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On-Board Advanced Traveler Information Systems

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Description

Advanced Traveler Information Systems (ATIS) acquire, analyze, communicate, and present information to assist travelers to have a safer, more reliable, and more enjoyable travel experience. Two major types of ATIS are available:

- Real-time network information, including traffic and transit information.
- Traveler information such as pre-trip or on-route route guidance or destination information.

This information can be provided in a variety of ways: at kiosks, on websites, using mobile phones enabled by wireless application protocol (WAP); through hand-held computers or "personal digital assistants" (PDA); or via on-board (in-vehicle) computers and displays.

Several kinds of information are provided by various systems:

1. In-Vehicle Routing and Navigation. These systems provide drivers with information about how to get from one place to another, and may include information on traffic operations and recurrent and non-recurrent urban traffic congestion. Seven functional components have been identified. They are: trip planning, multi-mode travel coordination and planning, pre-drive route and destination selection, dynamic route selection, route guidance, route navigation, automated toll collection.

2. In-Vehicle Motorist Services Information. These systems provide information related to "other services" a traveler may need, such as information on tourist attractions, entertainment and shopping, hotels and restaurants, gas stations, and hospitals and other emergency care. Some of this information might otherwise be found on roadside signs. In some applications the information is tied to route guidance to the displayed destinations. A destination coordination function enables the driver to communicate with the destination and make reservations, place orders, etc.; a message transfer function can automatically generate "preset" messages at the touch of a button (hot-key function) and also could receive messages by text or phone..

3. In-Vehicle Regulatory and Signing Information. These systems provide in-vehicle displays of routing, warning, regulatory, and advisory information that is currently depicted on external roadway signs. The guidance information may include street signs, interchange graphics, route markers, and mile posts. Notification information tells drivers of upcoming changes in the roadway, such as merge signs, advisory speed limits, and curve arrows, or temporary conditions such as construction, lane closures, and accidents ahead. Regulation information, such as speed limits, stop signs, yield signs, turn prohibitions, and lane use, also can be provided in-vehicle.

4. In-Vehicle Safety Advisories and Warnings. These systems provide warnings on hazards, road conditions/situations affecting the roadway ahead of the driver, and vehicle operation conditions (e.g. traction, brake overheating) with sufficient advance warning for the driver to take remedial action (e.g., to slow down). Information provided to the driver can include the relative location of a hazard, the type of hazard, notification of the approach of an emergency vehicle, warning of an accident ahead, and information on road conditions, such as traction, congestion, or construction, within some "predefined

proximity" to the vehicle or the driver's route. The systems also may allow motorists to request aid, with manual requests as well and May Day systems for severe emergencies (e.g., vehicle collision, rollover, airbag deployment.) Emergency workers would automatically be provided with the vehicle's current location and the nature of the problem. This function also may include feedback to notify the driver of the status of the response, such as the expected arrival time of service.

A number of motor vehicle information systems are already available through the private sector, either as accessories or as special features of new cars and trucks.[1] These include visual and auditory map display systems, most of which can be updated by purchasing and downloading up-to-date map and conditions information on the internet or by buying a new CD with the updates. Luxury cars increasingly have vehicle warning systems that measure vehicle component performance (braking, tire traction, tipping) as well as outdoor conditions (temperature, wet pavements, ice) and provide the driver with advisories; many also have manual and May Day motorist aid systems, and a few have automatic responses (speed reductions, brake assistance) designed to increase safety. Public sector efforts to develop information that can be used in public sector applications (transit kiosks, roadside variable message signs) as well as in private applications also are underway. Currently a key issue seems to be whether enough motorists are willing to pay for additional information to make the investment in data provision and processing cost-effective. Cases that review testing experiences with on-board systems for motor vehicles [2]provide some insights into consumer response.

