asked to perform pre-trip and en-route travel decisions (such as goal specification, route choice, lane changes, use of information technologies, etc.). Two alternative modeling approaches were used to model route switching behavior. One was based on a utility maximization approach (logit and probit estimations) for primary and secondary diversion behavior; the other was based on conflict resolution concepts to model drivers' behavior. According to this approach, when conflict rises to a level that exceeds a personal threshold of tolerance, drivers are likely to alter en-route behavior by either diverting to an alternative or by revising their goals. Preliminary analysis showed that en-route diversion behavior is influenced by familiarity of drivers with the potential alternative routes and their traffic conditions, the information provided by the VMS, the changes in travel speeds, and the drivers' risk preferences. Moreover the value of information decreases among more experienced drivers.

- He also discussed the human factors studies versus traveller behavior studies debate. The human factor people use tight experimental design, and the behavior people do not use tight controls, and they emphasize driver response. Both sides would benefit from better communication.

Speaker 4: Thomas Sheridan, MIT

Title: What Can be Learned about ATIS from a Simulator

- Spoke about the historical use of simulators, driving simulator classes, performance measures in driving simulators, experimental advantages of driving simulators, and experimental validation limitations.

Speaker 5: Thomas Dingus, University of Iowa

Title: Assessment of User Response to ATIS: Human Factors Research Issues

Gave suggestions to the project:

- Discussed Human Factors versus Driver Behavior. He said that driver decision making is human factors and that human factor people don't just look at human factors like nobs and colors. The two fields need to cooperate and communicate better. This project is ignoring the contribution that the human factor people can make.

- There is a micro aspect to studying ATIS, which is driver behavior, and a macro aspect, which is the impact on the network. This project needs to have a more macro view on ATIS.

- All tools available need to be utilized to understand the complex issue of ATIS. Other data sources to be used that were not mentioned in the reports are surveys and questionnaires, high fidelity simulators, and single vehicle studies.

Speaker 6: Barry Kantowitz, Battelle Human Factors Transportation Center

- Battelle has a $5 million, 40 month project to design human factor guidelines for ATIS. There are three parts: analytic, empirical, and integration.

- ATIS simulators are nothing special, they use all the same stuff already done in human factors, and driver behavior people should check into it.

- Psychological fidelity is much more necessary than physical fidelity (not necessary or cost effective). For example, it was found that the incredibly expensive, high fidelity air force simulator produced the same behavioral results with and without all of its "bells and whistles" on.

- All of the tools available to us should be used. They should be used sequentially (simulators, laboratory experiments, and finally field tests) to get maximum benefit from each step. A priori research and assumptions lead to simulator tests, which then narrow down a set of alternatives. The laboratory tests are then used to see if results validated partially in the simulator work on a lab road. This step provides the biggest bang for the buck. Finally the field tests are the definitive test as to whether it works in the real world.

Discussion

The chairman requested that people send information related to this project to MIT.

- Question about what biases incentives cause and what are the value of incentives.

- Paul Jovanis pointed out the difficulty of Barry Kantowitz's 'series approach'. For example, non TravTek people wanted to test the interface they were going to use in a simulator, but TravTek didn't want to stop and look, they just wanted to hit the street with the fancy stuff. Tom Dingus mentioned that field test do not use rigorous R&D, because there is an urge to get field tests on the road, they want answers quickly, and this is harmful to the results.

- Charles Goodman pointed out that field tests were not the ultimate test because they often involve a narrow scope (particularly geographic), and the government approval process is special.

- Another participant mentioned the IEEE standard Simulator test protocol ('DIS Protocol')

- Tom Sheridan pointed out that formal experiences are not always necessary. There is a need for preliminary test and informal experiments before formal tests. It does not have to be fancy, just need thoughtful game playing.

- Andre De Palma commented on the interest in understanding the market of ATIS. There are lots of people and things involved, how do we simulate the market to get at awareness and access? Joseph Sussman added that the question of how consumers will evaluate ATIS (widget or value added) is important.

- Barry Kantowitz discussed the Battelle simulator that he said gets at awareness and access. 'Task h' in their $5 million project gets at consumer acceptance. The question is how do you ask people if they will buy when they don't know enough about the product. How much information should be provided? The answer is enough to be tangible, but not too much to overwhelm. In their project, they showed a video of TravTek to people and gave them the same survey as the TravTek people. They then compared the responses

of those who actually used the system to those who watched the video. It appears that those who watched the video are more likely to buy!

