User Acceptance of ATIS Products and Services:
A briefing book on the current status of JPO research

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1. Overview

A. What is the purpose of this document, and how is it structured?

This document is a product of Charles River Associates' current task to develop a structured workplan for the study of customer acceptance of ATIS products and services. The draft workplan itself will be available shortly. It is being prepared in a form suitable for selective or general publication, should the ITS Joint Program Office decide to do that.

This document is designed as a "briefing book" on customer acceptance for a narrower audience: for senior management of the JPO, in preparation for forthcoming Congressional appropriations hearings. It was prepared specifically

- to answer the question *"What do we know now about ATIS customer acceptance?"*
- to summarize the *issues* that arise in gaining a better understanding of customer acceptance *("Why is it vitally important?" "Why is it a governmental interest?" "How can the information be used?")*
- to summarize the research strategy that our workplan will recommend, and the reasons for recommending it.

The sections of the briefing book follow a logical development of the subject matter:

1. **Overview**
2. **How do people make their current travel decisions?**
   A. What types of decisions are involved?
   B. What types of research have been carried out, and why?
   C. What has the research shown?
   D. What do such findings tell us about traveler requirements and values?
   E. How has information helped shape existing travel behavior?
3. **What forms of ATIS are currently available to individual travelers?**
   A. What are the various major consumer decisions with respect to ATIS products and services?
   B. What ATIS products and services are currently on the market?
   C. What is known about the marketplace reception of these offerings?
   D. Who are the consumers?
   E. Opportunities and obstacles to further market evolution

4. **What user acceptance research has been carried out?**
   A. What do travelers think of ATIS *concepts,* when they learn about them? What do they want from ATIS?
   B. What have researchers learned from analyzing *existing* behaviors that can help forecast what travelers might do with ATIS?
   C. What do people who have used ATIS have to say about their experiences?
   D. What are customers willing to pay for ATIS information and hardware?

5. **How should new JPO-sponsored user acceptance work for ATIS be planned?**
   A. What do public officials most need to know about ATIS, and why?
   B. What do we need to do to answer their questions?

Throughout the text, where appropriate, we have inserted examples and brief summaries of specific information gleaned from operational tests, relevant survey research, theoretical analyses, and other sources. For ease of identification, these summaries have been formatted distinctively.

The briefing book was mostly prepared by staff of Charles River Associates, with major contributions in Section 3 prepared by Jane Lappin and by staff of the VNTSC.

B. Primary messages

Like travel behavior itself, the story is a complicated one, not readily reduced to a small number of easily-assimilated "truths." This document, however, includes several major themes.

Understanding the potential scope and magnitude of user responses to ATIS is vitally important to both the public and private sectors

The huge anticipated private investments in ITS will not be made unless the expected value of the return is adequate. Potential investors will require reasonable assurance of a "bankable revenue stream." Neither current *transportation planning* methods nor current *market research* methods are capable of producing credible predictions of how people's travel behaviors will adapt with the growth of ATIS innovations.

The travel behavioral responses will be the result of consumers perceiving personal benefits from making adjustments in their travel. If these benefits do not materialize, there will be no travel changes. With no travel changes, there will be no sales of ATIS products and services.

Success in deploying ITS products and services results when users value the services enough to change their behavior as a result of the benefits that ITS can provide. More specifically, ATIS information has value only because travelers use it to make more intelligent travel decisions that add value to them because of the travel.

This means that the benefits from using the information — the benefits that individual consumers value and will pay for to finance private-sector ITS deployments — are essentially the *same* benefits people derive from their travel decisions currently.

However, current transportation planning tools are not up to the task of forecasting traveler adjustments to ATIS, for several reasons:

- ATIS applications will affect travel behavior in ways that do not permit us to predict, in a simple manner, the future travel times (and other costs and benefits) that individual travelers will experience when making their travel decisions; and
- As travelers come to rely on more dependable information on travel times and costs, they will value those attributes of travel much more highly than they do now. The costs of missing deadlines and appointments becomes greater as people depend more and more on the reliable performance of the transportation system.

Our good understanding of existing travel behavior is a positive asset

While *existing* demand and choice models won't work when traveler values have been changed by widespread ITS, the understanding of basic travel behaviors and the key characteristics of current methods will stand us in good stead to incorporate new learning about ATIS.

Early ATIS experience gives clues on factors important to users

People respond positively to ATIS concepts when first exposed to them, and early operational test experience suggests that "hands on" experience can reinforce the initial enthusiasm. The market research to date has highlighted the relative importance of certain ATIS features to particular segments of the population. Accuracy and timeliness are important to everyone.

This is definitely not a run-of-the-mill market research project, using well-established "off the shelf" met hods

Progressive learning about appropriate methods is essential. We need to learn how best to communicate ATIS concepts to respondents, in a way that minimizes various sorts of survey response biases. We need to learn much more about what ATIS features are important to people, and what groupings of people (or trips) are likely to respond in similar ways. To do these things, we need to focus on a small — but important — set of ATIS concepts and prototypical products.

2. How do people make their current travel decisions?

A. What types of decisions are involved?

The volumes of travel observed on a transportation facility (measured in trips, vehicle kms., passenger kms., etc.) are obviously the aggregate result of decisions made by many individual travelers to move from one place to another. However, understanding and analyzing the demand for travel, both local and longer distance, is inherently more complicated than understanding the demand for (say) cans of Coca Cola, Mercury Sables, or seats at a ball game, for several reasons:

- **Travel is predominantly a *derived* demand**
  Relatively little travel is undertaken as an end in itself. Almost all travel is made to allow the traveler to fulfill some other purpose at the destination. Consequently, as advances in communications technologies continue to allow more purposes to be satisfied from a wider range of locations, this should reduce the need to travel (other factors-being equal).

- **Travel involves decisions in many different "dimensions"**
  Travelers are not making just a simple "buy or do not buy" decision. Rather, they must decide:
  – whether to make a trip at all ("trip frequency");
  – where to travel to ("destination choice");
  – when to travel ("schedule choice");
  – *how* to travel ("mode choice"); and
  – by which *route* to travel ("path choice").
  Sometimes these decisions are largely independent and sequential, perhaps (but not necessarily) made in the order listed above. They may, however, be interdependent choices — for example, the feasible options meeting the traveler's constraints may be a limited set of mode, route, and time of day combinations.
  Sometimes, many or several of these choices are reconsidered each time a new trip is made. Much travel is habitual, however, and new alternatives may be reconsidered relatively rarely.

- **The more you buy, the worse it gets**
  The level of service provided by a transportation facility is not constant, but declines as demand increases. This fall-off in the quality of the product becomes most marked when the demand is approaching the capacity of the facility. The congested highway and the crowded bus or plane offer slower speeds and/or more uncomfortable traveling conditions as the demand increases.

How do people make their current travel decisions?

It is because of inherent complexities like these that forecasting future travel is such a difficult undertaking. People have many different ways in which they can react to conditions or circumstances that do not meet their liking, both *before* making a trip and *while* making the trip. They can decide to go at a different time, or not to go at all. They may be able to satisfy their purpose at a different destination. They may switch modes, or go by a different route.

But despite the many different ways in which individual travelers may respond to the travel conditions, when looked at in aggregate, *current* travel volumes on existing transportation facilities have many regularities that (as we shall see) can be explained by a relatively small number of influencing factors.

C. *What has the research shown?*

Evidence from early attitudinal surveys

While most of the quantitative models used in forecasting travel behavior and in planning conventional transportation infrastructure investments are derived from the analysis of existing behavior, **a richer insight into underlying traveler motivations can be gained from attitudinal research.** In particular, much attitudinal work was done in the latter half of the 1960s largely as an outgrowth of the federal government's then fascination with potential major investments in technologically new systems of urban public transportation.

Some key studies were carried out by a team of researchers at the University of Maryland,[1] by John Lansing and his co-workers at the University of Michigan,[2] by Chilton Research and National Analysts in a national NCHRP-sponsored survey,[3] by Russell Ackoff at the University of Pennsylvania,[4] and by Abt Associates.[5] Most of these studies were concerned primarily with local (urban) travel.

Synthesizers of this work observed many general similarities among the findings.[6] First, people frequently say that ***travel* time-related factors are very important to them in making their travel decisions.** Significantly, **this includes not only the *amount* of travel time (or the average travel speed) but also the *reliability* of the time.** Reliability considerations figured consistently highly whenever questions were asked about this aspect.

***Safety* aspects are also always rated highly** when they are explicitly included in attitudinal surveys. However, people often do not perceive much difference between their available travel options with regard to safety — typically all of the choices meet the threshold level beneath which safety might be a significant concern — so that **the expressed strong interest in safety doesn't have much practical effect in influencing the marginal travel decisions.**

Personal comfort and convenience aspects also receive strong endorsement. Different researchers have used these terms to include somewhat different concepts, but it is clear that **people rate highly such considerations as not needing to transfer between vehicles, having control over departure times, and having adequate personal space and privacy.**

Typically, despite often vocal opposition to increases in highway tolls and transit fares, the ***out-of-pocket costs* associated with travel decisions usually appear well down the rankings of factors.** Here the opinion survey evidence is consistent with the behavioral evidence: as we shall observe shortly, transportation price elasticities are low, and the trends are often towards options that imply higher travel costs.

The University of Maryland studies,[7] carried out among Baltimore and Philadelphia residents, are particularly interesting because they used 33 different attitudinal statements to characterize various choice attributes. The authors observe that, while they found absolute differences among their importance ratings by trip purpose, the relative ranking of factors was similar for all trip purposes:

1. "Reliability of destination achievement (probably reflecting both safety and time consideration);
2. Convenience and comfort (with emphasis on flexibility and ease of departure);
3. Travel time (but considerable difference depending on trip purpose);
4. cost;
5. Independence of control (reflecting individual autonomy in determining speed, routes, diversions, etc. during the trip);
6. Traffic and congestion (probably reflecting annoyance and perhaps safety);
7. Social (reflecting concern about who is being, or capable of being, traveled with);
8. Age of vehicle (perhaps indicative of a status dimension); and
9. Diversions (with some understatement of the importance of the scenery attribute)".

As one might expect, the more qualitative or abstract the attitudinal concept, the more sensitive are the findings to the particular context and wording of the survey. Examples include such considerations as "status," "self-esteem," and "social contact." These concepts were felt to play some potentially important role in (for example) commuting mode choice — at least in the 1960s, when racial distinctions and tensions were much in the public consciousness in the major cities — but attitude survey responses suggested that such aspects were well down in the importance rankings of major influencing factors.

