# ADVANCED TECHNIQUES FOR INFLUENCING THE PRE-TRIP PLANNING PROCESS

by

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**SUMMARY**

This report is a review of the state-of-the-art in pre-trip information systems. It was motivated by several changes in urban transportation, including the growing emphasis on advanced traffic management centers and the development of automated transit vehicle monitoring systems. These new technologies have increased the quantity and quality of available information in some areas. As such, there are potential benefits to distributing information to commuters at their homes or places of work.

Recent research on traveller information systems is summarized to provide some insight into the pre-trip planning process. Pre-trip planning is the set of decisions made before every trip, including mode choice, route choice, and departure time. The purpose for distributing pre-trip information is to maximize the efficient use of the transportation system by influencing those decisions. Research has shown that not all commuters are equally flexible in their pre-trip planning. Identifying and accommodating the different sub-groups are important steps in the development of an effective pre-trip information system. In general, most commuters would modify their route, some would change departure times, and a few would consider alternate modes based on pre-trip information.

Several communication techniques for disseminating pre-trip traffic and transit information are identified in the review of current practices. To emphasize the diversity, they are grouped by transmission medium: either radio broadcasting, television, or telephone. Specific techniques include commercial radio, commercial television, cable television, teletext, advanced telephone information systems and videotext. Applications of each technique for pre-trip information are discussed, and appropriate examples are provided.

A series of steps is presented for the development of an effective pre-trip information system. The recommended approach is based upon the findings of related research and the review of current practices. It is suggested that additional benefits are possible with integrated commuter information systems. An integrated commuter information system would combine pre-trip and in-vehicle information, use multiple delivery mediums, and serve both transit and automobile users.

## TABLE OF CONTENTS


**INTRODUCTION** ........ C-1
- **Purpose of Report** ........ C-1
- **Background** ........ C-1
- **Scope of Report** ........ C-1
- **Report Organization** ........ C-2

**THE PRE-TRIP PLANNING PROCESS** ........ C-3
- **Introduction** ........ C-3
- **Objective** ........ C-3
- **Potential Benefits** ........ C-3
- **Improving Pre-Trip Information Systems** ........ C-4

**REVIEW OF CURRENT PRACTICES** ........ C-6
- **Introduction** ........ C-6
- **Radio Broadcasting** ........ C-6
  - *Commercial Radio* ........ C-6
- **Television** ........ C-10
  - *Commercial Television* ........ C-10
  - *Cable Television* ........ C-11
  - *Teletext* ........ C-12
- **Telephone** ........ C-16
  - *Advanced Telephone Information Systems* ........ C-16
  - *Videotext* ........ C-20

**DISCUSSION** ........ C-23

**ACKNOWLEDGMENTS** ........ C-25

**REFERENCES** ........ C-26

# INTRODUCTION

## Purpose of Report

The purpose of this report is to investigate and evaluate the state-of-the-art in traveller information systems used for pre-trip planning. The increased application of advanced technologies to the management and operation of urban transportation systems has significantly improved both the quantity and quality of information available to travellers. This report examines the various techniques currently employed to disseminate that information to commuters at their homes or places of work and provides a summary of some of the recent research on the subject.

## Background

Faced with mounting environmental concerns and shrinking resources, many urban areas are shifting away from the practice of constructing new facilities to meet the continuous growth in travel demand. In some of those cities the emphasis is now on the development and expansion of advanced traffic management systems. Those advanced traffic management systems gather a significant amount of data in the process of monitoring the current traffic conditions on city streets and highways. The primary use of the data is to control system elements, such as signalized intersections and ramp meters, or to identify the locations of incidents. Another potentially beneficial use for current traffic information is to disseminate it to the public, permitting commuters to make more informed decisions about their daily trips.

Advanced traffic management systems are not the only source of current information for commuters. A growing number of transit agencies are also beginning to incorporate advanced technologies, such as automated vehicle monitoring (AVM) systems, into the operation and management of their fleets. With those new technologies, dispatchers now can monitor and regulate several aspects of fleet operations, particularly deviations from fixed schedules. Some transit agencies are making the current operating information available to commuters as a marketing technique, increasing the attractiveness and accessibility of their services. As more AVM systems are installed, the use of advanced techniques for disseminating transit information is expected to increase substantially.

One objective of providing information to commuters is to influence the pre-trip planning process, which consists of decisions about mode, route, and departure time. Because enhancing the pre-trip planning process has the potential to contribute to the efficient use of the transportation system, this review of the current techniques for disseminating pre-trip information has been prepared.

## Scope of Report

This report is a summary of the techniques currently employed to disseminate traffic or transit information to commuters at their homes or places of work. The emphasis is on systems that incorporate innovative or advanced technologies for the collection, processing, and distribution of current information. The various communication technologies in use are described, along with some representative examples. It is not an exhaustive effort at identifying and evaluating every operating or proposed pre-trip information system; instead it focuses on some of the more promising techniques in use, particularly in North America. The goal is to integrate the operational experiences and recent research in pre-trip information systems in a manner that encourages further development.

**Report Organization**

Following the introduction, there are three primary sections in this report. First is a discussion of the pre-trip planning process. In that section, important recent research on traveller information systems is reviewed. The second section of this report contains a summary of advanced or innovative techniques currently used to disseminate pre-trip information to commuters. The various techniques are grouped according to the transmission medium employed: radio broadcasting, television, or telephone. General descriptions of each technique are provided, followed by selected examples. The final section contains some concluding remarks about the development of pre-trip information systems, based upon the recent research and the review of current practices.

## THE PRE-TRIP PLANNING PROCESS

### Introduction

The process of pre-trip planning—which includes decisions about mode choice, route choice, and departure time—occurs, by definition, before every trip begins. Planning complex or unfamiliar trips may require substantial effort, while decisions about a daily commute to work are usually perpetuated from one day to the next without consideration. Most commuters have discovered a satisfactory pattern of mode, route, and departure time, and any explicit decision-making is a matter of adjusting some aspect of that routine. Under "normal" operating conditions, commuters generally encounter what they expect, and their travel decisions are reinforced. However, when inevitable disruptions in the normal equilibrium are not accounted for in the pre-trip planning process, it is unlikely that the decisions will result in a trip meeting the commuter's needs. The probability of making a successful commute every day can be increased by providing appropriate information to influence the pre-trip decision-making process. Increasing the availability of information on current conditions and travel alternatives before departure is a promising use of advanced technology. It will result in "smart" travellers, who make more effective decisions and contribute to the efficient use of all transportation facilities (1, 2).

### Objective

More than ever, urban transportation is a customer-oriented service industry. From that perspective there are two reasonable justifications for attempting to influence the pre-trip planning process. For highway operations the goal is demand management, by which travel demand is redistributed over time and space, taking advantage of spare capacity (3). On the other hand, public transportation agencies are more concerned with market development, seeking to encourage the use of transit or ridesharing among commuters by improving user services (4). The differences in information content and format to achieve those goals disguises the fact that they share a common objective-to contribute to the efficient overall use of the existing transportation facilities.