Case Examples

1. TravTek

Travel Technology (TravTek) is an in-vehicle route planning and navigation system manufactured by General Motors. The TravTek system w operational field test was recently completed; TravTek has been subjected to more than 1.6 million km of user testing. An in-depth field test on this system commenced in Orlando, Florida, in 1992, in which TravTek was installed in 100 cars (75 were rental cars) and participants were surveyed after they returned the rental cars. Twenty-five cars were used for research and development testing. The TravTek field test is the largest evaluation of an ATIS system to date in the United States. It was anticipated that the initial TravTek research, in addition to available knowledge about the TravTek design process, would provide the greatest number and most relevant ATIS lessons.

The TravTek system was composed of three primary components: the TravTek Information Services Center, the Traffic Management Center, and the TravTek vehicles. The Information Services Center was managed by the American Automobile Association (AAA) of Florida during the deployment phase and provided help-line functions by means of a cellular telephone link. Supplemental travel, accommodation information, and emergency road service were available to TravTek users via this communications channel as requested. In addition, the Information Services Center supplied local business and services data, a special events database, and selected listings from the Central Florida telephone book yellow pages for in-vehicle use.

The Traffic Management Center collected and fused traffic information from several sources. These included historical travel times as a function of time of day and dynamic times from roadway loop

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[1]. Commercial trucks as well as light duty trucks can be outfitted with traveler information systems of various sorts.

[2] Traveler information also can be made available at bus stops and airports, on board buses, etc.

detectors, police reports, city reports of maintenance and road closures, and probes of travel times from TravTek vehicles.

In the TravTek vehicle was navigation system using a combination of map-matching and Global Positioning System information to track the vehicle's position. The functions available in the vehicle included: navigation information, route guidance, real-time traffic information, and information on local services and attractions. As shown on the main menu screen (Figure 1), drivers could choose to enter a destination, browse through information about local services and attractions, browse through maps of the local area, request emergency services, go through tutorial instructions, or correct the location of their vehicle on the map display. The color CRT with touch-screen overlay is shown in Figure 2. The touch-screen provided a 5 x 5 matrix of touch-screen "keys" whose functionality changed with different screens. Eight steering wheel buttons used to pick displays are shown in Figure 3.

The touch-screen was only active when the car was in PARK (designated "PRE-DRIVE") or for selected functions when the car was in DRIVE but at zero speed. When the car was moving, only the steering wheel buttons were accessible to the driver. The system also had the capability of providing "synthesized voice information" to the driver upon request.
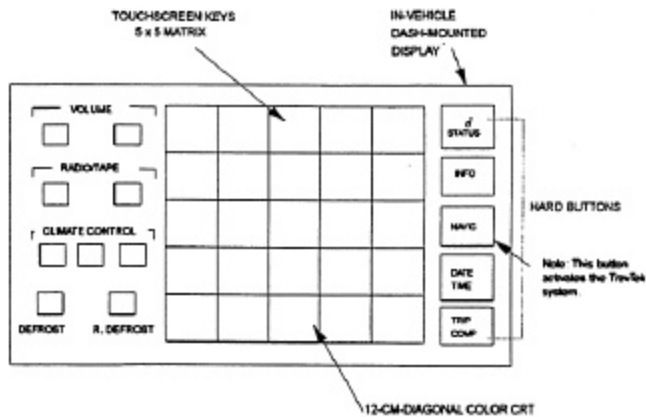

Figure 1. TravTek main menu.
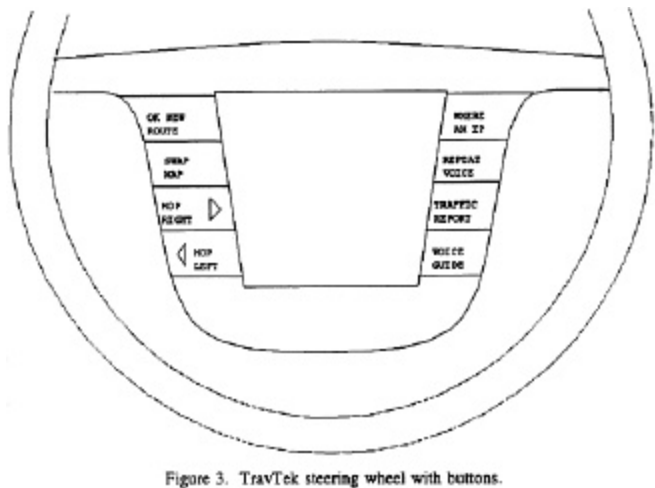
Figure 2. TravTek CRT screen.

