MODULE 7. INFORMATION DISSEMINATION

TABLE OF CONTENTS

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Figure 7-1. Dynamic Message Signing on New Jersey Turnpike.

7.1 INTRODUCTION

It is well known that the key to successful driving task performance is efficient information gathering and processing.[1] Likewise, properly communicating with motorists is critical to successful freeway traffic management and operations. Motorists rely on a wide variety of information to properly accomplish the control, guidance, and navigational aspects of the driving task. The roadway alignment and general terrain itself provides a great deal of this information through visual "cues;" sources such as pavement markings and regulatory, warning, and guide signs also contribute greatly to the overall information system. However, in an effective freeway management system, dynamic methods of conveying information to motorists or travelers are often needed to better operate and control the system.

Freeway management systems rely on various information dissemination components to apprise all types of travelers (motorists, transit users, commercial vehicle operators, etc.) of current and anticipated travel conditions so that informed mode, departure time, and route choice decisions can be made.

Information dissemination is also managed in order to improve travel conditions in the corridor by influencing traveler behavior (by recommending diversion routes around an incident, for example). This information can be disseminated from a variety of sources (State departments of transportation, transit agencies, private-sector information service providers, etc.) using a variety of methods (dynamic message signs, commercial radio traffic reports, traffic information kiosks, etc.).

MODULE OBJECTIVES

The objectives of this module are threefold:

- To describe how to define, establish, and coordinate effective traveler information components in a freeway management system.
- To identify existing and emerging technologies available to facilitate information dissemination to travelers.
- To illustrate how information dissemination components can integrate with each other and with other components of a freeway management system.

MODULE SCOPE

This module addresses both traditional and emerging information dissemination processes and technologies for freeway management systems. Whereas a number of technologies (i.e., dynamic message signs, highway advisory radio) have been around for a number of years, there are new opportunities today. In the past, information was distributed in response to an incident. Today, the focus is to provide a continuous flow of information to travelers, businesses, and commercial carriers in order to make their trip travel time more predictable. The focus of this module is to emphasize the need for integration among all components and technologies being utilized for information dissemination within the integrated regional transportation management system.

7.2 DESIGN PROCESS

Decisions about when, where, and how to disseminate travel-related information to the public have become much more complex in recent years, due to improved traffic/weather/transit surveillance capabilities and expanded information dissemination options. As with the other components that can be included in a freeway management system, the decisions necessary to develop and integrate information dissemination into the system can be best accomplished by following the basic decision process described in Module 2. Specific application of this process to the task of incorporating information dissemination into a freeway management system is discussed in the following sections.

IDENTIFY NEEDS

The first step in the decision process is to identify the need to be addressed through information dissemination, or stated another way, the information needs that exist in the freeway corridor. Two basic categories of information dissemination exist:

- Pre-trip planning.
- En route guidance and information.

Table 7-1 presents examples of some of the specific types of need and/or information needs in these categories. Certain information may be needed both pre-trip and en route, whereas other information may be needed for either one or the other. To the extent possible, these information needs should be further defined by the following:

Table 7-1. Information Need Categories.

Category	Examples of Information Need
pre-trip planning	• current/anticipated traffic conditions - speeds - incident locations - other congestion locations - upcoming road closures • weather effects - pavement conditions - road closures • route guidance - around incidents - to special events • transit information - bus schedules and status - transfer locations - rideshare matching (preplanning and real-time matching)
en route guidance and information	• current traffic conditions - speeds - incident locations - other congestion locations • weather effects - pavement conditions - road closures • route guidance - around incidents - to special events • lane/shoulder/ramp use status

- Audience.
- Location.
- Time-of-day.

These characteristics affect how well information can be received by the users, and what types of responses can be expected from the users who have that information available.

In addition to the needs to be addressed through information dissemination efforts, it is also important early on to identify those factors or issues that will influence the ability of agencies and/or the private sector to provide that information. Tort liability concerns can be one such factor. Some agencies may avoid providing current pavement condition information, for example, for fear of establishing a precedent that may be used against them if they fail to warn of that pavement condition (or a similar one) in the future. Preestablished agreements between public agencies and private sector companies regarding access to agency data may also influence the direction of future dissemination efforts.

The problem identification step of the decision process also includes an inventory of existing information sources, including media reports and private sector initiatives. The inventory can include such data items as target audiences, accessibility, frequency of reports, and information accuracy. If possible, assessments of user satisfaction with the information should also be obtained.

IDENTIFY INFORMATION DISSEMINATION PARTNERS

The key partners in the development of the information dissemination component of a freeway management system include the following:

- Traditional State and local public sector agencies (transportation and public works, transit, toll authorities, law enforcement).
- Commercial media.
- Private sector traffic reporting services (distributing through commercial media venues or through direct subscription to motorists).
- Local fleet operators (delivery services, taxis, etc.).

In some cases, the owners/operators of major traffic generators (malls, tourist attractions, annual special event promotions, etc.) could also be important partners to include in the decision-making process.