### Potential Benefits

Advanced information and communication technologies are expected to have a significant impact on how commuters plan their daily trips, most likely resulting in greater utilization of transit and ridesharing (2). Priority facilities for high-occupancy vehicles (HOVs) are becoming more common, providing the incentive for some commuters to stop driving alone. Enhanced pre-trip information systems will be invaluable for persuading leery motorists to change modes (2). Many transportation agencies are becoming aware of the contribution pre-trip information systems can make toward the efficient use of transportation facilities, particularly as an element of a system management effort like the Los Angeles "Smart Corridor" project (3).

There has been some research on the potential benefits of providing current information about traffic conditions to motorists. A 1971 survey by the Texas Transportation

Institute during the design of a real-time freeway information system revealed that motorists preferred to receive current information before entering the freeway (5). Eighty-five percent of the respondents indicated that they would make frequent use of accurate information to plan their trips. In Indianapolis, Indiana, an assessment of the impact and value of traffic advisories showed significant benefits, justifying their use as a demand management measure (6). Based upon a hypothetical incident on an urban highway network, it was discovered that the resulting queue cleared 21% sooner and 33% of the delay was avoided when just 20% of the drivers responded to an advisory.

**Improving Pre-Trip Information Systems**

The provision of pre-trip information—regardless of how accurate and timely it is—does not result in improved transportation system operation; it is the response of the travellers that produces the benefits. In other words, the purpose of a pre-trip information system is not just to provide information, it is to influence the decision-making process of commuters with the objective of enhancing the operation of the system. To develop an effective technique for accomplishing that requires knowledge of communication technology and, more importantly, an awareness of the commuter decision-making process. With that premise, a comprehensive study of Seattle area commuters was conducted in 1989 to determine their behavior and information needs relevant to the design of a traveller information system (7). The study included a mail-back survey of 10,000 motorists with a 40% response rate, and 100 follow-up interviews. The results showed that commuters are not a single, homogenous group with similar behavior and needs. During the analysis of the survey responses, four distinct commuter groups emerged (7):

1. *Route changers* were willing to change routes before or during their commute but unwilling to change departure time or transportation mode (20.6%);

2. *Non-changers* were unwilling to change departure time, route, or transportation mode (23.4%);

3. *Route and time changers* were willing to change route and time but not transportation mode (40.1%); and

4. *Pre-trip changers* were unwilling to change route while driving but willing to change time, route, or mode before leaving their home (15.9%).

The process of identifying commuter sub-groups is stressed as a critical element in the design and development of traveller information systems (7). Influencing the decision-making of only a small proportion of commuters could result in more efficient use of transportation facilities. It is important to note that the ultimate objective is to enhance the operation of the transportation system, not to be useful to all commuters at all times. The identification of sub-groups allows the targeting of specific information to those who are most likely to adjust a particular decision.

The dissemination of information to commuters before departure was found to be very promising (7). Survey respondents were very interested in the communication of traffic information into their homes, and most were willing to modify their travel routes based on pre-trip information. Dissemination of mode choice information could be effective if it was targeted at the sub-group of receptive commuters. The possibility of influencing the departure time decision with pre-trip information is also highly dependant on effective targeting; it was the most flexible decision for 56% of the survey respondents and the least flexible decision for the remainder (7). This survey resulted in two recommendations relevant to pre-trip information systems. First, place a high priority on home delivery of motorist information, particularly related to influencing departure time. And second, target home delivered motorist information for specific types of commuters, based on the driving decision to be affected (7).

Designing and developing an advanced traveller information system that is capable of influencing all the pre-trip decisions of every commuter would be an enormous undertaking. Fortunately, that is not necessary to improve the operation of the system. A more effective strategy is to identify the specific pre-trip decision that needs to be modified and focus on those commuters who are most likely to alter that behavior (7). Efforts directed at modifying a particular behavior in a group of commuters who—for whatever reason—are unwilling to change that behavior are generally not an efficient use of resources. That is particularly true when there are significant groups who are willing to modify their decisions and are eagerly seeking information to help them do so (7).

## REVIEW OF CURRENT PRACTICES

### Introduction

One of the primary objectives of this report is to provide a summary of the current applications of advanced or innovative techniques for the dissemination of pre-trip information. Interest in pre-trip information systems is growing as research and operational experience reveal its potential benefits as a transportation systems management tool. Providing commuters with current information before departure can enhance system operations by promoting more effective decisions about mode, route, and departure time.

To emphasize the variety of techniques currently used for disseminating pre-trip information, this review is organized by the specific communication technology employed. Those communication technologies have been categorized according to their transmission medium. The selection of techniques for this review was limited to those incorporating advanced or innovative technology to collect, process, or disseminate travel information for use by commuters at their homes or places of work. It is not a comprehensive inventory of every system in operation; rather it focuses on some of the more promising techniques in use. Information on current practices was gathered from many sources, including both the literature and discussions with system operators. These pre-trip information systems comprise an important element of Advanced Traveller Information Systems (ATIS), which involves the use of advanced communications technology to achieve a number of objectives.

### Radio Broadcasting

The concept of broadcasting motorist information over the radio has existed for decades. Over those years, the practice has grown to become the most significant and widely-used technique for providing commuters with information about traffic conditions. This growth has been fueled by increases in traffic congestion and the competitive nature of the commercial media industry. Unfortunately, for commuters in most of those cities the quality of the information being disseminated has not improved as dramatically. The application of advanced technology in the development of traffic management systems promises to substantially increase both the quantity and quality of pre-trip information available for radio broadcasting.

#### *Commercial Radio*

Although traffic advisories are provided by commercial radio stations in nearly every city with any degree of traffic congestion, the use of advanced technology to enhance the quality of the information is relatively uncommon. In most cases, radio broadcasters collect information from a variety of sources. Examples include telephone calls to or from police dispatchers, police radio scanners, stationary or mobile observers, and reports from news helicopters or aircraft.

Commercial radio stations that provide information about traffic conditions may be performing a public service, but it is also a promotional tool with an important role in the highly competitive commercial radio industry. In most larger cities those competitive conditions have led to the establishment of traffic information services like the Shadow Traffic Radio Network and Metro Traffic Control (8). By contracting with a traffic information service, smaller media outlets—particularly radio stations—can provide their listeners with professionally prepared traffic advisories.

The increasingly competitive nature of commercial traffic reporting indicates that a strong market exists for current information about traffic conditions. In 1971, research on the provision of real-time information to motorists in Texas revealed that most drivers normally use radio traffic reports for trip planning during peak periods and that commercial radio was the preferred form of delivery (5, 9). A 1976 survey of Chicago area commuters to determine how to improve commercial radio traffic reports indicated that 99% had working radios in their homes (10). The major findings of that survey support the theory that commercial radio is an effective means of disseminating pre-trip planning information.

Commercial radio traffic advisories in several cities are being improved significantly by the incorporation of new or innovative technology. The development of an advanced traffic management center automates the process of monitoring conditions and creates a centralized location for the collection, processing, and dissemination of current information. As of 1990, nine regional traffic operations centers had electronic surveillance and/or closed-circuit television (CCTV) in place, and 16 more were in the planning process (11). Although it is not their primary function, many traffic control centers are finding that keeping motorists well-informed contributes to the efficient use of the highways. The result has been some mutually beneficial partnerships with the media and traffic reporting services.