Figure 3. TravTek steering wheel with buttons.

Overall, users were positive about the experience of using TravTek. About 85% of visitors made use of TravTek when it was available, and local drivers used it 70% of the time. Drivers found the route guidance element found it faster than using paper maps and, with the voice assistance, made fewer errors. However, they actually made more errors using TravTek without voice than they did with maps alone. The majority of drivers preferred turn-by-turn guidance over the full-route moving map. However, when the driver had gone off route, the full map proved very useful. The TravTek strategy of allowing the driver to access both types of maps appears to have been the most effective choice.

2. The UMTRI Laboratory and Field Test Program

The University of Michigan Transportation Research Institute (UMTRI) has performed a series of laboratory and field studies on the development of in-vehicle interfaces for driver information systems. The emphasis has been on the design of the controls and displays, the presentation logic, and the sequencing of information. The objectives of the UMTRI research are to develop safe and easy-to-use in-car traffic information systems, as well as guidelines and methods for their evaluation. UMTRI researchers have investigated in-vehicle and cellular phone-based systems providing route guidance, traffic information, vehicle monitoring, and safety warnings. They have utilized an iterative design- test-redesign approach that allows rapid low-cost examination of prototypes.

Some of the findings that have emerged from the UMTRI studies include the following:

- Interface consistency is essential - including location of information on the screen, size of displays, and use of terms and symbols.
- Display character size should be legible from normal driving position, by people with low visual acuity.
- The location of hazards should be stated verbally - a simple verbal message giving the nature of the hazard, followed by its location, works best.
- The two features users rate most highly are information about roadway hazards (ex: crash site, construction, railroad crossing) and information about traffic congestion.
- At any given time, only about 6 percent of motorists are either lost or uncertain of where they are.

The latter two findings provide insights on why in-vehicle traveler information systems are not more popular - the hazards and traffic information most valued by motorists is often available from other sources, including radio, and most of the time motorists don't need route guidance.

3. The Navmate System

Navmate is an in-vehicle route planning and guidance system tested on Avis rental cars in San Jose, California. Data from the equipped vehicles have been used to evaluate the interface, features, and functions of the current prototype, and develop improvements.
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The Navmate utilizes a combination of vehicle location techniques and provides the driver with turn-by-turn route guidance. Drivers can select from a number of destinations by proceeding through various text-based menu screens and selecting a point of interest or a particular intersection from a database. A driver also may enter a street address as a destination. Once a destination is entered, Navmate calculates the fastest route, posted speed limits, number of intersections, and left/right turns. The route is displayed on a digital map showing varying levels of detail contingent on the driver-selected map scale.

The Navmate display provides both text- and map-based information to the driver. The display unit can be attached to the dashboard with a special mount, and can swivel and adjust horizontally and vertically. A GPS unit and other hardware are mounted in the trunk. The current Navmate prototype, including all hardware, wiring, and antenna, can be installed in a test vehicle in less than 1 hour without making any permanent modifications to the vehicle.

The user system utilizes a combination of positioning techniques, including the Global Positioning System (GPS), map-matching, etc. It provides the driver with real-time vehicle location and route guidance information as the driver progresses to a selected destination

When power is available and the Navmate's "On/Off" switch is turned to "On", an introductory message is displayed. This message notifies the driver that he/she should always drive defensively and implies that the device should not hinder driving safely. Once the driver acknowledges the message, the main "Where do you want to go?" menu is displayed. All the menus are text-based and presented with color schemes to enhance visibility and contrast.