BUILD CONSENSUS AMONG PARTNERS

Identify Differences in Operating Philosophies Among Partners

Developing a consensus regarding the importance of information dissemination and its role as part of an overall freeway management system is the next step in the decision process. It is important that project partners take ownership of the effort up front, or it may never work. To make this happen, it is important to identify and understand the differences in operational philosophies of the different partners involved.

For example, highway and transit agencies may view the presence of some degree of recurrent congestion on the freeway in very different ways if an HOV lane is included within the freeway right-of-way. Whereas diverting freeway traffic to arterial streets might be a primary goal of the highway agency, the transit agency may desire to promote bus utilization and the HOV lane as a means of reducing that congestion. Partners need to communicate these concerns to each other so that a consensus about goals can be reached.

The partners must also be aware of the differences in operational philosophies between public agencies and private sector entities. Whereas equity concerns typically drive public agency decisions regarding the dissemination of travel-related information, marketing opportunities and profit motives will generally dictate private sector interests, perceptions, and decisions. A clear understanding of the differences among these philosophies is required.

Establish Common Ground Between Partners

Once operational and philosophical differences among the various partners have been identified, the next step is to establish areas of common concern or priorities between the partners with respect to travel-related information dissemination. Common ground must be established both at the upper management and political level, and at the day-to-day operations level. Information dissemination requires upper management and political support of a common vision of information availability in order to ensure continued funding support. Meanwhile, consensus among partners at the operations level is needed to promote true operations integration among the various information dissemination components utilized within the corridor.

ESTABLISH GOALS AND OBJECTIVES

Once a consensus has been established among the partners involved with information dissemination efforts, it is necessary to define the goals and specific objectives that are going to be addressed through this component of the freeway management system. As discussed in Module 2, goals are broad statements of the intent of the system or one of its components, whereas objectives are specific statements about what the system or component of that system will attempt to accomplish. A given goal may have more than one objective specified to reach that goal. Table 7-2 presents examples of goals and objectives an agency might have for the information dissemination component of its freeway management system.

Table 7-2. Examples of Goals and Objectives for Information Dissemination.

Category	Examples
Goals	• Reduce motorist demands upstream of a freeway incident • Reduce motorist errors in locating unfamiliar destinations • Reduce transit user uncertainty about bus arrivals
Objectives	• Warn motorists of adverse weather conditions • Notify motorists of downstream incidents • Advise motorists when to seek alternative routes • Provide motorists with origin-to-destination route guidance assistance • Inform motorists at park-and-ride lots when the next bus will arrive

In general terms, each of the objectives developed for information dissemination should be specific enough to answer the following questions: [(1)]

- Who is being communicated with?
- What responses are desired or anticipated?
- Where will the responses take place?

ESTABLISH PERFORMANCE CRITERIA AND MEASURES

In order to assess the extent to which information dissemination efforts within a freeway management system are meeting goals and objectives, a set of performance criteria and measures-of-effectiveness pertaining to these efforts must be identified. Relative to information dissemination, performance criteria have three different dimensions that are of interest:

- Information credibility.
- Market penetration.
- Traveler response.

These three dimensions are interrelated. The following sections provide additional details and examples of criteria for each of the above dimensions.

Information Credibility

An information dissemination tool must be credible to travelers if it is to be utilized and have an impact upon traffic operations. The following criteria define how credibility is established: [(2)]

- The information must be accurate.
- The information must be timely.
- The information must be relevant to its intended audience.

While these are generally accepted concepts, it is sometimes difficult to identify and obtain objective and quantifiable measures with which to judge them. This task is further complicated by the fact that the measures themselves may depend on the specific message or unit of information that a partner is trying to convey. Examples of performance measures that could be used to evaluate the credibility of information being disseminated to motorists are provided in Table 7-3. Local concerns and capabilities will dictate which performance measures are most appropriate for evaluating information credibility in a given locale.

Market Penetration

Market penetration refers to the percentage of the potential audience reached by the information dissemination efforts. Performance criteria regarding market penetration may be appropriate for evaluating certain system goals and technologies, particularly those emerging as part of Advanced Traveler Information Systems (ATIS). It is expected that some technologies, such as in-vehicle dynamic route guidance, will require only limited market penetration in order to achieve operational benefits. Other technologies, such as information kiosks in major traffic generators, may require agencies to strive for as great a market penetration as possible in order to distribute the information to a wider audience and possibly attract private sector advertising and sponsorship.

Table 7-3. Examples of Performance Measures for Information Dissemination.