The relationship between local commercial radio stations and the Minneapolis/St. Paul Traffic Management Center is a typical example of the new partnerships being formed. As the traffic management system expands to cover more of the area highways, the value of effectively disseminating current traffic information is increasing. The Minnesota Department of Transportation (MnDOT) currently provides the information by telephone to the large broadcasting companies and Metro Traffic Control (11). In an effort to improve the quality of traffic reporting in the Twin Cities, MnDOT has proposed a unique arrangement with a local media company to broadcast directly from the Traffic Management Center. The announcer would be a MnDOT employee with training in broadcasting. In exchange, MnDOT would have direct communication with observers in the station's helicopters. The arrangement could eventually lead to a pooling of resources that would ensure aerial coverage of the entire region, even during major incidents that now attract helicopters from several stations. The proposal has been challenged by Metro Traffic Control (11). Regardless of the outcome, it is certain that MnDOT and other public agencies will continue to pursue innovative relationships with commercial broadcasters.

The effectiveness of these partnerships at providing accurate, timely information to motorists depends to a large extent upon the efficient processing and distribution of the information to the announcers. A 1971 evaluation of commercial radio traffic reporting in Houston concluded that improvements were necessary for the provision of real-time information to commuters (9). Fifty-two percent of the accidents observed on a study section were not reported by any of three monitored radio stations. The average delay in reporting accidents was over 20 minutes, which was longer than the average incident duration. Several traffic management centers are finding that replacing voice communication with computerized networks improves the quality of radio traffic reporting.

The traffic management system for the Central Corridor on Long Island, INFORM, relies upon the commercial media broadcasters in the area to advise commuters about current conditions and to provide diversion information. The information is collected and processed at the INFORM operations center and distributed to the media announcers using a relay broadcasting facsimile machine. There is also a remote INFORM system terminal, located at the Shadow Traffic Radio Network office, which provides direct access to freeway traffic information reports (12).

Researchers at the University of Washington are developing an interactive, PC-based, graphical traffic information system. Using a modem, the system will communicate with the computer at the Traffic Management Center in Seattle, receiving occupancy and volume data, updated once each minute. The interactive interface will allow users to obtain specific information about current traffic conditions on the area freeways. Tests are currently being conducted with Seattle area traffic reporters to determine how they might use it as a tool to improve their advisories (13).

In Los Angeles, radio stations currently receive information on congestion and major incidents from the commercial radio advisory service. The commercial radio advisory service is a teletype network that is operated by the California Department of Transportation (Caltrans) and the California Highway Patrol (CHP) (11). Caltrans and CHP are committed to enhancing their relationships with the commercial media, and radio traffic reporting in Los Angeles is expected to improve significantly in the future. The quality of the information available for broadcast will increase as more of the area freeways are placed under surveillance for traffic management purposes (14).

Although the concept and most of the technology are at least a decade old, the computerized traffic information network in Chicago is still one of the most comprehensive and advanced systems in operation. Current traffic data is collected at over 1800 detector locations on 118 miles of Chicago's expressway system. The data is processed at the Illinois Department of Transportation (IDOT) Traffic Systems Center (TSC), where it is used for incident detection and to control an extensive ramp metering system (15). The TSC computer also produces congestion reports every five minutes, 24 hours a day, indicating the locations of significant congestion. The reports are formatted for convenient use by the media, using cross streets to identify the location and extent of congested areas. A sample of a typical congestion report is shown in Figure 1. Listings on the congestion report are prompted automatically when two or more adjacent, or once-removed, surveillance sections are congested, based on five-minute average lane occupancy readings of 30% or more (10). Additional messages can be added to the congestion report using a keyboard at the TSC. When the system was initiated in 1974, the TSC distributed the congestion reports to radio stations over a network of teleprinters (8). Now most of the subscribers use video display terminals to obtain the reports from the network. The competitiveness of the commercial

```
OB RYAN LOC      45TH  ->65TH *
IB RYAN EXP      26TH  ->TYLOR*
1630
OB EDENS         S.TOUH ->CARPEN
IB EDENS         LINCLN ->CARPEN   ELSTON ->MONT *
OB KENNEDY       OGDEN  ->ADDSON
IB KENNEDY       W.HAR  ->ADDSON
IB I-90 EXT      N.NORT ->1 N.ST
OB IKE           *MORGN ->DESP A
IB IKE            1ST   ->CENTRL
OB STEVENSON     NORMAL ->ARCHER
OB RYAN EXP      *TYLOR -> ROOS     51ST  -> 71ST
OB RYAN LOC       45TH  ->65TH *
IB RYAN EXP       26TH  ->TYLOR*
1631  THE KENNEDY EXPRESS LANES ARE CLOSED
1635
IB EDENS         LINCLN ->CARPEN   ELSTON ->MONT *
OB KENNEDY       OGDEN  ->ADDSON
IB KENNEDY       CANFLD ->ADDSON
IB I-90 EXT      N.NORT ->1 N.ST
OB IKE           *MORGN ->ADD CK
IB IKE            17TH  ->E.HAR    CENTRL ->KOSTNR
OB STEVENSON     ARCHER ->HOYNE
OB RYAN EXP      *TYLOR -> ROOS     51ST  -> 59TH     83RD  -> 87TH
OB RYAN LOC       45TH  ->65TH *
IB RYAN EXP       26TH  ->TYLOR*
1640
OB EDENS         S.TOUH ->CARPEN
IB EDENS         ELSTON ->MONT *
OB KENNEDY       OGDEN  ->ADDSON
IB KENNEDY       W.CUMB ->ADDSON
IB I-90 EXT      N.NORT ->1 N.ST
OB IKE           *MORGN -> 17TH
IB IKE            17TH  ->  1ST    W.AUS  ->KOSTNR
OB STEVENSON     HOYNE  ->PENN RR
OB RYAN EXP      *TYLOR -> ROOS     51ST  -> 69TH     79TH  -> 87TH
OB RYAN LOC       45TH  ->65TH *
IB RYAN EXP       26TH  ->TYLOR*
1645
OB EDENS         S.TOUH ->CARPEN
IB EDENS         LINCLN ->CARPEN   ELSTON ->MONT *
OB KENNEDY       OGDEN  ->ADDSON
IB KENNEDY       W.CUMB ->ADDSON
OB I-90 EXT      W.83   ->ADD.
IB I-90 EXT      N.NORT ->1 N.ST
OB IKE           *MORGN ->E.HAMN
IB IKE           ADD CK ->DESP R   F.AUS  ->KOSTNR
OB STEVENSON     ARCHER ->PENN RR
OB RYAN EXP      *TYLOR -> ROOS     51ST  -> 87TH
OB RYAN LOC       45TH  ->65TH *
IB RYAN EXP       26TH  ->TYLOR*
1647  THE KENNEDY EXPRESS LANES ARE CLOSED
1650
OB EDENS         S.TOUH ->CARPEN
IB EDENS         ELSTON ->MONT *
OB KENNEDY       OGDEN  ->ADDSON
IB KENNEDY       W.CUMB ->ADDSON
OB I-90 EXT      CHURCH ->GRAND
IB I-90 EXT      N.NORT ->1 N.ST
OB IKE           *MORGN -> 17TH
```

EXAMPLE

At 4:40p.m., the outbound Edens Expressway congested from South of Touhy Ave. through Carpenter Rd. etc., etc.