The main menu screen is accessible when the vehicle is stationary or in motion. It allows a destination to be selected. From the main menu, the driver has four options for choosing the desired destination:

- Street Address.

- Intersection.
- Points of Interest.
- Guidance History (previously selected destinations).

In the rental car experiment to date, "Points of Interest" is the most frequently used category. Possible choices include:

- Airports
- Gas Station
- Hotel
- Restaurant.
- Rental Car Base

After a specific destination type is selected (e.g., Restaurant), the system requests that the driver "Select the Listing Mode." The driver can list each directory alphabetically or by distance (the closest restaurant at the top of the list). As selections are chosen, the direction, distance, and address of that selection are displayed at the top of the screen. Once the driver enters the desired destination (e.g., Mr. Right's Cafe), the system displays a message indicating that it is calculating the shortest route. This may take several seconds, depending on the distance to the destination. Once the route is calculated, a map-based display is shown with the route highlighted in magenta.

The map displays the position of the vehicle with a triangle indicating the vehicle heading. The driver can select to have the map displayed in either the "heading-up or North-up" orientation. Most drivers seem to prefer the "heading-up" mode. Once the destination has been selected and the route is established, the driver is not capable of altering the route; however, he or she can select a new destination. The driver also can change the system's setup (e.g., the map scale) or switch between the map and route guidance screens. When the vehicle begins to "move", the system automatically switches from the map to the "route guidance screen". The driver does have the option, however, of selecting the map display while in motion. The route guidance display provides "turn-by-turn instructions" for proceeding to the destination.
The guidance display indicates the name of the street for the next turn at the top of the screen in uppercase letters. Underneath is a large yellow arrow indicating the direction of the next turn. Just below the arrow, the approximate distance to the next turn in displayed in miles. If the driver leaves the planned route for any reason, the system displays a message indicating that the driver has "Left the Route" and also asks whether a new (alternate) route should be calculated to the same destination from the current position.

A complementary "auditory system" - a digitized male voice providing route guidance information at two volume levels (low or high) -- can be used or deactivated. When the vehicle approaches a turn (0.16 to 0.80 km away, depending on the vehicle speed), the system provides a voice announcement such as "Left Turn Ahead."

The Navmate system has several discrete controls located below the display. These are used to relocate the vehicle position on the display when a calibration error occurs, to switch back and forth between the map and guidance screens while driving, and to change the system settings for map size, map orientation, and voice volume. The majority of the system navigation and destination selection functions are normally performed when the vehicle is in park or at zero speed.

Implementation testing revealed a number of lessons:

- Lrge databases require simple user access. The motorist information for the Bay Area that was contained in the Navmate database was large. Scrolling through long lists was awkward. More work needs to be done on enabling users to access large databases quickly.
- Detailed accuracy of map database must be maintained. Map databases for ATIS systems must account for one-way streets and two-way streets with a center divider. Errors of this type can cause incorrect guidance. Updating map databases will be a challenge that must be met to provide the foundation for accurate ATIS systems.
- Users want the capability of previewing an entire route on the digital map at a selectable scale.
- Providing this option during the destination selection process (pre-drive mode) should be considered.
- Drivers would like to be able to reject unviable routes (e.g., due to inaccuracy in the map database) or request a different route than the one provided (e.g., one that excludes a particular street).In-vehicle navigation systems should provide users with the ability to request an alternate route to the one provided.
- Drivers should be notified when vehicle position calibration is required. The system allowed drivers to adjust the position of the vehicle symbol to the correct position, but few of the drivers realized that this could be done, and none made use of the feature. The lack of use of this manual correction capability indicates that many drivers did not recognize when the system was generating guidance based on an erroneous location. An intelligent system to estimate probable error and to notify the driver would be useful.
- Route departure notification should be provided verbally and visually. The visual display indicating that the driver is no longer following the route was sometimes not detected by the driver. An auditory indication could be helpful, but would be tolerated only if the high false alarm rate of this indication was reduced.
- There was an annoyingly high frequency of false "you have left the route" messages displayed within the first minute of departing (typically in situations when buildings or structures obscured satellite signal strength).