The NCHRP national survey[3] of the travel attitudes and behavior of approximately 5,000 people produced rankings of attitudinal factors that were very similar to those found in the earlier University of Maryland surveys. Here are the seven highest attitudinal measures, when ranked by the proportions of respondents rating them "of great importance" in connection with any trip purpose:

- *Feel confident the vehicle will get you to destination without accident* — *48%*
- *Feel confident vehicle would not need to be stopped for repairs* — *45%*
- *To feel independent of anyone else for your transportation* — *41%*
- *To not have to change vehicles* — *38%*
- *To be protected from weather while waiting for a ride* — *37%*
- *To travel in an uncrowded vehicle* — *32%*
- *To have a comfortable vehicle* — *31%*

The one surprise in the NCHRP survey results was that the statement "To make the trip as fast as possible" was thought to be "of great importance" by only 17% of the sample, thereby ranking travel time considerations significantly lower than found in other attitude surveys. This was thought to be due, at least in part, to a *higher proportion of private vehicle users in the sample than for other surveys, and these people's speed expectations may have been satisfied for many of their trips.*

This last finding highlights a problem with many of the attitudinal studies. The findings on the importance of influencing factors on travel **are inversely related to the current level of satisfaction with that attribute.**

The analysts of the 1960s attitudinal surveys also examined which characteristics of the travelers and of their trips were associated with the most important variations in the expressed attitudes. The *purpose* of the trip was an obvious candidate, because it reflects the varying values that people are likely to derive from their activities at the destination. Nevertheless, **at least as far as the relative *rankings* of choice attributes were concerned, trip purpose didn't seem to have much effect.**

The most important differences noted were that **travelers making work-related trips expressed a slightly greater interest in travel time and speed,** whereas **for non-work trips "comfort" and "convenience" considerations increase somewhat in importance.**

The University of Pennsylvania study,[4] concerned (like many of the other studies) primarily with modal choice decisions, provides the most marked example of this tendency:

> "... it was found that, for work and school trips, 33% of the sample felt they were primarily sensitive to time, 23% felt they were primarily sensitive to comfort, 15% to cost, and 15% to convenience. For other trips, 37% felt they were primarily sensitive to comfort, 23% to convenience, 11% to cost, and only 12% to time."

The only other trip descriptor that appeared to have some influence on attitudes is trip *length.* Not surprisingly, **the longer the trip, the more people are interested in comfort and convenience aspects,** particularly if they are traveling by common carrier.

As for variations in attitudes by the demographic and socioeconomic characteristics of travelers, **the most important personal characteristics appear to be the obviously associated factors of *income level* and *education.*** In most (but not all) studies, the cost **associated with travel options increased in importance as income and education declined.** But there were some more subtle effects, too, as the University of Maryland work' found:

> "(Reliability) is most important to respondents on the 'to work' trip . . . Its importance increases to those (a) with lower incomes, (b) with full-time jobs, (c) who are non-whites, (d) who are employed and middle-aged, and (e) who are non-owners of homes and automobiles."

Evidence from revealed preference studies

The main features of the attitudinal survey findings are supported by behavioral evidence at several different levels, ranging from superficial observation through to painstaking statistical analyses of detailed information about travel patterns.

A good example is the low importance of out-of-pocket costs as an influence on travel choices, relative to travel time and reliability considerations. At the anecdotal level, one has only to observe the high level of taxicab ridership and revenues nationally, relative to those of rail transit, or the relative growth of private vehicle commuting in dense metropolitan areas. In 1990, over 70% of all US workers living in urbanized areas drove alone to work each day by private vehicle. Many have a transit alternative that would be considerably cheaper for them if money cost were their major consideration. People are clearly telling us by their behavior that, at least under present economic conditions, **they are prepared to pay for *quality* transportation service.'**

Time series analysis of local travel purchases by consumers — be they of gasoline, turnpike tolls, or transit rides — generally shows that **the aggregate demand is quite inelastic with respect to prices.** There are sometimes specific market segments that reveal a higher-than-average price sensitivity — even, in a few rare cases, sufficiently elastic that revenues can be increased by lowering prices — but for the overriding majority of travelers and trips, price increases have only a limited impact on their travel behavior. And **this finding is not restricted to the price levels typical of current North American experience; in other developed countries, where fuel taxation policies usually make travel significantly more expensive, behavior is equally price-inelastic.**

Many of the same analyses of time series data have shown a greater sensitivity of demand to changes in average travel times and other service quality variations. However, at the aggregate level, and over time, these differences may be relatively rare and difficult to measure. A much richer vein of quantitative analysis derives from investigating the effects of cross-sectional variations in travel conditions. For example, analysts have studied how people's choices of mode, route, or parking facility vary with the prices and the perceived service characteristics of the various alternatives open to them.

One convenient way to summarize key findings from analyses of this type is to express the travelers' values for marginal adjustments in various service attributes in terms of the magnitude of the price change that would have an equivalent effect. For instance, analysts often infer an average monetary value for travel time savings. Comparable valuations can be made for other service attributes — reliability, comfort, convenience, and so on — insofar as these attributes can be quantified and their individual influence on travel choices can be identified.

There is a very substantial body of literature of this sort, in which multivariate analysis methods and model structures have been applied to investigate how travel choices vary as the characteristics of the available options, and of the travelers, differ. A **number of generalizations, or "rules of thumb," have emerged from these investigations,** all consistent with the evidence from both attitudinal surveys and aggregate times series analysis:

1. **Travel times are relatively important**

   The studies uniformly show that the travel time implications of travel alternatives are a highly important determinant of consumer choices. Other *factors being equal,* people are very likely to choose the option with the lowest *origin-to-destination* travel time.

   For urban area travel to and from work, people behave as if they value travel time savings at roughly a third to a half of the wage rate, on average. This can vary depending on the choice situation involved (for instance, mode choice, path choice, and so on). Non-work travel time savings are usually valued less highly.

2. **Not all time savings are equal**

   The time spent getting to and from motorized transport, or waiting for the vehicle to arrive or depart — components of the complete trip that are often referred to as the excess or *access/egress* components — appear to be more onerous than the time spent actually traveling in the vehicle (the so-called *Eine-haul* component). Travelers typically value reductions in excess times more highly than reductions in line-haul times.

   Moreover, the excess time spent in *waiting* for service — at a bus stop or subway station, for instance — is judged more onerous than the excess time spent walking or riding to or from the line-haul mode.

   By analogy, it is often hypothesized that, for private vehicle trips, reduction in the time spent in stalled or slow-moving traffic is likely to be valued more highly than the same savings in the time spent under free-flowing conditions. While casual observation and introspection strongly suggest that this is true, strong evidence on the matter is less abundant and more circumstantial. This is largely because the necessary conditions and data to make statistically sound analyses of *route* choice behavior are much more elusive than the corresponding requirements for *mode* choice studies.

3. **Travel prices do influence consumer choices**

   To say that the out-of-pocket costs of travel options *are less important* than travel time considerations isn't the same as saying that they are *not important* at all. Other factors being equal, people will choose the least expensive alternative. The results of cross-sectional studies of travel behavior reinforce the attitudinal and time series evidence: prices do influence choices, but a 10% change in travel times is likely to have a greater impact than a 10% change in costs.

4. Aspects of "comfort" and "convenience" that are quantified usually prove to be very important

It is difficult to develop quantitative measures of such amorphous travel attributes as (for example) *comfort, convenience, flexibility,* or *control* that do justice to the full scope of each of these concepts. In multivariate studies, it is often assumed that the unquantifiable characteristics are basically *inherent* to each of the travel choices (modes or routes, say) being examined. Consequently, these "residual" characteristics are represented in the analysis essentially by using a dummy variable to represent each of the choices. Typically, the coefficients for these dummy variables ("choice-specific constants") turn out to be significantly different from each other. This says that unquantifiable aspects do differ between the alternatives, and do indeed influence consumer choices.

Sometimes, some small component of one of these concepts can be quantified relatively easily. A good example for common carrier travel is the *need to transfer between vehicles.* It is common in studies of mode choice between transit and private vehicles, for example, to include a variable indicating the number of transit transfers required. Analysis has shown that such transfers are judged to be particularly onerous. To explain travel patterns, it is necessary to posit a "transfer penalty" — typically equivalent to between 5 and 15 minutes of travel time savings per transfer — *in addition to* the extra travel time involved in making the transfer. This helps us understand why few transit passengers are prepared to transfer more than once in the course of making their trips.

Evidence from more sophisticated stated preference techniques

Survey research techniques have progressed significantly since the early attitudinal studies carried out in the late 1960s. In particular, the 1970s saw the development of so-called *trade off* survey methods, in which respondents are asked to indicate their preferences among a set of hypothetical alternative choices, each one described in terms of several of its key attributes.[1] A tradeoff survey basically simulates a marketplace choice. It essentially says to the respondent, "*If, under certain specified conditions, you were presented with each of these different alternatives, which combination of attributes would you most prefer? Which next?*" If the choices have been designed carefully to maximize the learning potential, multivariate analysis methods can then be used to infer the respondents' underlying preference structure.

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1 ***The original*** and best-known tradeoff method is called ***conjoint measurement,*** which uses a variant of the analysis of variance to estimate each respondent's utility function. Since the late 1980s, tradeoff ***survey*** data have ***also*** been analyzed using similar ***discrete choice models*** to those originally developed to analyze observed (revealed preference) travel choices.

Such methods are likely to be less vulnerable to the response biases that make stated preference methods more suspect than revealed preference evidence. The “art” lies in designing questionnaires that provide a realistic simulation of a real life decision, while not overtaxing the typical respondent’s interest, patience, or information-handling capabilities.

Tradeoff methods are most useful when they can extend understanding into areas that cannot be addressed by behavioral evidence, while anchoring the analysis by reference to behavioral aspects that are already well understood. In a travel choice context, travel times and costs are such strong influences that they must be included in any realistic tradeoff exercise. The fact that the expressed preferences with regard to these “traditional” attributes typically conform to the well-established “rules of thumb” (about, say, elasticities or the valuation of travel time savings) helps to validate the tradeoff method. But one can also include attributes (or attribute values) that are not found in the marketplace today, or attributes that may not be well quantified in behavioral datasets, or attributes than in real life are so highly correlated that their individual influence cannot be clearly identified.

For example, in previous stated preference tradeoff surveys, Charles River Associates has included such variables as

- schedule reliability (or the probability of arriving at the destination within x minutes of the target arrival time);
- amenity aspects of existing travel choices (such as traveling in a new or refurbished car on the New York subway, or using a renovated station);
- personal security considerations;
- technologically advanced modes (for example, high speed rail or maglev peoplemover); and
- amenity aspects for intercity common carrier modes (such as seating density, carry-on luggage arrangements, and cabin arrangements tailored to business travelers).

The relative importance of many of these variables has proved (not surprisingly) to be quite sensitive to the context, and to vary with the nature of both the trip and the traveler in ways that conform to common-sense expectations. For example, in our studies conducted to date, the highest values for marginal improvements in *reliability* have been observed among people making ground access trips to New York area airports, who are very concerned that they catch their flights (that is, the cost of missing their flights is very high). In other studies, reliability is a relatively important consideration for both intercity travelers and New York subway users, with (in both cases) a greater value for work-related trips than for personal trips.

D. What do such findings tell us about traveler requirements and values?

Collectively, the insights gained from attitudinal surveys, from the analysis of time series and cross-sectional behavioral evidence, and from stated preference tradeoff survey methods have helped to shape and reinforce the body of understanding about the most important factors that influence traveler decisions. The early attitudinal survey information helped show what types of measurements were needed to develop quantitative demand and choice models to describe existing behavior. The later quantitative models confirmed many of the insights from the attitudinal work with respect to easily quantified attributes. Practically, the models have been used to improve the methods by which we forecast (say) the demand for new infrastructure investments or new services, or the traveler responses to new operating policies. Now, more sophisticated stated-preference methods are extending our ability to include less easily quantified attributes, and also to include the unprecedented features of new technologies and new options.