- Bob Dial was concerned that the first aim of ATIS is at the general public instead of at the commercial sector. No one values time more than the commercial sector.

- Asad Khattak said that preliminary studies at UC Berkeley have found that the travel time benefits of ATIS are very limited, even in unexpected conditions.

- Tom Sheridan mentioned that evaluators of technology tend to be proponents of the technology and that negative response doesn't come until later. There is a tendency to say "here's how it is, how do you like it." It seems better if there was more care in acquainting the population, for example present it similarly to the way the health care debate is presented -- hear the subject debated among "experts" and make your opinion. Moshe Ben-Akiva mentioned that this is the idea of information acceleration: bring the subject to the lab, load them with information at their request and observe what information they consult and the reactions/responses to the information.

- Charles Goodman questioned what the premise of the simulators are. He is concerned that the commute to work is the primary target audience, but all sorts of trips are impacted by congestion. He suggested that a broader scope that the commute to work be considered.

Workshop on User Response to ATIS

Massachusetts Institute of Technology
Cambridge, Massachusetts

Summary of Session 3: Operational Tests and Travel Surveys
Chairman: John O'Donnell, The Volpe Center

Speaker 1: Paul Whitworth, EG&G/The Volpe Center

Title: A Review of ATIS Operational Tests

NOTE: Additional information on the subject of this presentation can be found in the section of the report with the same title

- Presented an outline of which operational tests could produce data useful for traveler behavior modeling.
- The presentation included:

  1. A Summary of ATIS Operational Tests
  2. Data Gathering Techniques for User Response
  3. Information From Operational Tests
  4. Conclusions

- Operational tests described include:

  1. Completed: TravTek, Pathfinder.
  2. Operational: SmarTraveler SMART Corridor.
  3. Being Planned: DIRECT, ADVANCE, FAST-TRAC, Houston Smart Commuter, Genesis.

- Data gathering techniques described include:

  1. Test Market
  2. Natural Use Study
  3. Yoked Study
  4. Stated Preference Data from Test Subjects

- Conclusions were the use of operational tests as a data source has strengths and weaknesses. Strengths are they provide good data on en-route usage and route choice. Weaknesses are they do not provide good data on awareness, access, pre-trip usage, mode choice, and departure time choice.

Speaker 2: Richard Bolczak, MITRE

Title: Assessing User Response in the ADVANCE Project

- ADVANCE is a full service in-vehicle system.
- ADVANCE features four major processes: Mobile Navigation Assistant (MNA), Radio Frequency (RF) Communication Network, Traffic Information Center and Traffic Related Functions. MNAs are in-vehicle devices that receive travel information that first is collected by traffic probes and then channelled through the RF Communications Network and the Traffic Information Center.
- Over a one and one-half year period, at least three thousand MNAs will be installed in privately owned vehicles and fleet vehicles. All units will be in operation for one year. In addition, one thousand volunteers will participate in an in-depth study.
- Through a unified survey approach designed to avoid duplication, ADVANCE will evaluate the effects of ADVANCE information products on driver route choice behavior and general travel behavior, operations of commercial and public fleet vehicles, driver perception of the products' effects on safety, anxiety, comfort and security and driver willingness to pay.
- ADVANCE information products include static and dynamic navigation, a business directory, and emergency request services.
- ADVANCE will distribute surveys before, during and after driver participation in the project. Travel data recorded by each MNA and surveys conducted with focus groups will supplement this information. No driver logs are planned.

Discussion

Issues discussed during the workshop included the degree to which information actually can be collected from private drivers and retained for private use. Another issue involved the recruitment of volunteers and their level of tolerance for the survey process. Another focused on driver reaction to poor travel information.

- Richard Juster thought that, in the absence of travel diaries, the project will get only geographical location and sequence of routes, but no records of activities with respect to destination.
- Another pointed out that once the driver has completed his/her route, no mechanism in the system indicates real travel time vs. suggested travel time.
- A representative from Multisystems, the evaluator for the SmarTraveler operational test in Cambridge, MA, stressed the importance of building an evaluation mechanism into the project so that data collection can occur at all points in the process. Bolczak responded that ADVANCE's focus is evaluation.