EXAMPLE

Special message repeating at 15 minute intervals due to major incident at Addison St. on Kennedy Expressway.

Figure 1. A typical traffic congestion report from the TSC computer (10).

broadcast media industry in Chicago is particularly evident in traffic reporting. There are at least 26 direct connections to the TSC network, two of which are traffic reporting services that are used by at least 40 other media outlets. Most announcers simply read the congestion updates directly, while others use them as the basis for more detailed traffic reporting (8, 11).

**Television**

There are several techniques for disseminating commuter information that employ television technology as a transmission medium. The current level of use is low (5), but some developments in the television industry have increased the interest in providing pre-trip information by television. The accessibility of some television-based techniques in the home may be almost as high as radio broadcasting, and the audio/visual format is capable of delivering more complex information than audio alone.

As suggested in the discussion of radio broadcasting, many transportation agencies are employing advanced technologies to enhance the collection and processing of current data. The value of those improvements is not restricted to information disseminated by radio; television-based systems also benefit from the increased quantity and quality of available information. In addition to improvements in the collection and processing of current data, a few television-based techniques use innovative communication technology to disseminate the information to commuters.

*Commercial Television*

Traditionally, commercial broadcast television has not been a significant source of current traveller information, with the possible exception of major newsworthy incidents. However, many television stations in larger metropolitan areas are increasing their traffic coverage to meet the needs of their viewers in a competitive industry. The information is typically collected from the same conglomeration of sources used by commercial radio broadcasters. The commercial traffic information services, like Shadow Traffic Radio Network and Metro Traffic Control, are used by many television stations as well.

Many of the recent improvements in commercial television traffic reporting have paralleled those in radio broadcasting. The increased quantity and quality of information resulting from the development of advanced traffic management centers have encouraged many mutually beneficial relationships between transportation agencies and commercial media outlets. As indicated previously, several traffic management centers have improved the effectiveness of their media partnerships by distributing information over computer networks rather than manually. Examples of that innovative—but not necessarily new—technique were presented in the discussion of commercial radio broadcasting, including INFORM (12), Los Angles (14), and Chicago (8).

Although they have some common characteristics with respect to traffic reporting, commercial television and radio do not approach the task identically. The distinctions most likely arise from the differing merits of each broadcast medium. For example, radio broadcasts are highly accessible both before and during an automobile trip, but television has an audio/visual interface with the potential to deliver complex pre-trip information more effectively. Taking advantage of the visual capacity of television, some stations conduct live traffic reports from helicopters, with aerial video footage of the congested freeways below. The value of providing that visual reinforcement is debatable and has not been assessed from a traffic operations standpoint. Another visual enhancement incorporated into some newscasts is a graphical map of the regional freeway network, indicating the locations of known incidents or congestion. Usually, those maps are produced by a traffic reporter at the station with information gathered from several sources. An alternative approach that is receiving significant attention is to automate the map generation process. Examples of that advanced technique are found in the Central Corridor on Long Island (12) and in Seattle at an experimental level (13).

In addition to automatically distributing information about current traffic conditions to the broadcast media on a network of facsimile machines, the INFORM system in Long Island's Central Corridor also operates the Video Traffic Information Program (VTIP) (12). The VTIP provides a computer generated color graphic map indicating current traffic conditions on the corridor freeways. The principal user is a broadcast television station with a 24-hour news format. The station uses the map for traffic reports every 15 minutes during the peak periods. Several colors are used on the graphic to represent the current traffic speeds, which are gathered from over 2400 loop detectors. The graphic display is alternated with a screen of text containing messages entered by system operators (12).

A slightly different approach is being pursued by researchers at the University of Washington in Seattle. They are developing an interactive graphical user interface that will be capable of displaying maps of current freeway operation conditions at several levels of detail (13). One anticipated use of this new system is by traffic reporters at commercial television stations. The interactive interface will allow reporters to present both area-wide displays and detailed maps of any freeway section, all containing color-coded speed conditions, updated once each minute. The system will operate on a personal computer equipped with a modem and will obtain current volume and occupancy data from the Traffic Systems Management Center in Seattle (13). Since the maps will be produced by the user's computer, there will be a high degree of flexibility in displaying the desired information.

*Cable Television*

One of the most significant changes in the television industry over the past decade has been the proliferation of community antenna television (CATV) or cable TV. Cable television systems have tremendous broadcasting capacity, carrying as many as 75 full channels on a single coaxial cable (16). To many transportation system operators, cable television appears to be an effective technique for disseminating current information to commuters at their homes. However, there are several tradeoffs between the use of commercial television and cable TV in terms of influencing the pre-trip decision-making process. For instance, commercial television has a significantly larger audience, and the resources of the media may be taken advantage of through mutually beneficial partnerships. On the other hand, cable television has less competition for air-time during peak periods, and offers more control over the content and format of the information. Research has shown that it is not necessary or even possible to influence every commuter's decisions, and many of those that are willing to modify their behavior are actively seeking information to help them do so (7). That finding supports the use of cable television some extent, because information could be broadcast continuously during peak periods, available immediately to those who need it. The technical feasibility of delivering current information over cable television has been demonstrated by both research and operational experience (17). Figure 2 illustrates how real-time traffic information could be disseminated by cable television.

Chicago was one of the first cities to experiment with the use of cable television to broadcast real-time traffic conditions (8). In 1985, a cable television franchise began using the Traffic Systems Center's computerized congestion reports to update a color graphics map with the current traffic conditions on the region's expressway system. The map appeared on the cable system once every eight minutes, 24 hours a day. Map displays were terminated when the cable company suspended operations later that year. Recently, another Chicago area cable company began featuring similar real-time color-coded maps, along with digitized voice congestion reports, on a public access cable channel (8).

MnDOT is developing a cable television operation for commuters in Minneapolis/St. Paul that will be similar to Chicago's. It will include a color map displaying current traffic conditions, and the audio will be fed from the regional Highway Advisory Radio (HAR) system. The existing MnDOT cable television service provides text-only output of traffic information along with the HAR audio and has the capability to feed CCTV surveillance video over the cable system from any of its cameras (11).

Providing real-time traffic information over cable television is being considered as one element of the "Smart Corridor" Project in Los Angeles (14). It is a policy of the City of Los Angeles to require cable television franchises to allocate two channels for municipal access. The city is planning to distribute current traffic information over one of the municipal access channels, possibly with a live broadcast from its traffic control center (14).

Cable television is also being investigated as a technique for providing transit users with current operating information. A few transit agencies, including those in Ann Arbor, Michigan, Champaign/Urbana, Illinois, and Baltimore, Maryland, are experimenting with the use of cable television to deliver information on current bus locations and projected arrival times (4). The format of the messages includes schematic route maps, current bus locations, and expected arrival times at major stops. The displays will scroll through each route, possibly requiring some patience by the viewers for larger systems. Extensive transit operations could take advantage of the geographical segmentation of most cable television systems by providing only relevant information to each area (4).