Several traveler requirements were identified in the attitudinal studies as relatively important, but they have not yet been fully incorporated into planning and policymaking either because they are difficult to measure or because they have been difficult to address in any way that alters the *status quo* significantly. Travel time *reliability* — essentially reducing the variance in average travel times for a particular alternative — is an important example. Other examples include wanting greater *independence* and *control* over such aspects as departure times, routes, and feasible destinations. Historically, these have been features that, in a mode choice context, private vehicle travel could offer to a level unmatched by any realistic common carrier alternative. In demand models, they have helped contribute to the relatively high "modal constant" invariably found for private vehicle travel.

Unfortunately, none of the 1960s attitudinal surveys addressed specifically the role of improved *information* about travel alternatives in influencing consumer choices. None of them anticipated the growth of the information infrastructure to an extent that some (many?) of the "final demands" — the destination activities that create the demand for travel — might be satisfied without physical movement from place to place. The recent developments in electronic communications generally, and the ITS possibilities in particular, can potentially change the nature of demand for travel — the size and shape of the playing field — in quite radical ways.

E. *How has information helped shape existing travel behavior?*

Existing services and types of information provided to travelers

Readers will probably be quite familiar with historical standards of traveler information in the United States. Of course, practices vary locally, but general standards appear to be quite similar across the country. *On the roads,* the two major types of traveler information are:

- *highway signage and signals,* to regulate traffic lanes, speeds, and flows, to help drivers navigate, and to provide warnings of potential hazards; and
- *traffic information,* provided, both as a public service and as a competitive means of gaining audience, by the broadcast media, sometimes by the print news media, and occasionally (in recent years) by variable signage on the roadways themselves.

Navigational information *per* se on roadway signs is quite variable in quality, even on the Interstate system where some national standards are laid out. As to regulatory and warning signage, the United States nominally adopted the international system of signs in the 1970s (when the rest of the world adopted the US eight-sided "stop" sign as a *quid pro quo);* in practice, it is still very rare to find many international signs, either on the open highway or in local areas. Many signs are idiosyncratic, wordy, or ambiguous, and the local standards for signage are, in practice if not in theory, very variable. On the Interstate system, the level of informational signage is markedly less complete than in (say) Germany or the United Kingdom. The typical signing and traffic management for construction projects and for diversions are also noticeably less than in some other countries, both on principal highways and on local roads.

For US *transit systems,* the historical standards of information provisions appear to be based on the assumption that the predominant ridership is by habitual travelers, who consequently do not need to be told the fare or route structure. In practice, while it is true that the majority of trips are by commuters, the turnover among these people can be quite high. It has sometimes been difficult to acquire printed route, fare, and schedule information. The major investments in information systems have been for *telephoned* requests, assuming that "casual" or "impulse" riding was so trivial that it was not necessary to provide much information at rail stations or bus stops.

Over the last 20 to 25 years, this has begun to change slowly, as transit has started to think of demand in terms of "customers" and "market share" rather than as a fixed number of "trips" to be carried. Printed materials and boarding point information have increased. Telephone information systems have been automated in some cases, leading possibly to more complete and accurate information in answer to standardized types of questions, but possibly also to a narrowed scope of permissible questions. In our opinion, however, the standard of information provided to potential users by many transit systems still falls considerably short of the information the user needs to be able to make intelligent travel choices.

How do these “traditional” types of information affect travel behavior?

The understanding about existing travel patterns that is derived from *behavioral* (revealed preference) information intrinsically incorporates whatever standards of traveler information were extant in the data. By contrast, analyses based on *stated preference* studies assume that travelers would all possess the same level of information as is provided to the survey respondents. If this level of information is greater than the information that the traveler might reasonably have when making real-life travel decisions, then the stated preference findings represent, at best, the *target* behavioral response that could be achieved with an adequate investment in making travelers aware of the characteristics of their available travel options.

What is the effect on demand of increasing the scope, detail, and/or quality of information provided to travelers, either before or during their trips? Historically, this is a question which has rarely been researched. The pre-1990 literature contains a very small number of relevant studies, usually concerned with quite micro issues of information *design* and *dissemination methods:* transit system map or bus timetable design matters, for example. There is no adequate base of analysis for synthesizing any general lessons, either across different *types* of *information* or across *modes.*

The prospect of ATIS has begun to stimulate much more research into this question than was ever the case in the past. In the next section, we review a number of studies that have explored how present *route choice* decisions are influenced by existing sources of traffic information, and how ATIS innovations might change travel choices.

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7 Michael A Kemp & Melvyn D Cheslow (1976), "Transportation", in William Gorham & Nathan Glazer teds.), ***The Urban Predicament,*** Washington (DC): The Urban Institute.

3. What forms of ATIS are currently available to individual travelers?

A. What are the various major consumer decisions with respect to ATIS products and services?

At the beginning of the second section we described several inherent features of the demand for travel that make (say) forecasting the traffic volumes on a particular highway link in a particular time period a much more complex problem than (say) forecasting next year's sales of a particular brand of home computer. Similarly, the set of consumer decisions concerning ATIS information includes a number of different, but obviously related, components. To varying degrees depending on the precise nature of the ATIS product or service under consideration, four different, sequential processes may be involved:

- The consumer must become aware of the existence/availability of the ATIS information;
- He or she must take any steps necessary to be allowed *access* to the information, including acquisition of any equipment or skills necessary to gain access;
- The consumer must take any steps necessary to *obtain* the information in connection with *any proposed individual trip;* and
- With the information, the consumer then makes the customary *travel decisions* (whether, where, when, how, and by what route to travel).

To the extent that these travel decisions are *different* with the information than they would have been without it, the ATIS information may change aggregate observed travel behavior: the numbers of vehicles on specific highways or the numbers of people boarding specific bus routes at particular times.

Note that **substantially all of the user benefits attributable to the ATIS information derive exclusively from the fourth step in the sequential process.** While there is evidence that some people may have some small value for (that is, would be willing to pay something for) earlier steps in the process,[2] almost all of the benefits to the user

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2 Examples include perceived prestige from having a high-tech gizmo in one's car (whether or not it is ever used), or being able to make some valuable use of traffic information even when one has decided not to adjust travel behavior because of it (say, by calling ahead to apologize for an anticipated late arrival). The latter actually increases the benefit of the trip end activity, and therefore the net benefit from travel.

derive from making changes to travel plans to save time, to accomplish more activities, to have a less stressful journey, or whatever. **If there are no travel-related benefits to the end users, there will be no sales of ATIS equipment and services, and there will be no beneficial impacts on the publicly-owned transportation infrastructure.**

For this reason, forecasting *travel behavior* impacts has to be the primary concern of any study of ATIS customer acceptance. But it is not the only concern. Obviously, **the suppliers of products and services are vitally interested in the second phase of the consumer decisionmaking process —** the *access* phase — because that is where the sales of equipment and the subscription to services takes place.

The first phase — the *awareness* phase — isn't particularly interesting. *Any* new product or service faces a problem of making potential customers aware of its existence and potential user benefits, and ATIS isn't much different from anything else in this regard. Of most interest in this phase is predicting *the growth rate* for the adoption of a new product, but that is of secondary importance to predicting the magnitude of the steady *state demand* after a reasonable level of penetration has been achieved.

How far it will be necessary to understand the mechanics of the *access* phase in order to be able to understand the decisions *to obtain the information for a particular trip* and to *change one's travel behavior* as a result of it is an empirical question that cannot be answered at this stage. It is likely that a common set of influencing factors will play a role in all three types of decisions, albeit possibly to different extents. It may prove possible to identify "reduced form" relationships, that can help forecast *purchases* and *travel responses* separately (albeit interdependently), without being unduly concerned about the structural workings of the individual stages of the process. ATIS is certainly not unique in this access/response decisionmaking structure: somewhat similar situations hold for (for example) the sales of cameras and film, the sales of household appliances and electricity, or the sales of home computers, software, and on-line services. Nevertheless, in researching customer acceptance, **it will be very important, both in seeking information in surveys of potential consumers and in analyzing the findings, to draw clear distinctions between the various types of consumer decisions** being studied.

B. What ATIS products and services are currently on the market?

The ITS consumer marketplace is expected eventually **to provide a great variety of products and services, on a variety of platforms, at many different prices for many different market segments.** Future ATIS products will likely range from local, route-specific travel information available free of user charge on commonly owned communications platforms, to multi-function products that provide users with complete, inter-modal transportation system and traveler services information and interactivity for planning, booking, paying, and managing local and intercity travel.

The safety and security components of ATIS services are evolving largely independently of the traffic and travel information components. They are not addressed in this summary.

Currently, ATIS products and services fall into one of **two categories: live traffic information, and location, route guidance, and navigation products.** Traffic information is available to consumers generally free of additional charge via existing broadcast and communications services, such as radio, cellular phones, and the internet. Location, route guidance, and navigation products are sold through direct mail and audio and computer retail channels. Some of these require location display and interface hardware to utilize their digitized maps and navigation and routing software. **No product currently available on the market** marries these two service sets into a product that **can incorporate live traffic information into route guidance.** A list of commercially available ATIS products is contained in a separate VNTSC document.

Traffic information

Commercial radio traffic information broadcasts reach the largest number of travelers, and define travelers' expectations of the service, for better or worse. This service is available at varying intervals, depending upon local traffic conditions, throughout most of the country.

> *Traffic information on the radio is supported by advertising and has value to the advertiser based on the belief that car radio listeners are listening attentively for location-specific information when traffic information is broadcast and will not tune out the advertiser's message. Some transportation agencies broadcast traffic and incident information directly to travelers via highway advisory radio or local public radio, but most often this information is provided to commercial broadcasters. Traffic information is also available for a limited number of metropolitan areas on the internet, on cable television, during early morning local television news, and on cellular telephones (generally provided by the same company as provides radio information).*

Cellular phone service companies provide traffic information as one of their information services because it's there, not because their customers clamor for it. The decision to make such information available is made locally by the regional manager and is most frequently provided because the competitor service offers it. Regional service providers in Los Angeles and St. Louis have provided subscribers telephone access to talk to a live traffic reporter as a way to differentiate their service from that of their of their competitors, but this does not represent an industry trend.

Since 1993, several companies have attempted to sell traffic information directly to travelers via phone, pager, fax, and stand-alone communications devices, without success. Following a federally-sponsored ITS field test in 1993-4, Smart Route Systems of Cambridge, Massachusetts, has been providing free access to "SmarTraveler" traffic information by phone, under contract to state or local governments in metropolitan Boston, MA, and Cincinnati, OH. Their efforts to sell the service directly to consumers have thus far been unsuccessful. As part of the operational test, an experiment in service pricing demonstrated conclusively that ***Cell One phone subscribers in greater Boston would not pay the cost of air time to access SmarTraveler, though they would use the service regularly if it were entirely free.***

Cue Network Corporation offers a PC-based product that matches real-time traffic broadcasts to digitized maps in six counties in California, Portland OR, and Seattle, WA. Their belief is that the trip home or to a business meeting begins at the commuter's desk. This is currently the only computer-based traffic information product competing with free intemet sites. Consumer response to this product is unknown at this time.