Speaker 3: Asad Khattak, University of California, Berkely

Title: Travel Surveys as a Source of Advanced Traveler Information System User Response Data

- Advanced Traveler Information Systems (ATIS) are designed to manage and reduce congestion levels through the collection and dissemination of information to travelers. Determining user response can be achieved by collecting behavioral data through travel surveys.

- ATIS data collection and dissemination is a three-step process. Surveillance components include loop detectors, video cameras, probe vehicles and general observation. Computation involves the establishment of a real-time database, fusion and interpretation, systems modeling, and formation of a public database and archive. Dissemination is provided through private and public sector providers and fleet operators.

- Evaluation of traveler behavior through travel surveys indicates the impact of travel information on driver performance, the degree to which traveler information technologies are effective and the degree of public acceptance of ATIS. Evaluation through travel surveys further produces information on system benefits, costs, design, performance, pricing, marketing and implementation.

- Three types of real-world dynamics assessments examine traveler behavior, transport system performance, transit fleet management performance and information system performance by examining individual and environmental factors. Managed experiments in a lab setting involve controlled stimulus, lower cost, limited realism and a short time period. Managed experiments in a field setting involve partially-controlled stimulus, moderate cost, moderate/high realism and a short time period. Natural experiments in a field setting involve limited stimulus control, high cost, high realism, and an extended time period.

- System characteristics (i.e. information providers, content and attributes) determine individual perceptions, which in turn, influence preference and choice. Individual and situational variables also influence choice. Informational characteristics include content, format (terse, conversational), nature (historical, real-time, predictive), type (quantitative or qualitative, descriptive or prescriptive), and perceived attributes (accuracy). Users form perceptions of this information by evaluating accuracy, future validity (real-time, predictive), specificity (spatial, temporal), level of detail (nature of accidents, actions), consistency, relevance to decisions (completeness) and timeliness (available when needed).

- Given the above-mentioned ATIS characteristics, evaluation methodology and criteria, travel surveys may indicate potential for new communication technologies, intertwine research and FOTs and determine ATIS influence on traveler behavior and system performance.

Discussion

- One workshop participant wondered if ATIS benefits ultimately are limited. Another wondered if alternate routes would become congested. Another expressed concern that Vehicle Miles Traveled (VMT) would increase. Khattak found that drivers preferred the combination of shorter transit time and an increase in miles traveled to a longer transit time and decrease in miles traveled.

Speaker 4 Eric van Berkham, B.G.C. The Netherlands

Title: The Impact of Traffic Information: A Brief Summary

- In the absence of travel information, route choice is a function of habit. If accessible, information influences route choice. In either case, travelers continuously update their travel habits based on experiences with new information, the credibility of information, and new experiences encountered through of habitual decisions.

- After ten "good" experiences with traveler information, travelers generally form and adhere to a new habits. However, poor information and bad experiences with the system decrease the degree of traveler compliance significantly.

- This study analyzed the effect of traveler information on route choice selection. Amsterdam, like Boston, features tunnels and water. Metropolitan Amsterdam features two routes from the northern suburbs into the city. Congestion is measured by inductive loops.

- Travel time for the two separate routes into the city is calculated from points north. Variable Message Sign (VMS) installed at the location where travelers choose between the two routes provide estimated delays on the two routes to travelers.

- The model utilized probability of habit and utility function equations.

- After the introduction of Variable Message Signs (VMS), the model reflected a decrease in habit of 12%. Travel logs of one week duration were maintained before and after installation and results were used to develop a model of route choice. The effect of traveler information on route choice became progressively stronger in the second, third and fourth waves of the experiment.

Workshop on User Response to ATIS

Massachusetts Institute of Technology
Cambridge, Massachusetts

Summary of Session 4: Recomendations
Chairman: Moshe Ben-Akiva, MIT

Speaker : Amalia Polydoropoulou, MIT

Title: Proposed Data Collection and Analysis Program

NOTE: Additional information on the subject of this presentation can be found in the report titled "Public Acceptance and User Response to ATIS Products and Services: Modeling Framework and Data Requirements".

- Presented recommendations for data collection and analysis to model traveler behavior.