*Teletext*

Another innovation in the television industry that appears to have significant potential for disseminating pre-trip information is teletext. Teletext is a broadcasting technology that displays pages of information, selected by the user, on a television set. Like broadcast television, teletext services are free to the user; all that is required to receive the information anywhere in the broadcast area is a properly equipped television (18). Because there is no control over who may receive the information, teletext services are typically

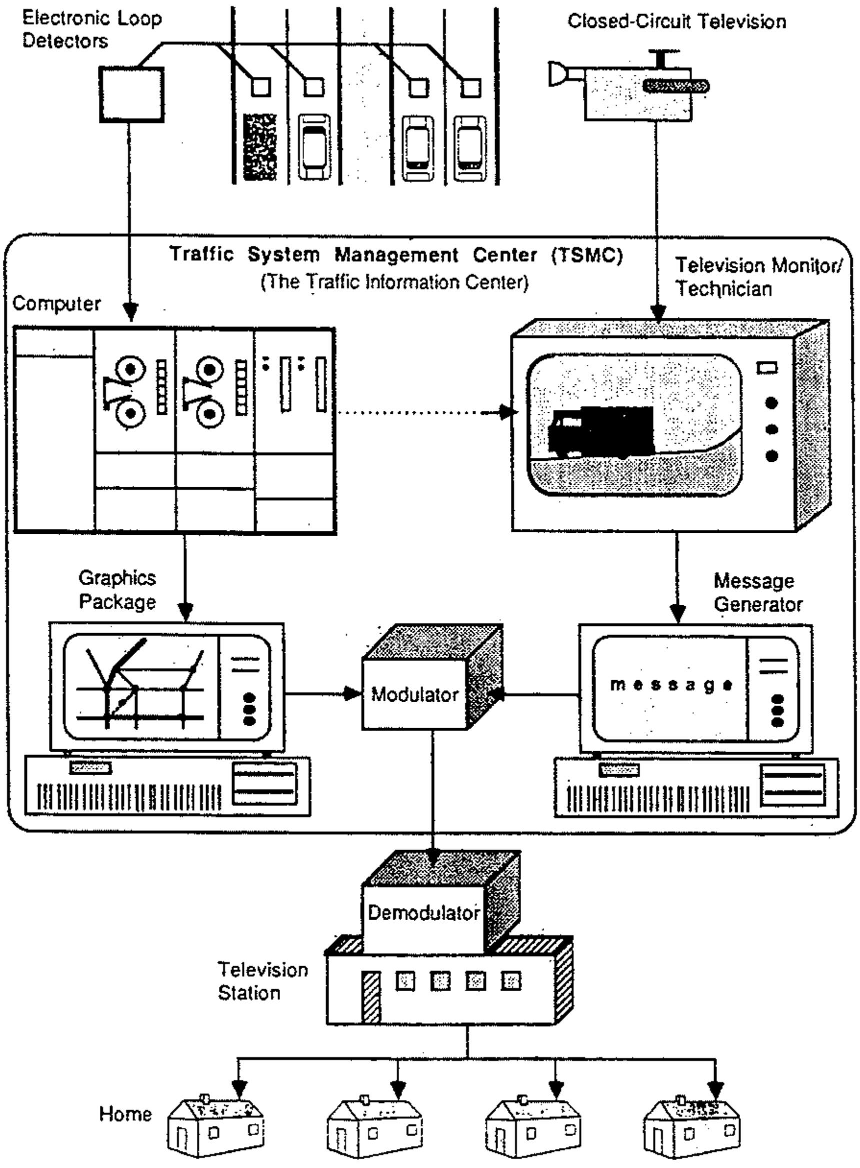


Figure 2. Providing real-time traffic information on cable television (17).

intended for general use, delivering information of broad public interest (19). These characteristics all indicate that teletext is a promising technology for use in advanced traveller information systems.

The teletext industry in the United States is not nearly as developed as it is in Western Europe. Most Western European countries have teletext services, and many of them provide real-time information on transit operations or traffic conditions (1). CEEFAX, the teletext service in Britain, provides several screens of traffic information to viewers. In France, the ANTIOPE teletext service displays regional road maps indicating the location and severity of traffic congestion (18).

Although teletext is not a well-known technology in the United States, there are indications that its use will become more widespread as the public demand for many types of current information grows. Because the use of teletext services for delivering pre-trip planning information is likely to expand in the United States, a general introduction to the technology and two operating examples have been included in this review.

Teletext services are provided by invisibly encoding pages, or frames, of data onto broadcast television signals. The frames are created and stored on a computer. When a frame is to be included in the broadcast cycle, it is transferred into the computer's main working buffer. From the working buffer the current group of frames, called a magazine, is continuously cycled through the teletext encoder, which prepares the information for broadcast (16). The most common technique for broadcasting teletext service information is to insert it into the Vertical Blanking Interval (VBI) of a standard television signal. The VBI is a portion of the signal that contains information for the proper synchronization of the receiving television set; it occasionally appears as a black horizontal band when the television picture "rolls" (3). Only half of the VBI is used for synchronization pulses, and it is the other half that is commonly used for broadcasting teletext. Figure 3 is a schematic diagram of a typical VBI teletext system. If a full channel is used for teletext the information capacity is more than 100 times that of a VBI system (16). It would not be practical to dedicate an entire commercial television channel to teletext, although it certainly is feasible on a cable television system.

After the information has been encoded and broadcast, it is retrieved for the user by a decoder device that is either built in or attached to a standard television set (1). When the user chooses to view teletext, the first frame displayed is an index of the current magazine on that particular television channel (19). Each frame in a magazine is identified by a code number, which are all listed on the index frame. The user enters the number of the desired frame using a keypad, and the decoder "grabs" that frame as it cycles past. Frames may be quickly edited or updated by swapping them while they are being cycled through the encoder. The revised frame becomes visible to the user as soon as it arrives at the decoder (19).

Caltrans is conducting a teletext demonstration project in Los Angeles called "Commuter TV." The objective of the project is to evaluate the use of this innovative technology for disseminating continuously updated traffic information (20). The information is compiled from surveillance and control systems, the California Highway Patrol, and