Location, navigation, and route guidance

This set of products is based upon digitized maps, routing software, and GPS location devices. They can be grouped by platform and functionality. **At the high end of the spectrum, consumers can purchase dedicated in-vehicle navigation and route guidance products for approximately $3,000.** This set includes the Rockwell Guidestar, Pioneer GPS-X77, and the Sony NVX-F160. **The mid-level of the in-vehicle market offers less functionality and a lower price tag, generally under $1,000.** This set includes Delco's Telepath 100, and Amerigon's Interactive Voice System sold under license to Clarion, Kenwood, and Pioneer through auto audio stores. The desk-top and portable computer are also platforms for navigation and route guidance products, and prices in this niche are considerably lower as they do not include the hardware, ranging from ~$400 to ~$50. One stand-alone product designed for both OEM and direct mail sells for under $100-$250, depending on the level of functionality selected.

The most sophisticated are built from maps that contain road-segment intelligence, such as one-way restrictions and altitude, and integrate GPS with dead reckoning and map matching. These maps can support a full array of location and navigation functions, and provide fully featured maps, with both voice and visual turn-by-turn directions to a precise location. The least sophisticated provide route guidance, but not navigation (i.e., turn by turn instructions, but not maps).

C. What is known about the marketplace reception of these offerings?

Where the market is just emerging and few products are available to consumers, some assessment of market response may be inferred from industry behavior. While it is very unusual for industry to speak openly and honestly about consumers' response to their products, **it is possible to discern some patterns through an historic review of industry and analysts statements, review of preliminary products' market positioning, and through survey of retail outlets.**

As traveler information system concepts were developing in 199 l-2, several truisms were frequently repeated: the price for any new in-vehicle ATIS product would need to be below that of an air conditioner, in-vehicle ATIS products will not debut as OEM equipment, and, as a communications application outside of the car, traffic information would never be an NII killer application — it would need to be combined with other services on a multi-purpose platform to be salable. Current market observations support these early assertions.

Traffic information

Traffic information is the laggard among early commercial ATIS offerings. This is probably attributable to a combination of market factors. **Metro Traffic Systems, and others** in the traffic information broadcast niche, **have established a service threshold in the traffic information market that defines travelers' expectations for free and accessible traffic information.** Cellular phone service providers have experimented with adding value to existing traffic information by providing subscribers with route specific information with limited success.

> *Metro and others have mastered a formula that maximizes the amount of traffic information produced in exchange* ***for*** *the minimum investment in surveillance and processing equipment. Commercial competitors have not yet discovered a cost-effective approach to improving the value of traffic information to travelers. The additional increment of traffic information required to create comparative consumer value would be disproportionately costly at this time, and no consumer study or market experiment to date has established that any traffic information short* ***of*** *time, location, and route specific information has market value.*

Field tests such as TravInfo in California hope to demonstrate that traffic information gathered and processed by a public agency will have commercial value when re-packaged as part of a value-added consumer product. Other traffic information businesses, most visibly Smart Route Systems, continue to explore the commercial value of proprietary traffic information services.

What forms of ATIS are currently available to individual travelers?

Location, navigation, and route guidance

The array of prices and functionality of early market ATIS entries, in-vehicle, desktop, and portable, indicate that manufacturers believe that there will be a broad consumer market for these products. As with any market, there are very few products offered at the high end of the price spectrum, and a greater number at a lesser price.

> *One market research study sponsored by Navigation Technologies (J. D. Power, 1995) on a high-function in-vehicle product supports the assertion, common among industry specialists, that market penetration concomitant with manufacturing economies of scale will not begin until a high-function in-vehicle product is priced below $500. Currently these products retail between $2,000 and $3,000 installed.*

Manufacturers' early product offerings are exploring the optimal value trade-off among price, function, market penetration, and return on investment. For example, Delco experimented with a high-end full-function "Telepath" prototype for several years before coming to market with a product priced at ~$995, or half that of the high-end competition, offering fewer high-function capabilities. This indicates that Delco does not believe there to be a sufficiently large market for high-priced in-vehicle location and navigation devices at this time without real time congestion information, but that there is a sufficient demand for a product today, which provides general directions to a chosen destination, but not turn by turn directions.

The current US in-vehicle ATIS market is essentially aftermarket. All but one in-vehicle ATIS product are being sold through retail or direct sale channels. Guidestar, a high-function location, navigation, and route guidance system is being sold on certain Oldsmobiles as a dealer installed option. The motivational value of such products to new car buyers has yet to be demonstrated in the competition for valuable dashboard real estate.

> *A newly formed company, Personal Onboard Information Systems, is selling low-end route guidance products, priced from under $100 to $250, and reports to have signed agreements with one or more automobile OEM that will provide their product as standard equipment for 1997. This company believes in a great response from new car buyers to a low priced OEM unit, and has staked out territory at the low end of the in-vehicle market with a lesser function product.*

The car rental market has emerged quickly as a market for in-vehicle ATIS products.

> *Promoting a variety of benefits highlighting personal security and convenience, Avis and Hertz have installed a portion of their high-end rental cars with products that feature location, navigation, route guidance and location-referenced service and tourism sites. These cars are available for rent at certain locations for an additional daily* ***fee of*** *~$5.00* ***The rental car companies report that these cars are in constant demand.***

What forms of ATIS are currently available to individual travelers?

Traffic information, trip planning, and other map-based ATIS products that operate on personal computers are available to travelers who begin their trips at their desks or in their homes. Equally, there is known to be a segment of business travelers who travel with a combination of laptop computer and mobile telecommunications devices who value trip planning and location specific transportation information. This niche is also being explored with competitively priced (relative to other software programs) early product offerings.

In a number of cases described above, **the target customer** is expected to find the greatest product value during business-related travel, and thus **may not be using personal funds to make the purchase.** Where the product is an in-vehicle unit, the customer may be a salesperson who can expense the investment against earnings over time. Where the customer is a frequent flier, carrying mobile productivity tools, the cost of the route guidance and navigation software may be borne directly by the employer. Finally, where access is mediated via intemet, it is as likely as not that the employing company has assumed the subscription costs of intemet access.

An informal survey of consumer and automobile electronics stores in metropolitan Boston, Washington, DC, Chicago, Miami, San Francisco, and Los Angeles provides further insight into consumer response to in-vehicle navigation products. Very few are being properly promoted and supported by their manufacturers and very few are being sold. Retailers say they themselves find the products very appealing and would like to promote them more actively, but cannot do so without marketing, product, and service support from the manufacturers.

D. Who *are the consumers?*

In the absence of direct survey and sales data, it is impossible to describe ATIS consumers with any precision or reliability. The data that does exist is from some field test evaluations, but even this data has limited applicability. Where ATIS products are available for sale on the market, one can assume that the manufacturer is basing marketing, advertising, and retail channel choices on marketing research, and thus infer certain consumer features from this evidence.

Very little is known about traffic information consumers. **Generally they appear to be employed drivers who listen to radio reports most frequently when driving to work in the morning.** Some segment of commuters listen to traffic reports before leaving for their morning drive to work; far fewer tune in to traffic information in preparation for their trip home from work.

> *The largest body of systematic data on this segment is contained in the SmarTraveler field test evaluations and indicates that most consumers are drivers who use the information mostly en-route and in the presence of bad weather or in the presence of a known incident or event. A small and unknown proportion* ***of*** *drivers who own cellular phones use them to obtain traffic information en-route, more often when confronted with evidence of unexpected congestion. An unknown number of computer owners with internet access may consult on-line traffic information pre-trip. Since non-radio, non-telephone access requires expensive media, we can assume incomes are higher than average, and users are employed males.*

The consumer segments that appear to have been **targeted by location, route guidance, and navigation market offerings** can be categorized similarly. Most obviously, they **are consumers who spend a significant amount of time traveling in autos in unfamiliar locations. They** travel in their own cars, in leased cars, and in short-term rental cars. They are employed. By and large they have sufficient disposable income or business expense benefits to enable them to make elective comfort and convenience purchases. They are buyers of high end auto stereos and computers, and they are male.

E Opportunities and obstacles to further market evolution

Reported obstacles to near-term ATIS market evolution include a lack of nationally consistent traffic information of sufficient quality, and a lack of national/international communications standards. One obstacle, the lack of precision and uncertainty of access to the Department of Defense global positioning system, is currently being resolved and can be expected to result in better, cheaper personal location products.

Manufacturers of in-vehicle and other ATIS products state that the **value of their products would be significantly enhanced by the addition of route specific traffic information. But, without a better understanding of the parameters of consumer value (need) and national standards for communications and for the information itself, they say there is no point investing in its inclusion.**

Consumer "need" is a tricky concept. Marketers say that we have explicit needs and undiscovered needs. The first are those that we recognize and address with existing products. Undiscovered needs are those we don't realize we have until an innovative product defines it. In the years that preceded automated teller machines, did we have the explicit need to conduct bank transactions any time of the day or night? Potential ATIS products fit into this niche of unknown need because we have had no personal experience with the products and thus no idea of the benefits it may provide to us.

4. What user acceptance research has been carried out?

A. What do travelers think of ATIS concepts, when they learn about them? What do they want from ATIS?

There have been a number of studies in which researchers have introduced members of the general public — singly or in groups — to ATIS ideas, and sought their reactions. Sometimes this has been in connection with one particular product or service concept, which may or may not have developed a "working model" that can be demonstrated, in person or on videotape. In other cases, the concepts have been presented in more general terms, or opinions solicited about how such market offerings should be designed to best meet the needs of their users.

In general, from CRA's experience and from what has been reported in the literature about this type of research, **many people get excited about the prospects of certain ATIS enhancements,** particularly for private vehicle travel.

> *As part of an ITS strategic planning study for the TRANSCOM consortium in the New York metropolitan region, a telephone survey of about 1,000 regular peak-period travelers was carried out.[1] This explored their current use of information sources regarding travel conditions, and their interest in obtaining ATIS information of various sorts. Most of the ATIS improvements presented involved pre-trip or en-route information obtained from a fixed location (at home, or at transit facilities) or by radio or telephone from within a private vehicle; relatively little emphasis was placed on enhanced in-vehicle equipment. While such a telephone survey method may be expected to produce overstatement of the respondents' interest, the very high level of support for enhanced traveler information was remarkable: 88% said that they "favored building an improved travel information system like the one discussed in this survey," and 78% indicated that they would be willing to pay something to do so. The improvements receiving most positive endorsement were those providing real-time information on the locations and extent of traffic delays, travel times using various routes, and expected arrival times for transit vehicles. Interestingly, when asked to speculate about how their travel behavior might be affected by enhanced information, for the third of this New York region sample who anticipated greater tripmaking, 82% foresaw more transit trips, compared with only 13% who foresaw making more private vehicle trips.*

For private vehicle travel, there are tentative suggestions that users may be more interested in ATIS information for long-distance trips than for local trips, and in ***en route*** **information than in pre-trip information.** We suspect these indications may be somewhat context- and survey-specific, however, and would caution about generalizing from them at this stage of understanding.