Demand for ATIS

Evaluation findings suggest that consumer demand for ATIS depends on road and traffic conditions, trip time of day and purpose, and the quality of service provided by ATIS, plus the characteristics of the travelers themselves and their familiarity with the route and conditions likely to occur. In a survey[3] about the benefits of ATIS, respondents identified four primary benefits of the services: to save time avoid congestion or allow for arrangements to be made in case of unavoidable delays, reduce stress of uncertainty about travel times, arrivals, etc., and to avoid unsafe conditions. So far, however, ATIS devices have been slow to find a market. One reason is that road condition data are not always reliable; developers attribute slow market penetration to lack of good data on certain routes and conditions. The US DOT estimates that only about 12 percent of the urban freeway network nationwide is fully instrumented and even in major metropolitan areas like Los Angeles and Sacramento, major links are omitted.

Others believe that the problem is a broader one. Research indicates that for the vast majority of trips, travelers know where they are going, what route is usually best, and what alternative routes could be used. Route guidance in the form of maps plus turn-by-turn instructions are available free on the internet.

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[3] Source: ITS Resource Guide, 2001

Nearly real-time, moderately accurate travel information is available for free from radio, variable roadside signs, and internet systems. Hence the issue is whether new systems would provide significantly better services than those available for free.

Recent evidence suggests that many ATIS applications do not, in fact, offer services that consumers are presently willing to pay for. SmarTraveler, a provider of electronic, personalized traveler information, is ceasing operations in Washington DC after failing to become commercially viable in its five years of operation. Motorists appeared to lack interest in computer and telephone based travel services. Ford Motor Company also announced that it was going to terminate its joint venture with Qualcomm, Wingcast, that would have provided travel information services to Ford owners. On the other hand, Federal Communication Commission (FCC) enactment of a national 3-digit traveler information number [511] should further accelerate customer use of public ATIS.

Table 1 [4] provides some comments on various ATIS services, their deployment levels, and limiting factors.

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[4] Source: ITS Resource Guide, 2001

ATIS Service	Deployment Level	Limiting Factors
Real-time traffic information on the internet	Widespread Deployment	While deployment is widespread, customer satisfaction with the services seems related to local traffic conditions and website information quality
Real-time transit status information on the Internet	Limited Deployment	Transit authorities have limited funds for ATIS investments and little data that establish a relationship between ridership and ATIS
Static transit system information on the Internet	Widespread Deployment	
Real-time traffic information on cable television	Limited Deployment	Limited by information quality and production costs, although one service provider has developed a way to automate production
Real-time transit status information at terminals and major bus stops	Limited Deployment	Cost
In-vehicle navigation systems (no traffic information)	Limited Deployment*	Purchase cost
In-vehicle dynamic route guidance (navigation with real-time traffic information)	No commercial deployment; the San Antonio MMDI installed prototype systems in public agency vehicles*	Irregular coverage and data quality, combined with conflicting industry geocode

Table 1. ATIS Deployment

References

Websites:
1. http://www.fhwa.dot.gov/tfhrc/safety/pubs/95197/exec/exec.html
2. http://www.its.dot.gov/
3. http://www.its-standards.net/
4. http://www.its.dot.gov/guide.html (ITS Resource Guide 2001; on-line version)

Publications:
1. Clarke, D.L., M.E. McCauley, T.J. Sharkey, T.A. Dingus, & J.D. Lee, Development of Human Factors Guidelines for Advance Traveler Information System (ATIS) and Commercial Vehicle Operations. FHWA Publication No. FHWA-RD-95-197
2. US Department of Transportation. ITS Resource Guide 2001