- The presentation included:

  1. Modeling Framework
  2. Data Needs
  3. Evaluation of Existing Data
     - travel surveys
     - driving simulators
     - field experiments

- Recommendation for further research included:

  1. Develop extended simulators with information acceleration capabilities.
  2. Assemble a data base consisting of data from simulators, operational tests and surveys.
  3. Develop and validate ATIS user response models.

Discussion

- Even where some data is available from simulators, the data currently available may not be satisfactory and collection procedures have to be improved, including enhancing the fidelity of these simulators.

- The need for standards on simulator design as well as on data collection and usage was discussed. The purpose would be to make data available to a wider audience in a comprehensible format. A process/synergy is required to achieve that. DOT recognizes the existence of this problem, it was noted. While DOT might have to take the lead in that matter as far as policy questions are concerned, it was emphasized that this issue reflects heavily on researchers who are the major consumers of data. Other possibilities included establishing a committee or task force within TRB or IVHS America to define data consistency guidelines.

- Some participants cautioned that it may not be a simple task to consume other peoples' data, and that other data bases may not be set up to answer questions one has in mind.

- It was suggested that institutional arrangements are needed which would ensure that some agency is overseeing information consistency in all evaluations of Field Operational Tests. Such a process would have that agency involved from the outset so that data may be put in a standardized format. If sets of dependent variables and classes of independent variables can be identified and agreed upon, this will help define what data needs to be collected. In addition DOT should have enough control to make sure that all info (including negative results) are out and are not suppressed.

- As far as data from TravTek is concerned, it was noted that some data collection was funded by GM which now owns the data. Most other TravTek data is in principle public but some difficulties are materializing in terms of the technical complexity of the data set and in setting up a proper database. While forthcoming reports are expected to publish such data, it was viewed that the priority will be given to using the data for evaluation purposes as opposed to making it publicly available. Questions were raised as to who should bear the cost of making the data useful and widely available and putting it in shape.

- Two approaches were identified in terms of data collection. The first would make use of large scale data collection intended to study natural behavior with outcome being made available to the public and is within the spirit of the traditional travel behavior community. The second utilizes smaller operational tests, following initial simulation experiments in a laboratory setting, in the hope that more useful data may be obtained and would publicize results of analyses based on collected data.

- It was emphasized that since ATIS represent new products, there might be a lot to learn about potential responses from controlled experiments which are small-scale and controlled and which take human factors aspects into consideration.

- The need to consider situational factors (is it a work trip or Sunday afternoon trip?) in simulator designs was emphasized. Many replications with a variety of situational factors would be required towards that end.

- It was noted that some of the operational tests to be conducted in the Bay area (TravInfo) will allow an evaluation of awareness and access thus providing test markets. The open architecture setup will allow any providers to come in with new products.

- It was noted that the big operational tests are really technology tests rather than focusing on an evaluation of user response to and overall benefits from such systems.

Workshop on User Response to ATIS
October 1, 1993

Attendance List

Elizabeth Alicandri	FHWA
Moshe Ben-Akiva	MIT
Adriana Bernardino	MIT
Richard Bolczak	MITRE
Elizabeth Borg	EG&G / The Volpe Center
Peter Chen	University of Texas at Austin
Andre de Palma	Universite de Geneve
Tom Dingus	University of Iowa
Walter Gazda	The Volpe Center
Ron Giguere	FHWA
Charles Goodman	FHWA
Dinesh Gopinath	MIT
Paul Jovanis	University of California at Davis
Richard Juster	Multisystems
Barry Kantowitz	Battelle Human Factors Transportation Center
Isam Kaysi	American University of Beirut
Asad Khattak	University of California at Berkeley
Haris Koutsopoulos	Carnegie Mellon University
Jane Lappin	EG&G / The Volpe Center
Truman Mast	FHWA
James March	FHWA
Rabi Mishalani	MIT
John O' Donnell	The Volpe Center
Amalia Polydoropoulou	MIT
Ajay Rathi	Oak Ridge National Laboratory
Gary Ritter	The Volpe Center
Thomas Sheridan	MIT
Richard Sherman	Loral - Western Development Laboratories
Susan Sloan	EG&G / The Volpe Center
Joseph Sussman	MIT
Peter van der Mede	Bureau Goudappel Coffeng
Eric van Berkum	Bureau Goudappel Coffeng
Joan Walker	MIT
Paul Whitworth	EG&G / The Volpe Center
Qi Yang	MIT