The I-95 Corridor Coalition has surveyed a variety of Northeast Corridor travelers by various modes, asking them about various forms of ATIS information that they would find useful.[2] Here are the proportions of long-distance private vehicle travelers rating different types of information as either "somewhat important" or "very important":

	pre-trip	***en route***
weather information	*90%*	*93%*
construction information	*80%*	*94%*
traffic conditions	*74%*	*86%*
local directions	*71%*	*74%*
long distance directions	*70%*	*na*
alternative routes	*na*	*95%*

For local private vehicle travelers, the proportions are smaller and the priorities are slightly different:

	pre-trip	***en route***
weather information	*80%*	*82%*
construction information	*73%*	*86%*
traffic conditions	*71%*	*81%*
alternative routes	*na*	*84%*

For public transportation passengers, both intercity and local, en route information is again valued more highly than pre-trip:

	pre-trip	***en route***
Intercity rail passengers:		
train schedules	*88%*	*na*
train delays	*64%*	*82%*
arrival time	*na*	*88%*
Air passengers:		
confirmed schedules	*75%*	*na*
flight delays	*71%*	*na*
airline connections	*na*	*80%*
destination information	*na*	*54%*
Rail transit passengers:		
train schedules	*86%*	*na*
train delays	*65%*	*83%*
arrival time	*na*	*83%*
Bus transit passengers:		
bus schedules	*77%*	*na*
bus delays	*65%*	*85%*
arrival time	*na*	**88%**

Personal and vehicular security **and *convenience* are two features that often resonate most immediately** with respondents. "Mayday" features do not duplicate anything currently on the market, and they appeal particularly to women. The ability to locate stolen vehicles also has a quite strong appeal to focus group participants, despite the somewhat lukewarm growth (over the last 10 years or so) of products available to enable just this function.

> *In a USDoT-sponsored project to determine what* ***rural*** *drivers are looking for from an ATIS system, national telephone surveys of over 1,000 respondents were used to develop an "importance ranking" of possible features or benefits.*[3] *The mean respondent importance scores were for (in descending order) a mayday device, warning* ***of*** *rapidly approaching hazards, a signal to "wake-up" a drowsy driver, information concerning road closures and congestion, information concerning safe driving speeds under prevailing conditions, and pre-trip planning information to facilitate route selection and navigation. Other features thought to be important included the location* ***of*** *ATM machines, restaurants, and motels, a listing* ***of*** *points of interest along a given route, and information on the speed limits and regulations in local areas.*

For ***navigational*** **and *traffic reporting* functions, there is enthusiasm among the general public which is tempered by a degree of skepticism.** In both cases, **these functions will only be useful to the extent that they prove to be both *accurate* and *reliable.*** In the case of navigational information ***per*** se, people who make mostly local trips may not immediately see much need for assistance. They think that they know their local areas well, and routine (infrequent) navigational uncertainties — identifying the location of an unfamiliar street name, for example — can be easily resolved by consulting a map or obtaining directions. On reflection, some people realize that they make more trips in unfamiliar territory than at first they appreciate (taking children to away sports fixtures, for instance), and then begin to see a greater personal utility.

Electronic map devices can create initial concerns about being distracting, and potentially complex to use. The "heads up" nature of *audio* instructions provided by some navigational devices is consequently an appealing feature.

> *109 licensed drivers in the Seattle area were exposed, in small groups, to two videotaped depictions of the TravTek system (which includes a voice guidance feature).*[4] *One was a "how to use" tutorial; the second depicted a drive through the Orlando area using the system. After each of the presentations, the participants independently completed a questionnaire, without any group discussion. In general, the respondents rated the system both "easy to learn" and "easy to use," assigning mean scores of 4.35 and 4.25 respectively on a scale of zero to six. Age proved to be the only classtfication variable to have a significant effect on the ratings: younger dn'vers gave higher ratings than older drivers. After seeing the product in action in the second video, ease of learning and use scores mostly increased, to extents that varied by age and sex.*

What user acceptance research has been carried out?

The skepticism about *traffic reporting information* focuses on whether it will provide more detailed, complete, action-oriented, or timely information than that available, at zero incremental cost, from traditional sources, primarily radio stations. To the extent that the information meets these criteria, people respond very positively to the concept. The provision of traffic-sensitive *route guidance* is viewed as a significant service increment over simple *traffic reporting.*

> *in research designed to aid the development of an ATIS component ("Genesis") for the Minnesota "Guidestar" ITS initiative, focus groups of Twin Cities' travelers were undertaken to learn what potential users thought were the most important features **of** a system to be based around personal communications devices.' It was found that the key issue for participants was unanticipated travel delays caused by accidents, bad weather, and construction. Drivers felt the core information that needed to be conveyed included the precise location and time of bottlenecks and accidents, what lanes were affected, realistic estimates of the delay time, and guidance on alternative routes. More general information about road and weather conditions were also felt to be valuable.*

There has been some qualitative research of a similar nature among business occupational groups expected to have above-average use for in-vehicle navigational and route guidance information (such occupations as real estate agents **or** delivery staff). As might be expected, **business people tend** to **be more interested in the navigational and delay avoidance capabilities —** allowing the driver to keep appointment schedules and communicate ahead if problems arise **— and less interested in security features than are the people making mostly non-work trips.**

The lowest interest levels concerning the capabilities of ATIS devices in private vehicles are reported for features that overlap with currently available technologies: general communications features, for example, which may replicate (sometimes less flexibly or completely) the capabilities of mobile telephones, or "yellow pages" types of information to direct one to (say) the nearest ATM, restaurant, or filling station.

B. What have researchers learned from analyzing existing behaviors that can help forecast what travelers might do with ATIS?

Route choice decisions made by private vehicle users have been the focus of most current work on *existing* travel behavior that may have strong implications for the ways in which travelers respond to ATIS information. There are two reasons for this. First, of all existing travel choices, route choice has been arguably the least studied historically, and is consequently the least well understood.[3] Secondly, there is some evidence that the primary use for *currently-available* forms of travel information is to make route adjustments.

> *Respondents to the TRANSCOM strategic planning telephone survey were asked whether, in the preceding twelve months, they had ever changed their intended form of transportation, departure time, or route as the result of receiving information of various types. For highway-related information, changes of route had been more common than either mode or departure time adjustments.*[1]

The frequency of making a trip appears to have a major influence on adaptive routing behavior. For frequent trips, "habit" can affect behavior:

> *For a period in the early 1980s, the toll on the Golden Gate Bridge was increased to $2 per automobile on Fridays and Saturdays, while remaining at $1 on other days of the week. Researchers at George Mason University, analyzing time series traffic data, found evidence that this caused little time switching (people working shorter work weeks, for instance), and that some people who sought alternatives for the high toll days extended that behavior to other days as well.*[6]

There are also differences in behavior depending on whether relevant information on traffic conditions is received before starting the trip or while *en route.* There are certainly differences related to the driver's perception of the *likely accuracy* of the information.

> *University of California researchers undertook two waves of computer-assisted telephone interviews, working with an initial sample of over 940 morning commuters in the Los Angeles area, to study (i) who was most likely to seek out radio trafic information, and (ii) how the acquisition and use of such information affected routing decisions.*[7] *The responses were analyzed in part by developing discrete choice models for various behaviors. When a traffic incident was reported on a respondent's regular commuting route, (s)he was more likely to stay on the route than to divert, whether or not (s)he had received the information. If information was received before beginning the trip, this offered the opportunity to*

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3 The existing travel forecasting models assign projected vehicle trips to routes essentially by assuming that drivers seek to minimize travel times, and they reallocate trips essentially randomly among competing routes when projected flows approach the capacity of a highway link.

make major route adjustments, whereas en route information is more likely to lead to only a minor local deviation around the immediate location of the problem.

The people most likely to acquire radio traffic information include those who believe most in its accuracy, those whose trips face the most variable traffic conditions, and women. The probability of making route adjustments was higher for the drivers with longer trips, those who believe the information to be accurate, those with the most variable conditions, and for better educated drivers. Women were less likely than men to divert, as were people passing through unfamiliar areas or neighborhoods thought to be unsafe.

Northwestern University researchers undertook a stated preference study of route switching behavior in response to trafic information, using a mail-back survey asking respondents how they would react to specific hypothetical delay situations.[8] *They found that commuters would be most willing to divert when the alternate route was a familiar one, when the driver was under time pressures, when the congestion was a non-recurring rather than a chronic problem, and when the information was "validated" by a radio report rather than relying wholly on personal observation.*

At least one study has been less concerned with pinning down the behavioral response to ATIS information than with identifying likely differences among various categories of drivers. In this and other studies **there are strong hints that sex may be a significant market segmentation variable,** a conclusion that will not be surprising to those who hold that men are much less likely to "ask the way" than are women.

A mail-back survey was conducted of some 4,000 Seattle drivers intercepted at ramps of the I-5.[9] *The questionnaire asked about route familiarity, schedule flexibility, travel preferences, and whether pre-trip or en route traffic information had ever made the respondent change an aspect of his or her trip. Cluster analysis was conducted of the reported propensity to make changes, and four groupings were identified: "non-changers", "pre-trip changers", "route changers", and "route and time changers". Over 75% of the sample had made changes of one sort or another. Demographically, the non-changers and the route changers were quite similar to each other, as were the other two groups. However, the pre-trip changers and the route and time changers had significantly more females and younger people than the other two groups. Also, even the non-changers appreciated receiving traffic information, even if their travel behavior was not influenced by it.*

Because of the obvious practical difficulties of obtaining detailed (decision by decision) information about route choice behaviors, most analysis of *behavioral* information is for frequent commuting trips. Some studies, like the Northwestern University one, use *stated preference* responses to hypothetical situations, while a few studies attempt to simulate route choice situations in the laboratory.

In Japanese laboratory simulations, 40 participants made choices between two possible routes from a single origin to a single workplace, departing at a common time.[10] *As a result of their collective choices, the experimenter used a speedflow* *function to tell each participant privately how long "that day's" journey took. Participants then each predicted the travel time for the next day' s journey, and chose their routes accordingly. This process was repeated through some 20 "days" — that is, repeated iterations of the learning about the last travel time, predicting the next travel time, and choosing a route. Different experiments varied the amount* ***of*** *historical information given to the participants, and whether or not they were allowed to keep their own records. The results of this simulation suggest that* ***improved information can help bring flows towards equilibrium faster. They also*** *suggest that* ***accuracy in predicting the travel time is inversely correlated with the propensity to switch routes.***

Some of the route choice research has specifically explored the potential impacts of having additional information of a sort that would be made feasible by various ATIS concepts.