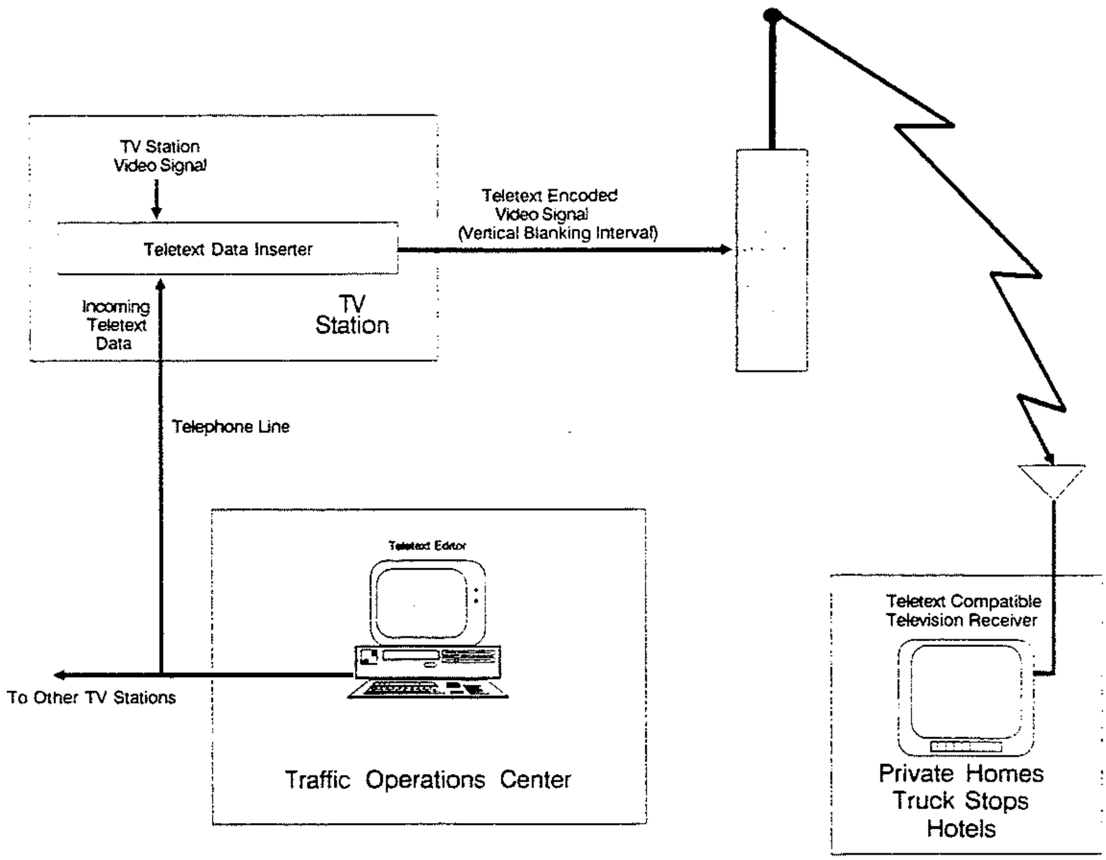


Figure 3. Components of a typical teletext system (16).

construction and maintenance schedules (16). The frames are generated and updated at the Traffic Operations Center and transmitted to a local television station, where they are inserted into the VBI of the video signal and broadcast to the public (21). As a part of the demonstration, the lobbies of several office buildings in downtown Los Angeles have been equipped with monitors to receive the information (3). Those public teletext displays have been designed to scroll continuously through the frames containing current traffic information, eliminating the viewer's ability to key in desired frame numbers. The elimination of the viewer's ability to key in desired frame numbers was intended to provide equal access to all interested commuters, but the excess delay may be detrimental to the success of the demonstration. A very similar teletext system is being demonstrated in Houston as well. Displays that provide information on current traffic conditions have been located in public areas and near parking garages at Greenway Plaza, a commercial activity center (22).

**Telephone**

The final communication medium considered in this review of current practices for disseminating pre-trip information is the telephone network. This medium has the significant advantage of a communication system that is designed for two-way, interactive use and is highly accessible at both homes and places of work. The automation of the response and delivery of information in an interactive communication environment is one of the several areas in which advanced or innovative techniques are being used to influence the pre-trip planning process.

Although nearly every transportation agency has some capacity to respond manually to requests for information over the telephone, manual response is frequently viewed as a burden rather than a potential measure for enhancing the operation of the system. As the quantity and quality of available information improve with advanced surveillance and monitoring technology, the potential value of disseminating information to commuters increases. There are several enhancements in telecommunications that are receiving much attention from other service-oriented industries, and the applications in transportation are growing rapidly. Advanced telephone information systems and videotext are two innovative techniques for disseminating pre-trip information to both motorists and transit users.

*Advanced Telephone Information Systems*

Advanced telephone information systems represent a very broad range of technological enhancements to the traditional manual systems. Although there are some examples of telephone-based traffic advisory services, a majority of the advanced systems are currently used in transit applications. For convenience, the current applications in transit will be introduced first, followed by some noteworthy applications for highway motorist information systems.

Telephone information centers are in use by many transit operators as an element of their customer service or marketing strategy. In a typical telephone information center, customer service agents respond to questions about routes, schedules, and fares from potential passengers. The customer service agent provides the information to the caller by recollection or by consulting maps and fixed schedules. A customer service agent normally can attend to an average of 20 to 40 calls per hour, depending upon his or her experience and the system complexity (23). Although nearly all transit agencies operate some type of manual telephone information service, enhanced systems are becoming more common as the potential benefits are discovered. The application of advanced technology to transit telephone information systems may be divided into three levels: automated information retrieval, automated information retrieval with digitized response, and automated real-time information access.

As an enhancement to the basic operations of a telephone information center, some transit agencies have developed computerized data bases of their route and fixed schedule information. The primary advantages of this measure include faster information retrieval, increased reliability and consistency of information provided, and ease of incorporating service changes into the passenger information system (23).

One example of an enhanced telephone information center is found in Washington, D.C. The Washington Metropolitan Area Transit Authority (WMATA) operates an advanced telephone information center it calls the Automated Information Directory System (AIDS). AIDS is a computerized data base that is capable of generating detailed trip information; incorporating bus, rail, or both. When using AIDS, a customer service agent enters the relevant trip data from the caller into a computer terminal. The system computer searches its data base for route alternatives based upon an optimization of the caller's stated trip parameters (travel time, walking distances, transfers, or others). The alternatives are displayed on a computer terminal for the customer service agent, who relays the requested information to the caller (24).

Megadine Information Systems has developed an automated information retrieval system for transit information and has implemented it in Denver, Boston, and Southern California (4). The system is designed to assist customer service agents by providing information on alternative transit trips to specified destinations. It uses a computerized data base of transit services, street addresses, intersections, and landmark names. Traveller preferences are taken into account in the generation of possible itineraries to reach the desired destination (4).

The next level of technological enhancement for telephone information systems is to automate the response with digitized or computer-generated voice. Advanced telephone information systems that have fully automated interaction with the caller have become quite common in industries that are oriented towards customer service. There are currently many systems in use in the transit industry as well. For transit applications, there are two different approaches at this level of automation.

The first approach to fully automated interaction is audiotext, which employs a digitized voice to greet the caller and lists the different types of information available. The caller makes selections with the keys of a touch-tone telephone. By incorporating multiple levels of lists it is possible to quickly provide very specific information to the caller. Outside of transit, audiotext is the dominant technology in automated telephone information systems.

The Metro-North Commuter Railroad—with 95,000 daily riders in New York and Connecticut—has implemented an audiotext system to provide customers with train information by digitized voice (25). The system is intended to handle the majority of callers who are already familiar with the railroad's operation but need schedule or fare information. The new system has relieved much of the burden on customer service representatives, resulting in fewer busy signals and lost calls. Since audiotext requires a touch-tone telephone, callers from rotary phones are quickly forwarded to a live customer service representative. The interface is designed to be user friendly, so that first-time callers will not hesitate to use the system again, particularly if they make a mistake the first time. When the system does detect a mistake, the question is repeated; if the mistake occurs again, the caller is automatically transferred to a customer service representative. Updating the fixed schedule and fare database is a simple procedure, and there is a provision to insert emergency messages into the system. A password feature allows those messages to be recorded by an information supervisor from any touch-tone phone. Overall, the operation has been very successful, but it is emphasized that some capacity for person-to-person interaction should always be provided (25).