Three academic researchers have undertaken theoretical analysis of a simple case ***of*** *commuters choosing between two routes on the basis of pre-trip information." Both routes have bottlenecks whose capacities vary at random. Travelers can also* ***use*** *the information to change their departure times, but there is assumed to be some disutility in arriving at work before or after the desired arrival time. With a numerical example and a mathematical proof the authors show that not only will there be individual user benefits from the pre-trip information but, with perfectly accurate information available to all of the commuters, there will also be system benefits — that is, total travel time reductions — by comparison with the "no information" case.*

One of the issues addressed by this type of research has been the levels of ATIS penetration at which user (and system) benefits might be maximized. At low penetration, drivers receiving reliable route guidance should benefit from being able to "outsmart" the drivers without it. As the penetration increases, this advantage is reduced, particularly if the system(s) being used compute individual user optima rather than a global optimization of traffic. Two theoretical studies based on network analysis methods have concluded that **diminishing returns for individual users may be experienced before the private vehicle fleet is uniformly equipped with ATIS capabilities.**

Researchers at the University of Texas simulated the effects of an in-vehicle ATIS that receives updated information at each intersection.[12] The researchers assumed that drivers had a threshold travel time saving, below which they would not divert from their routes. When this threshold is low — that is, when travelers switch routes to save even a marginal amount of travel time — total time savings are maximized ***if*** *about one-quarter to one-half of all drivers receive the information. At higher penetration levels, over-reaction to the information will cause congestion on alternate routes. At the other extreme, if the diversion threshold is very high, there will be little or no diversion. Under more moderate levels of driver response to the information, the model suggests that total travel time savings could continue to be realized up to the point where every driver has an ATIS, although most of the benefits to both users and nonusers occur when half or fewer drivers are receiving the* ***information.***

What user acceptance research has been carried out?

> *Researchers at MIT examined the effects of using different algorithms in forecasting network travel times to provide in-vehicle information,*[13] *in an attempt to maintain travel time benefits with increasing ATIS penetration levels. However, given a limited number of roadside beacons to transmit updated traffic information to the in-vehicle units, these researchers observed a similar relationship between travel time savings and the share of vehicles receiving information as did the Texas study.*

These theoretical network studies suggest several conclusions, at least about ATIS routing information designed to optimize the individual user's route:

- **It may not be necessary to have high penetration levels of in-vehicle ATIS in order to observe most of the travel time-related benefits to users and the highway system.**
- Because of diminishing individual benefits from acquiring an in-vehicle device as penetration grows, there may be a natural incentive for "late adopters" never to acquire the ATIS capability — that is to say, market equilibrium may be at less than full market penetration.
- **As market acceptance of this form of ATIS grows, *so* must the *quality* of the information** — for example, in terms of its ability to be based on global rather than user optima, its geographic scope, or its update frequency — or the additional features (safety functions, for example, or motorist services information) that the in-vehicle unit can fulfill.

In driving simulation tests, researchers have found that, **as a driver's personal familiarity with the road network increases, he or she becomes less likely to accept advice** from an external source. Other work has focused on how people respond to receiving inaccurate information. Not surprisingly, they are less likely to use information if they have found it to be bad in the past, and measures of their trust in the information source also decrease. However drivers will often continue to **use** the information, and their trust increases when inaccurate information is followed by what proves to be accurate information.

C. What do people who have used ATIS have to say about their experiences?

The ongoing program of operational tests has exposed samples of the general public to using various forms of advanced traveler information in a variety of different contexts. Information from the evaluation of some tests is beginning to become available. The ATIS operational tests that are most open to the general public, and for which participation requires the lowest level of personal engagement or expense, are those providing high quality traffic information by telephone. It appears that **users can perceive a quality differential by comparison with the traffic information that they obtain from the general broadcast media, but wish that the telephone service would provide greater guidance about route diversions.**

Telephone surveys were conducted with representative samples of the SmarTraveler system that has operated in the Boston metropolitan area since January 1993.[14] Respondents were asked about the sources of traffic information that they use, and were asked to rate several attributes of each source on a ten-point scale. Overall, four-fifths of the Smat-Traveler users were "very satisfied" with the service (scores of 8 or higher), and the users on average rated the SmarTraveler information more highly than alternative sources on every characteristic questioned: coverage of routes, accuracy, time of availability, and frequency of update. Also, the SmarTraveler users were more satisfied with their service than were the users of radio and TV information. [The method employed to sample users — intercepting them as they called in to the system- may account in part for these higher satisfaction scores, likely to have been produced by positive response biases]. However, SmarTraveler users were disappointed by the lack of guidance regarding alternate routes; the service does not provide such guidance because of legal and jurisdictional considerations.

There is evidence from other operational tests that travelers do indeed **find high quality traffic and travel information to be useful, and would appreciate more types of information and its more widespread promulgation.**

In one component of the Travlink study in Minnesota, 150 people were recruited, from nine Twin Cities' businesses, to examine travel information from an on-line source.[15] During the first month of the study, the 150 recruits made almost 1,400 on-line requests. Participants reported that they were sharing the information with their colleagues, and thought that the Travlink project should get more businesses involved. The most popular data requested were traffic and construction information. Bus riders used real-time bus arrival information when that was available. The most requested potential improvements were for more extensive traffic and bus arrival information, and more trip planning features (possibly including nwre detailed bus connection information). While some features of the existing software were largely ignored, participants expressed an interest in enhanced mapping and printing capabilities.

A separate Travlink initiative placed travel information kiosks in malls, major businesses, and transit transfer locations. The kiosks in transit locations were heavily used, although they did not offer real-time bus arrival information. As with the on-line participants, kiosk users requested traffic information most often, and used the features with static text menus least often.

Most of the information in the public domain concerning customer acceptance of, and operational experience with, in-vehicle navigational and route guidance devices comes from the *TravTek* operational test. Between March 1992 and March 1993, 100 Avis rental cars in Orlando were equipped with devices that could provide traffic congestion information, motorist services ("yellow pages") information, tourist information, and route guidance. There were three different configurations of the equipment. One provided motorist services only, the second provided static route guidance (with no real-time information about traffic conditions), and the third provided dynamic route guidance.

The evaluation included three studies:

- A "*yoked* driver" study, in which three drivers drove vehicles with each of the three unit configurations between selected origins and destinations at two-minute intervals under congested conditions.
- The Orlando *Test Network* study, in which drivers examined the possible display configurations in a sequence of three trips during off-peak hours. In this study, participants were assigned to cars with or without the voice guidance feature. During the test trips, each participant used no visual display for one trip and a detailed route map display for the other trips. Researchers monitored that the correct configuration was being used, and recorded the time taken for different components of the trip and the numbers of "wrong turns" made.
- The *Camera Car* study, in which a car specially equipped with four video cameras was used to monitor driver performance and workload.

A total of 134 women visitors and 878 men visitors received training to use the TravTek device before picking up their rental cars at Orlando International Airport.[16] *On returning the car, the participants were asked to rate several features **of** the equipment on a six-point scale. There were no statistically significant differences between the three configurations regarding reported ease of use. The mean rating scores were*

motorist services only	*5.15*
static route guidance	*5.18*
dynamic route guidance	*5.24*

All users gave high ratings (with a mean score of greater than 5) to the legibility of the display text, attractiveness of the screen colors, and the ease of understanding the information. Not surprisingly, the ratings differed most between the configurations when navigational and route guidance were being considered:

"TravTek helped me find my way"

motorist services only	*3.15*
static route guidance	*5.16*
*dynamic **route** guidance*	***5.29***

"TravTek helped save time in reaching destinations"

motorist services only	*2.45*
static route guidance	*4.52*
dynamic route guidance	***4.60***

"TravTek helped me drive more safely"

motorist services only	*2.32*
static route guidance	*3.90*
dynamic route guidance	*4.01*

As well as achieving high satisfaction ratings in the opinion survey of users, the TravTek observational studies provided more objective quantification of some of the user benefits.

*In the Orlando Test Network study, route planning for trips using TravTek features took between one and two minutes on average, compared with slightly over seven minutes **for** the control group (with no voice guidance and no display).[17] Trips guided by TravTek were completed in an average of about 22 minutes driving time, compared with about 27 minutes for the control group. All unit configurations except one resulted in less than one wrong turn per trip, on average (the range was about 0.80 to 0.95). The exception was the map display without voice guidance, with which drivers made an average of 1.3 wrong turns per trip.*

In a privately-funded study,[18] J.D. Power & Associates recruited a total of 170 drivers in three cities (Whittier, CA, Chicago, IL, and Garden City, NY) to use a navigational system ("GuideStar") in a private automobile. The device featured navigational capabilities, including static route guidance, and "electronic yellow pages" databases. The device also offered voice prompts, but did not incorporate real-time traffic information. The primary purpose of the study appears to have been to determine what level of navigational (and services directory) detail, and what product features, would be of most value to users.

The participants — all of whom spent two or more hours in their vehicles on business travel on a normal workday (not counting commuting time), and had cellular telephone bills of at least $50 per month- each had a lo-minute test drive and two days' subsequent use of the vehicle. They were interviewed before and after using the system. As for TravTek, the participants were enthusiastic about their experience, and the enthusiasm grew with greater familiarity.

A factor analysis was undertaken of the participants' expressed satisfaction with the system. J.D. Power identified five factors. In descending order of their contribution to the level of satisfaction, these were

- *the "utility value," accounting for 53% of the variation in satisfaction;*
- *the "point **of** interest variety" (23%);*

- *the "user interface " (10%);*
- *the "theft potential" (9%); and*
- *the "distraction potential" (5%).*

The "utility value" factor comprised such considerations as productivity convenience, sense of safety, ease of use, and accuracy. The "'point of interest variety " was concerned with the variety and selection in listings of points of interest that the system could provide.

*Participants said that the primary advantages to owning such a system were convenience, time savings, the ability to replace maps, and eliminating the need to ask **for** directions. After their two-day experience, they noted lower stress and higher driving confidence. The primary disadvantages were the expense, the theft potential, driver distraction, and system operational issues (including limitations in the geographical scope of the information).*

D. *What are customers willing to pay for ATIS information and hardware?*

As always, **behavioral ("revealed preference") evidence is the strongest — and, we believe, the only credible, currently available — evidence about customer willingness-to-pay.** Naturally, the behavioral evidence is still quite limited, since the number of available ATIS market offerings is slender.

A number of opinion surveys have also explored willingness-to-pay issues. However, as far as we can see (the published reports are not always explicit about the questions asked), *all* of these efforts have tried to ascertain willingness-to-pay by asking *direct questions* about the matter, such *as "How much would your household be willing to pay for...?"* or *"Would you be willing to pay x for... .?"* Such direct questions are notorious for producing response biases. The mean WTPs estimated from asking questions like these will usually be significantly higher — to variable and unpredictable extents — than are WTP estimates derived from analysis of consumer *behavior.* While we report some direct question findings in this section, **we must caution that we do not believe that their absolute values (as distinct from their relative values) have much practical utility at all.**

But first, the more believable behavioral evidence. Some marketplace offerings have not represented a sufficiently different service from competing products or services that their price differential was sustainable in the market.