A modified form of audiotext is used in the advanced telephone information system for the transit operations in Hamburg, Germany (1). Once a caller is connected to the system, a synthesized voice prompts him or her for input. Callers use their telephone keypad to enter code numbers for the necessary trip information, including origin, destination, day of week, and desired time (departure or arrival). A computer data base of scheduled transit services is searched for alternative itineraries to complete the trip, which are then described to the caller. No customer service agents are available to callers on this system (24).

The second technique for providing fully automated interaction in an advanced transit telephone information system relies more upon brute force that advanced technology. In this type of system, each bus stop in the service area is assigned a unique telephone number. A potential passenger can obtain fixed schedule information for a particular stop by calling the corresponding number. TeleRIDER is typical of this type of system.

TeleRIDER was developed by Teleride Sage Ltd., a transit software company from Toronto, Canada. The company has designed and implemented automated telephone response systems in at least 16 North American cities since 1977 (26). Their TeleRIDER system incorporates a computerized data base and digitized voice to provide callers with fixed transit schedule information (1). The system is intended to process the large proportion of callers only requesting schedule or service status information. In a community with a TeleRIDER system, each bus stop must be assigned a unique telephone number. When a caller dials the number for a particular stop, a digitized voice answers the call and announces the scheduled arrival times for the next two busses at that stop. Other relevant information may be added to the message by system operators when necessary, and software has been developed that will update the TeleRIDER data base with schedule changes very easily (26). The operation of the TeleRIDER system has been demonstrated in many cities, and the success is noteworthy. For example, in Ottawa/Carleton, Ontario, an early version of TeleRIDER installed in 1980 recovered its implementation cost in less than a year with increased ridership, particularly during the off-peak periods (27).

Although automated information retrieval systems are typically more efficient than unassisted customer service agents, most still rely upon fixed transit schedules for predicting bus arrivals. More accurate and timely information about transit operations would be valuable for pre-trip planning and could improve public perceptions and ridership as well. The incorporation of automated real-time information access has resulted in some of the most advanced transit telephone information systems. Those systems rely upon data generated by automatic vehicle monitoring (AVM) technology to provide detailed real-time bus location information. Transit agencies in several North American cities, including Halifax, Nova Scotia, Hull, Quebec, and San Antonio, Texas, are using data from AVM systems to enhance the information they provide to their customers (4).

Automated real-time information access systems operate much like the more common audiotext or TeleRIDER systems, but the computerized data base is continuously updated with data collected by the AVM system. Instead of announcing the scheduled arrival time of buses, TeleRIDER systems can be modified to estimate the actual arrival times based on current operating conditions or to indicate what the current deviation from the schedule is. Although the primary purpose for installing an AVM system is to improve fleet operations, there are also some potential benefits if the resulting information is disseminated with the goal of influencing the pre-trip planning process.

The use of advanced telephone information systems for motorists is not nearly as common as the transit applications, although interest in the concept has been growing with the recent emphasis on traffic management techniques. The potential of telephone-based systems for delivering pre-trip information to motorists appears significant because of the high accessibility and interactive capability. There are a few examples that may be used to assess that potential. These examples may also provide some insight into future applications of advanced telephone information systems for traffic management.

A telephone-based freeway traffic information system was developed and implemented for the Dallas Corridor Study in 1975. The system design was based upon the results of a survey of over 300 motorists from seven businesses in the downtown area (28). Seventy-five percent of the respondents indicated that they would use a call-in traffic information service. The most interest was expressed in information about the location and degree of congestion, alternate routes, the cause of the congestion, and whether a lane was blocked (28). The messages were recorded by an announcer and updated every ten minutes during peak periods and every half-hour in the off-peak. Information for the messages came from a variety of sources, including CCTV, police radio scanners, reports from field observers, and a computer printout of operating conditions. A consistent message format was used, providing priority information first (29).

On its first day of operation, 3315 calls were made to the freeway traffic information system; however over the first 12 months the average was only 83 calls per day (29). On days when major accidents and severe weather were reported on the radio or television, the number of calls was much higher. Because the level of use was much lower than anticipated, the system was terminated after 18 months. A follow-up survey was conducted to evaluate the service, producing 103 respondents from 700 direct mailings to individuals who had previously been introduced to the system (29). Only 42% of the respondents indicated that they had used the system. Out of the users, 36% said that they used it less than the first week. Reasons given for not continuing to use the system were: 50% forgot about it or did not know the number, 25% felt that conditions changed in the time between receiving the message and entering the freeway, 17% said it was not helpful, and 8% used commercial radio instead. For those who had not used the system, the reasons given were: 34% forgot about it or did not know about it, 23% did not need it, 16% thought conditions would change by the time they got to the freeway, 14% said no other route was available, and 5% used commercial radio instead. Based on the results of the project and the follow-up evaluation, it was recommended that telephone-based systems for delivering pre-trip traffic information be used only in conjunction with other communication modes that are accessible on the road (29).

The Traffic Systems Center in Chicago operates a telephone information service that provides current expressway congestion information, updated every five minutes (8). The messages are digitized voice announcements of the latest congestion report from the TSC computer. The system uses audiotext technology, presenting callers with menus that guide them to the desired information. The reports for each expressway are separated so that callers hear only the information that is relevant to their trip. Information is also provided about construction, lane closures, and road conditions during inclement weather. Ameritech Mobile, a Chicago area cellular telecommunications company, also provides digitized voice reports of current traffic conditions over the telephone (8). The messages are produced with the TSC congestion reports, which are distributed to dozens of media outlets over a network of computer terminals. The Ameritech service, SmartCall, is primarily targeted at cellular phone users, providing weather, sports, and stock quotes in addition to traffic advisories.

The Smart Corridor Project in Los Angeles will also provide automatic access to current traffic advisory information over the telephone using an audiotext system. As in Chicago, callers will be presented with a menu of options, permitting them to select and quickly obtain the desired information with their touch-tone telephones (14). The messages will be generated and updated from the Smart Corridor Central data base, which will be a gathering site for several sources of current information (3).

In Boston, a private company called SmartRoute Systems recently began providing real-time traffic advisories using several techniques, including audiotext and facsimile transmissions (30). The SmartRoute Operations Center collects information on Boston area traffic conditions from many sources, including remote video cameras, aircraft, mobile observers, construction schedules, emergency radio scanners, and direct communication with police and transportation agencies (31). Subscribers can obtain specific, instantaneous reports on traffic conditions by calling a traffic information hot line and entering a route identification number. The SmartRoute concept has been marketed primarily to the business community and to fleet operators, but the audiotext service is also being sold to Boston area hotels as an amenity for their guests (30).

*Videotext*

The final communication technology in this review of pre-trip information systems is videotext. Videotext is a term that refers to interactive systems for transmitting text or graphic information from a central computer data base to a remote video display over the telephone network (19). Although that description may be applied to many types of computer communications, videotext systems are typically characterized as low-cost, easy-to-use information networks, designed to serve large numbers of subscribers in the general public. The combination of a visual display format with the interactive capacity of the telephone network makes videotext ideal for communicating complex information in direct response to user requests (18).