> *In the San Francisco Bay area, travelers had several options for receiving up-to-date trafic information: the broadcast media, a telephone hot-line, and two in-vehicle receivers." The Fastline telephone hot-line offered pre-recorded messages, updated every ten minutes during peak traffic periods, accessed using a touch-tone menu of eleven choices. There was no direct user charge for accessing Fastline (just normal telephone call charges), but the system was j7nanced in part by carrying advertising.*
>
> *One in-vehicle receiver option was* ***Way-to-Go,*** *a personal pager-based service, started in 1993. Customers initially had to pay a $200 capital cost for the unit, and a service subscription of $15 per month. Users entered their origin and destination on a touch pad on the pager, and received a voice response tailored to their individual trip.*
>
> ***Autotalk*** was *another in-vehicle device, introduced in 1992. This was a $129 radio and TV audio receiver which was also capable of receiving, at no additional cost, the auxiliary audio (SAP) channel of a local television station. This channel provided frequent traffic updates (obtained from the same suppiier as that for Way-to-Go) which would interrupt any other program being received by the unit.*
>
> *Although Way-to-Go offered trip-specific information, sales were sluggish compared to those for the Autotalk receiver. Autotalk provided less specific traffic information, but with no marginal use charges, and commuters may have seen*

additional value in being able to receive the audio portion of TV programs while driving. Even after the Way-to-Go pager price was reduced to $99, at most 100 units were sold in total at this price. The company went out of business two years after first offering the product.

A nugget of further behavioral evidence comes from pricing changes for the SmarTraveler telephone hot-line service in the Boston area. It appears that, despite evidence (that we will review later) of a reported willingness-to-pay for such hot-line services, demand for the current market offerings is quite price-sensitive:

Until July 1995 (except for a free one-month promotional period during 1993) Cellular One mobile phone customers were charged normal air-time rates for their calls to SmarTraveLer, while NYNEX Cellular customers were able to call SmarTraveler without charge. Cellular One callers had historically made up a small share of the volume of SmarTraveler calls, except during the October 1993 promotion period when their volume reportedly shot up (by over 10090). Afer the free promotion, calls from Cellular One returned to the same level as before the promotion. Between April and December 1994, only 4% of calls to the ATIS were made by Cellular One subscribers.[20]

Moving on to the currently-available *stated preference* evidence, we would probably place greater credence in WTP estimates that come from respondents who have had *first-hand experience* in using ATIS information over those from more general projective surveys. The most detailed information of this sort comes from the debriefing interviews with TravTek users.

The purported willingness-to-pay for the capital cost of the TravTek system with either static or dynamic guidance, in response to direct questions, averaged about $900.[21] *The survey responses suggested that there would be a steep decline in interest in purchasing the unit as the price increased from $700 (over 80% of the sample said they were willing to purchase) to around $1,200 (less than 30% of the sample). The median claimed WTP was about $1,000. As far as can be judged from this source, the questionnaire said nothing about continuing operating costs, which implicitly may have been taken by the respondents to be zero. The mean purported WTPs for individual features of the TravTek system were about $400 for navigation, $400 for route guidance, $300 for up-to-date information, and $200 for motorist services and tourist information.*

The J.D. Power study also asked some willingness-to-pay questions for the navigational device used in that study.

By a four-to-one margin, the J.D. Power participants preferred that the device be factory-installed rather than bought in the after-market.[18] *When asked to estimate the retail cost of such a device, the mean estimate was about $1,000 for a factory-installed system and about $900 for an after-market system. The participants were asked their likelihoods of purchasing the device at their estimated prices. Likelihood of purchase did decrease as the expected prices increased. About 74% of respondents said that there was at least some likelihood of their purchasing the* *device at their estimated prices if it were factory-installed; only 55% gave the same response for an after-market system (at the respondent's estimated price for an after-market system}. These proportions were quite similar after both the 10-minute and the two-day tests, but after the two days' experience some people moved themselves from the "somewhat likely" to the "very likely" category.*

In the survey of SmarTraveler users, there were some questions about the respondent's projected usage at increased price levels. Since the calls were currently free for NYNEX cellular phone users (who made about half of all the calls) and were a local call for "land-line" callers, there is likely to be strategic bias in the answers to questions about imposing a charge. Respondents are very likely to have **overstated** the impact of price increases on their use of the system, so as to reduce the incentive to increase prices.

*If SmarTraveler were to impose a fee **of** 10 cents per call, NYNEX cellular users said they would reduce their calls by 35% while land-line callers anticipated an 18% reduction. At 50 cents per call, NYNEX patrons said they would make 71% fewer calls, land-line callers 58% fewer calls. The prospect of monthly subscriptions, to cover unlimited calls, was also explored. Here are the proportions **of** users who said that they would subscribe for a given monthly fee:*

	NYNEX cellular	***land-line callers***
$5 per month	***38%***	***24%***
***$25** per month*	***5%***	***3%***

Finally, there are a number of surveys in which respondents were asked a variety of direct questions about willingness-to-pay for various ATIS concepts without necessarily having any direct personal experience of them. The absolute levels of WTP responses in these cases must be considered particularly dubious.

*In the TRANSCOM survey of New York Region residents,[1] there were general questions about willingness-to-pay for a "travel information system like the one discussed in this survey. " About 78% of the sample claimed themselves willing to pay something. On a per phone call basis, 64% would pay 50 cents per call and 44% would pay $1 per call. On a monthly subscription basis **for** unlimited access, 56% would pay $5 per month, 40% would pay $10 per month, and 30% would pay $15 per month.*

*University of North Carolina researchers undertook telephone surveys of four potential ATIS user groups in the Charlotte metropolitan area: private commuters, commercial vehicle operators, fixed-site managers, and emergency response providers.22 In the survey of commuters, respondents were read a brief description **of** ATIS and its potential benefits, and asked if they would be interested in an ATIS that could reduce their driving times. About half of the approximately 580 respondents answered ajftrmatively. When questioned about their willingness-to-pay, they expressed a preference for a flat monthly subscription rather than a per-use charge. The mean WTP was $14 per month across the metropolitan area, varying by jurisdiction from $4.50 per month to $18 per month.*

Researchers at the New Jersey Institute of Technology developed a series of choice exercises administered to a self-selected convenience sample.23 The ATIS concept under test was an "incident alert system," accessed before beginning the trip. The responses to the stated preference tradeoff questions allowed the researchers to estimate a discrete choice model that was used to forecast the volume of subscriptions under different system configurations. With no charges to the users, about 79% of the sample would subscribe if the system only gave incident location information. The improvement to this baseline system that would attract most additional subscribers would be alternative route information. For the most extensive system — incident locations, alternative routes, expected delays, and transit schedules — 42% claimed that they would pay a $5 per month subscription and 78% would pay $2 per month.

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5. How should new JPO-sponsored user acceptance work for ATIS be planned?

A. *What do public officials most need to know about ATIS, and why?*

As we have seen, the benefits for all of the public and private "actors" with an interest in ITS innovations derive almost entirely from *the value placed on ITS participation by the end users.* In other words, customer acceptance is at the very heart of the private and public benefits that can arise from ITS initiatives. As in all markets, here too the ultimate consumer is king. The value of participating for the other actors — for equipment and activity providers, and for transportation system managers — will only be created to the extent that travelers "buy in" to ITS systems. Only if travelers value, and are willing to pay for, ITS information will value be created for the other actors — and then only to the extent that travelers value the information.

Current estimates of private versus public investment in ITS over the next twenty years in the US are that 80% of the expected $200 billion-plus investment will be private investment, compared with only 20% public investment. The private sector cannot make such an investment without a *bankable revenue stream.* In transportation, such revenue streams come from selling benefits to individual consumers, and they depend critically on the behavioral response to the investment. A bankable revenue stream is essentially the product of the number of users who change their behavior and the value that they derive from the change.

CRA is accustomed to making investment quality forecasts of the revenue stream from proposed private or public investments in transportation infrastructure that provide *predictable time savings* and *comfort benefits.* We know how travelers value those benefits, and we know their behavioral responses to *conventional* transportation improvements that *can provide* those benefits. We also make investment quality forecasts of the revenue stream from multi-billion dollar investments in *new* transportation technologies such as high speed rail and maglev, which can potentially provide the *same* types of predictable user benefits. However, ATIS applications will affect travel behavior in ways that do not allow us to predict what the future travel times (and other aspects of travel) will be that individual travelers will confront when making their travel decisions.

Identifying and measuring the ITS benefits that people value is a *much* harder problem than those we've already brought up to "bankable status" for non-ITS transportation investments. But it is, of course, what public officials need to know about ATIS to be able to plan for its deployment. How do we value ITS benefits so that we can make reliable forecasts of a revenue stream that will return a "profit" on multi-billion dollar ITS deployments — private investments returning profits to investors, and public investments that promote changes in travel behavior whose benefits are greater than their costs? This is the key objective of this user acceptance project.

5. What *do we need to do to answer their questions?*

In discussions with federal staff, **we have proposed to narrow the focus of immediate ITS customer acceptance work to** *ATIS products and* services. Because customer acceptance studies will require *specific* products and services to be presented to survey respondents — not just broad, abstract concepts — such a narrowing is essential to making significant progress. We chose ATIS as the highest priority because such systems are thought to proffer considerable benefits for many travelers; because some ATIS concepts imply major private and public investments; because ATIS has figured highly in the public perception of ITS; and because ATIS innovations present some of the hardest challenges to research methods.

To be able to predict reliably the numbers of travelers of different types who will decide to *gain* access to ATIS products and services, to *obtain ATIS information* in connection with a specific trip, and/or to *adjust travel behavior* as a result of the ATIS information requires quantitative relationships — or "models" — of these various behaviors. Such models are an ultimate objective of this research. They implicitly incorporate information about willingness to pay. They also provide a direct means of estimating the user benefits (consumer surplus) from various ATIS investments.

What will these quantitative relationships look like, and how do we go about deriving them from surveys of travelers? Like the current quantitative models of travel choices — choice of mode, say — we want to develop relationships that predict the choice probability as a function not only of the attributes of the *choices themselves* but also of the *key characteristics of the ATIS information* — information content, accuracy, ease of use, price, and so on. In other words, we want to adapt our current quantitative relationships that describe (for example) aspects of travel demand to incorporate explicitly the impact of the additional ATIS information.

It isn't clear the extent to which this ideal of well-identified, well-behaved quantitative relationships will be achievable in practice. Nevertheless, it is the goal that helps shape our thinking about the analytical approach, methods, and priorities.

The primary goal of the data collection activities under this program is to generate data from which such quantitative relationships can be derived.

The three "dimensions" of ATIS choices

In our reviews of the existing literature to enable us to summarize what is currently **known, we have found it valuable to organize our thinking around the three major categories of potential influence on ATIS user acceptance**:

- *Travel attributes* likely to be affected by ATIS innovations.
  These include "conventional" attributes like travel times and costs, as well as attributes (such as information content and reliability) that do not figure in conventional analyses of travel behavior.
- Different forms of ATIS *market offerings.*
  This dimension characterizes the variety of different services and products that fall under the heading of ATIS.
- Potential *market segmentation* variables.
  These characterize types of travelers and/or trips that differ significantly from others, such that a *separate* quantitative relationship should be developed for them.

We have found, not surprisingly, variable amounts of evidence in the literature about the various attribute, market offering, and market segmentation categories. In our work, exploring *all* of the cells of this three-dimensional matrix is obviously impossible. We need to identify the most important ones, and explore those. This implies some further narrowing of focus.

Practical survey method issues also shape what can be done

There are intrinsic difficulties in this work that arise because of the practical limitations of survey methods.

First, in any "new product" survey work — particularly for new products that are radically different from anything currently on the market — **there is always a problem of how best to communicate the key features of the new product** so that the survey respondent understands it clearly and unambiguously, so that he or she appreciates how it differs from existing products, and so that he or she is not thereby encouraged to overstate their interest in the product.