Much like teletext, videotext services are provided from a central computer system that produces frames of text or graphic information. The frames are stored in a data base for retrieval and transmission to a user's video display upon request. The videotext service provider operates the central computer system and either maintains the data base for the subscribers or provides access to other systems containing the desired information (16). Interactive communication between the central computer and the videotext subscribers is achieved using the standard telephone network. The advantages of using the telephone network are its relatively low cost and very high accessibility. However, there are some disadvantages as well, particularly the low transmission speed. Receiving frames containing graphics can produce distracting delays for the videotext subscriber.

In order for an individual to obtain information from a videotext service, some equipment is required to receive, translate, and display the videotext signal, and to interact with the service provider's central computer. A simple, compact terminal with a keyboard and video display may be leased or rented from many videotext services (1, 32). It is also possible to attach a videotext decoder and keyboard to any television. Of course, almost any personal computer can be configured with a modem and software to function as a terminal.

Most videotext systems provide their subscribers with access to a wide assortment of services and information sources. The most popular category of videotext applications is information retrieval, or electronic publishing. Examples of information retrieval services include news, weather, stock quotes, and airline schedules. Public agencies and governmental bodies are also a major source of information for operating videotext systems, particularly in Western Europe and Canada (16). Other videotext services that are becoming more popular include electronic banking and home shopping, which permit subscribers to conduct transactions from their homes at any time of the day.

In the United States, the most successful videotext systems have been text-only services. CompuServe, with more than 600,000 subscribers, offers a variety of applications including information retrieval, shopping, financial services, and educational material. The Source and Dow Jones News/Retrieval are also widely used (16). A more recent videotext service for personal computer users is a joint effort between IBM and Sears called Prodigy (4). Prodigy has been aggressively marketed to the growing home computer segment of the microcomputer industry. The Prodigy interface makes extensive use of graphics, which results in a user-friendly environment but noticeably increases the time required to display a frame.

Despite the growing interest in videotext, the industry in the United States is not as well developed as it is in Western Europe or even Canada. The federal government has provided very little encouragement for videotext, so most of the development in the United States has occurred in the private sector (16). In France, on the other hand, the initial launch of the TELETEL videotext service was promoted by the national government, which financed the distribution of four million simple remote terminals to subscribers (1). The TELETEL service has been very successful, and millions of homes and businesses have access to over 7000 services on the national videotext system (32). Some of the TELETEL services available include maps of current road conditions at various levels of detail (18) and real-time travel information on bus and rail operations (1).

Although videotext appears to be an ideal communication technology for pre-trip information systems, that use alone will not justify further development in the United States videotext industry. However, as the personal computer becomes a more common fixture in American homes, and as the demand for convenient access to all types of services and information grows, the videotext concept should achieve the widespread public interest it needs to succeed. To capitalize on these and other future changes in communications technology, pre-trip information systems must be responsive and flexible. If advanced pre-trip information systems are designed to be adaptive, new technologies like videotext could be incorporated incrementally, as public use warrants.

## DISCUSSION

The primary objective of this report was to provide a summary of the current practices in pre-trip information systems, with a focus on the use of advanced or innovative techniques. Interest in pre-trip information systems is growing as the national emphasis shifts towards maximizing the efficiency of the existing transportation systems. Advances in the surveillance and monitoring of the highway systems have increased the quantity and quality of available information. Providing this information to the public can contribute to more effective pre-trip decision-making by some commuters, which has the potential to enhance the operation of the systems.

The application of advanced or innovative technology to the gathering of real-time operating data is only the first stage in the development of an effective pre-trip information system. Based on the findings of a study of commuter decision-making and behavior (7) and the review of current practices, a recommended approach for the development of a pre-trip information system also incorporates the following steps.

1. *Isolate the particular commuter decision that is to be influenced.* There are essentially three decisions that may be affected by the provision of pre-trip planning information: mode choice, route choice, and departure time. For information delivered to motorists in their vehicles, only route choice has the potential to be modified.

2. *Identify those commuters who are willing to modify that decision.* Surveys have shown that commuters are not a single, homogeneous group with similar behavior and information needs. It is possible, and necessary, to identify sub-groups of commuters that are more likely to change certain decisions based on pre-trip information. In general, most commuters would consider changing their planned route, many would consider changing their departure time, and a few would consider changing their mode.

3. *Determine on what basis commuter decision is made.* There are many factors that an individual commuter may use as a basis for his or her trip decision-making process. Some examples include: travel time, travel distance, familiarity, and cost. Often, the members of each distinct commuter sub-group will share a similar basis for their decisions.

4. *Create an algorithm for converting real-time data to information that is relevant to the decision.* In order to affect a particular decision, the relevant information must be derived from any or all available sources. A single mechanism for the collection of real-time data may simplify the processing, but several sources may be necessary to provide an adequate supply of information for effective decision-making. An approach for efficiently managing and processing real-time data from numerous sources may be the most complex task in the development of an advanced pre-trip information system.

5. *Determine where the decision-making process occurs.* Although many commuters are willing to alter their travel route while driving, nearly all motorists select the route they intend to use before departure. Clearly, commuter decisions about departure time and mode choice are made exclusively prior to departure.

6. *Deliver information designed to meet the needs of the targeted commuters.* Despite the existence of a receptive audience for pre-trip information, a few issues must be addressed in the design of an effective delivery process. To provide the necessary accessibility to the information, multiple dissemination channels may be required, each of which can influence the design of the message. Ideally, the content and format of the message should be consistent with the target group's basis for decision-making. Unfortunately, the design of the message is frequently dictated by the communication technology used to disseminate it. Another consideration is that advanced pre-trip information systems should not require advanced users. It is important to develop an effective user interface that is not intimidating to commuters.

7. *Provide feedback indicating the consequences of the modified decision.* One of the most significant problems with pre-trip planning information is a lack of credibility. Commuters who do modify their travel based upon pre-trip information should be provided with some indication that they made the proper decision. Feedback will reinforce the decisions and improve the credibility of pre-trip information systems.

It is evident from both the research and the current practices that pre-trip information systems have an increasingly significant role in urban travel. There are many opportunities for enhancing existing services and implementing new ones. A promising concept for advanced commuter information systems that addresses many of the current deficiencies is integration. Integration is the next logical step in advanced commuter information systems. Progress is being made in several separate but related areas, and combining those efforts should lead to additional benefits. An integrated system could combine pre-trip and in-vehicle information, use multiple delivery mediums and serve both transit and automobile users. The critical element of such a system would be a central data base of real-time commuter information, linking all the diverse data collection, processing, and dissemination techniques available. This type of system has been proposed in some cities, including Houston's "Smart Commuter" project.

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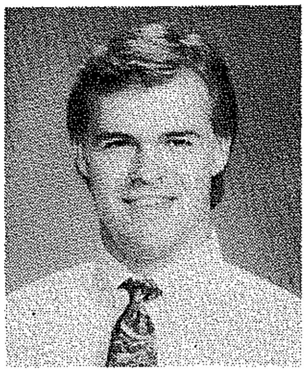

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