For there is a second, related problem: **survey respondents asked to indicate their interest in new ideas are very likely to overstate their willingness to purchase —** to actually fork over dollars for — the product, if they are asked *direct questions* about it. In the transportation literature, this phenomenon is known as the "noncommitment bias." The effect is likely to be more pronounced, the more elaborate are the efforts to portray or explain the new product concept.

Response biases of this sort can be minimized if *tradeoff survey* methods are used in preference to asking direct questions of the *"How likely would you be to purchase . . . ?"* or the *"How much would you be willing to pay . . .* ?" sorts. In the tradeoff survey, the questionnaire simulates an actual marketplace choice, albeit among hypothetical alternatives, so that in giving an answer the respondent is always forced to tradeoff some benefit (improved product quality, for example) against some disbenefit (a higher price, say).

However, respondents have limited capabilities to appraise large amounts of information to consider their preferences. In the real world, they may well not be motivated to *gather* all of the information presented in the questionnaire, never mind consider it thoughtfully, And one can never be absolutely sure that the way in which the respondent may simplify an overly demanding questionnaire task is the same way it would be done in making an actual marketplace choice. **For this reason, tradeoff questions are best kept simple.**

Suggested focus for this research

So the survey method limitations drive us once again to narrow the focus, to consider a limited set of specific market offerings. Specifically, we recommend selecting a small number of ATIS concepts, and talking with survey respondents about some well-defined prototype products and services that exemplify different key variants of each of those concepts.

The different ATIS concepts, or "cases," should be selected to be

- potentially important, reasonably broad market opportunities;
- qualitatively different from each other (for example, with regard to trip length, purpose, trip frequency, public/private transportation, etc.);
- representative of existing technologies, but with substantial scope for technological advances; and
- likely to permit good progress in understanding potential user acceptance, of interest to broad constituencies, perhaps by virtue of testing promising market research methods.

Our recommendations for consideration as selected market offerings are, in approximate priority order:

1. **ATIS devices in private vehicles,** with varying levels of en-route navigational, route guidance, and personal security capabilities.
2. **Pre-trip travel information for commuter travel** to and from work (within the home metropolitan area), for which choice of destination isn't an important factor.
3. **Pre-trip travel information for local non-work travel** (within the home metropolitan area), for which choice of destination and possible substitution of other activities are important considerations.
4. **Pre-trip travel information for intermediate-distance travel** (100 to 300 miles), for which private vehicle, **air,** and possibly other common carrier modes may be competitive, and for which destination choice may be a consideration.

Case 1 is one in which there are obviously strong private sector interests, but not yet much understanding of market behavior **in** the public domain. Behavioral responses to these types of applications can potentially have significant effects on (for instance) path choice and traffic flows, and hence are equally important to governments.

Cases 2, 3, and (to a lesser extent) 4 represent markets for which basic consumer behavior (absent the incremental contribution of the ITS information) is reasonably well understood already (for example, the willingness to pay for travel time savings, increased service frequencies, and so on). Cases 2 and 3 are likely to be the ones of most interest to the transit community. Case 2 potentially affects mode choice as well as path choice, while Case 3 addresses explicitly and systematically the issue of induced and foregone travel. Understanding the latter issue is key to measuring the benefits of travel information.

Case 4 would allow us to examine situations in which

- there are well-established patterns for advance booking of capacity (for example, common carrier seats, rental cars, hotel beds), often using an intermediate agent (whose functions may well become less valuable with advancing technology); and
- there are potentially important *public* and private sector interests involved (for example, the promotion of tourism), that may have strong relevance for *financing mechanisms.*

Within each of the market offering cases with which it is agreed we should proceed, we should also posit a relatively small number of well-defined *product/service concepts,* specified in terms of their functional capabilities (and possibly also their technologies). These would range from relatively simple, basic forms of the concept (possibly already available generally, or in operational testing) through to more advanced capabilities. Each specific concept would represent a potentially significant improvement in some key functional feature. We'll start with some "straw men", based on our collective judgments, but we may well redefine some or all of these product concepts following initial qualitative work.

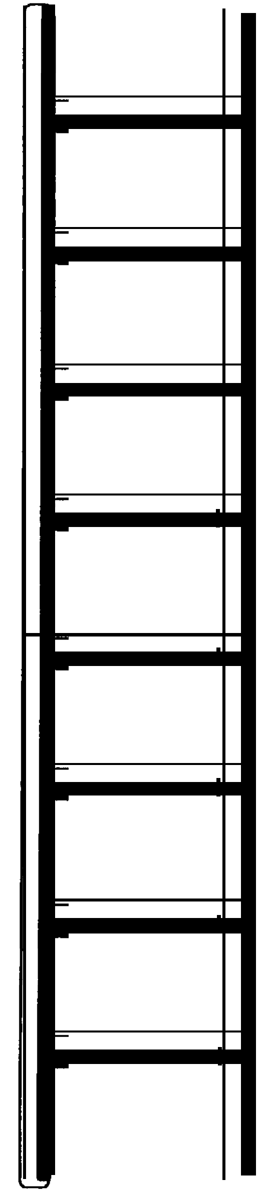
The concepts will represent a spectrum of different requirements with regard to consumer skills and *capital and operating costs,* which we will need to specify (at some stage, not necessarily initially).

The need to learn progressively

The survey method considerations also point to the importance of a well-designed program of *progressive* learning, so that we can build up the understanding of how to communicate concepts to respondents clearly, how to define meaningful ATIS attributes, and so on. Exhibit 1 characterizes this progressive learning as a ladder leading up from qualitative investigation towards the ultimate goal of conducting surveys of large, representative samples of the general population using "low intensity" survey methods that have a reasonable cost per respondent.

Exhibit 1. The "ladder" of sequential learning about customer acceptance of ITS applications

Step of the ladder	Examples of studies at this level	Example research issues
Large sample general population surveys	Quantitative studies, using CATI, mail, or diskette-based self-administered interviews, of representative samples of major segments of the general population	. Propensity to purchase . Likely patterns of use . Functional requirements . Price sensitivity
General population surveys using personalized interview techniques	Quantitative studies, using personal or telephone interviews, of representative samples of major segments of the general population	. Propensity to purchase . Likely patterns of use . Functional requirements . Price sensitivity
Surveys of identified **target groupsfor** particular products/ services	Qualitative or quantitative surveys of particular occupational / industry / interest groups, concerning attitudes and behavior relevant to specific, tightly-defined products/ services	. Propensity to purchase . Likely patterns of use . Functional requirements . Price sensitivity
Generic market segmentation to identify key groups of potential customers	Psychometric and behavioral surveys (small- or large-scale), with multivariate analysis of responses. For example: . Factor analysis . Cluster analysis . Perceptual mapping . Discriminant function analysis	. Useful groupings (by demographic/ socioeconomic characteristics, current behavior, or attitudes) of potential customers . Identifying "early adopter" characteristics
Revealed preference evidence	Analysis of consumer behavior with analogous products/services in existing markets. For example: . Airline CRS use . Purchase of automobile accessories (OEM and aftermarket) . Trials of in-vehicle navigational aids . Travel & entertainment bookings through direct on-line services	. Types of purchasers . Patterns of purchase and use . Choice structures (what alternatives are considered, and in what order) . Influencing factors in choices . Price sensitivity
Qualitative work	. Focus groups . In-depth personal interviews	. Communication of concept(s) . Key dimensions of customer reactions . Opinion shifts from added information/ discussion
Literature review	Analysis, data, simulation studies, and data collection methods particularly germane to ITS innovations	What's the current best understanding and practice?



Our research strategy, currently still evolving, identifies four different phases of work, consistent with various rungs of the "learning ladder." For each selected "case," we propose to carry out the following tasks:

A. Qualitative exploration (mostly or exclusively focus groups).

B. Analysis of existing experience with respect to some innovative form of the case (existing data from operational tests; CRA team input into future evaluation of relevant operational tests; possibly new surveys of people who participated in operational tests).

C. Surveys of market segments identified as potential early *adopters* (for example, identified by profession, vehicle ownership, travel patterns, high tech orientation, or other characteristics).

D. Surveys of *more general populations.*

Activities A and B can progress somewhat concurrently; C and D then follow sequentially. In some of the activities, it may be feasible or advantageous to address more than one market offering case (for instance, one series of focus groups might combine both cases 2 and 3, and possibly 4).

The qualitative phase

For the qualitative phase of the work, we anticipate undertaking about four focus groups per selected case, unless the chosen cases are conducive to pooling some of the discussion agenda. The primary objectives of this phase of the work are to:

- Identify the *range* of immediate qualitative responses to the market offering (and to the specific product prototypes that exemplify the concept), among groups of ordinary consumers whom we believe might have some interest in them.
- Develop different ways of communicating the concepts to respondents (videotape, graphical presentations, verbal descriptions) in economical ways that get across key ideas and functional capabilities while minimizing the likelihood of response biases.
- Identify the key service attributes that appear to be important in connection with the offering and concepts, and seek any consensus on the relative *rankings* of the importance of those attributes.
- Explore potential metrics for describing clear variations in the levels of the attributes.
- Develop some initial hypotheses about the range of WTP values among market segments of interest.

Opportunities to survey people with hands-on experience of ATIS innovations

The objectives of the second work element will be to:

- Identify any feasible and cost-effective opportunities to base further data collection activities on people who have participated (or will participate) in operational ATIS tests.
- Feed the customer acceptance understandings developed by this program into the measurement/evaluation activities of current and new operational tests as rapidly as possible.
- Ensure that any potentially interesting user-related datasets generated by completed or ongoing operational tests are analyzed thoroughly, to help build the quantitative relationships that are our goal.

We have yet to compile our inventory of relevant existing datasets and relevant planned data collection efforts from the operational test program, so we are not yet in a position to make specific recommendations regarding components of this phase.

Surveys to understand the motivations and likely responses of "early adopters"

The objectives for this element are as follows:

- Particularly for concepts beyond those currently available in any market, survey potential early adopter groups (possibly using statistically generalizable samples of those particular population subgroups) to ascertain (i) their level of interest in, and willingness to pay for, the key features ("service attributes") of the concept; and (ii) their likely usage pattern for the concept, and the implications for their travel behavior.
- Generalize the user acceptance implications (with regard to access, use, and/or response) to whatever conclusions can be drawn about the potential size of the markets and the potential diffusion patterns.

Surveys of more general populations

At this stage of development, the key objectives will be to:

- Develop and deploy interview methods that can be used, for specific ATIS concepts, among general population samples to determine propensities to obtain access to, use, and make behavioral responses to ATIS information, given the attributes of the information/concept and the price structure.
- Undertake such surveys for one or more designated ATIS concepts, to the extent that the program budgets permit.

The information that will ultimately be generated by representative samples of the population at large will begin to provide a statistically sound basis for analyzing *aggregate* travel effects — that is, flows and speeds on networks, as determined by equilibrating the aggregate demand with the physical capacity of the transportation system. The quantitative relationships developed should provide insights into the design and pricing of ATIS products and services, and the user and societal benefits from proposed ATIS investments.