Category	Examples
Information accuracy	• Difference in the number of incidents in the system and number of incidents reported • Difference between reported expected arrival times of buses and the times the buses actually arrive at a transit station • Number of complaints received from the public about inaccurate information (by device and type of information)
Information timeliness	• Average delay time between when an incident is verified and when information about the incident is disseminated to travelers
Information relevance	• Number of travelers who access a given information component or unit

Traveler Response

Ultimately, the purpose of providing information to travelers is to effect some-change in traveler behavior that will cause an improvement in safety or operations. Thus, performance measures are also needed to determine the extent to which information dissemination accomplishes this purpose. Changes in traveler mode, departure time, and route (if appropriate) are appropriate for evaluating the effectiveness of real-time travel-related information. However, it may be very difficult and expensive to obtain actual data for these measures. Traveler opinions about the effectiveness of the information being provided can be another important eval-uation measure. Reductions in travel time, turning and route choice errors, or similar measures may also be useful to evaluate certain types of information. (3)

It is important to recognize that because of the complex travel patterns of travelers at any point in the roadway, it may not be possible to adequately measure the overall effects of many types of information or dissemination modes upon traffic volumes, speeds, or delays. The day-to-day variances in travel patterns themselves may mask the effects of any information disseminated during a specific event such as an incident, particularly if the information is intended for a very specific audience (such as vehicles within a freeway traffic stream destined for a specific downstream exit).

Consequently, it may sometimes be necessary to include performance measures that evaluate the effect of information dissemination at an individual traveler's level. For example, trip diaries that identify a specific driver's travels on any given day may need to be compared to determine whether the presence of information had any influence on driving behavior for that select group with drivers on that particular day. This approach can be very costly and manpower intensive, however.

FUNCTIONAL REQUIREMENTS

The functional requirements of information dissemination components in a freeway management system define specific actions or activities that are to be performed in order to achieve one or more of the objectives. Initially, the functions should be defined without considering the dissemination technology or system architecture that will be employed. Functions simply specify what information will be disseminated and possibly when and where it is to be presented, not how this will be done. Table 7-4 presents some examples of functional requirements for various information dissemination objectives.

The ITS National Architecture should serve as the basic building block of the functional requirements definition process for information dissemination.(4) The functions described in the National Architecture must then be detailed to match the needs and desires of the local agencies.

Details regarding who should receive information, as well as when and where that should occur, all become a part of the functional definitions. The intent of this step in the design process is not only to specify functions independent of the technology that could be used to achieve those functions, but also to highlight what and why other components of the freeway management system must link with the information dissemination components.

Table 7-4. Examples of Functional Requirements for Information Dissemination Objectives.

Examples of Objectives	Examples of Possible Functions
• Warn motorists of adverse weather conditions	• Notify freeway motorists of downstream roadway flooding whenever more than 100 mm of water collects in an underpass section • Notify motorists approaching an entrance ramp whenever the freeway is closed because of adverse weather conditions such as high winds or ice
• Notify motorists of downstream incidents	• Within “X” minutes of its occurrence, notify freeway motorists of any incident that occurs in the travel lanes within the next exit or decision point
• Advise motorists when to seek alternative routes	• If the road is closed due to an accident, recommend that freeway motorists traveling to the CBD exit at an upstream connector to a parallel toll road whenever travel times to the CBD on the freeway are more than “X” minutes longer than on the toll road

For example, an information dissemination function that gives route specific travel times requires that travel time monitoring be a function in the freeway management system. Likewise, a function of notifying motorists about downstream lane-blocking incidents within a set time also affects the design of the freeway surveillance component of the freeway management system (what type of vehicle detection technology can be used, how close together detectors must be placed, etc.). As a final example, notifying motorists that lanes are closed downstream for maintenance work implies that a mechanism for determining when and where such closures occur is available via direct communication between the maintenance and operations divisions of the transportation agency, observation of the closure via closed-circuit television, or other methods.

DEFINE FUNCTIONAL RELATIONSHIPS, DATA REQUIREMENTS, AND INFORMATION FLOWS

The purpose of defining functional relationships, data requirements, and information flows is to establish an understanding of how the various information dissemination functions that are to be accomplished will be integrated with each other and with the other components in the freeway management system. In this step, the relationships between information dissemination functions are further refined to incorporate local issues, concerns, and capabilities.

The relationships between the desired information dissemination functions and necessary data flows to those functions can be particularly important when designing a freeway management system, especially if several partners are involved in the information dissemination process. Locations of potential information dissemination conflicts can be identified beforehand (a highway and a transit agency may want to display information at the same roadway location, for example). Perhaps more commonly, locations and situations where information sharing between partners can occur may be identified, and result in a more efficient system design.

IDENTIFY AND SCREEN TECHNOLOGIES

Once the system requirements for information dissemination have been developed, it is then appropriate to assess the actual technologies available to meet the functional and system architectural requirements that have been developed for meeting the goals and objectives of information dissemination. Technologies that are available for information dissemination can be grouped into one of three categories:

- Those located on the roadway where the information transfer to the traveler occurs at a specific point or within a very small segment of roadway (i.e., using dynamic message signs or highway advisory radios.)

- Those located within the vehicle where the information transfer is not constrained to a point or a small segment of roadway (e.g., using radio, cellular telephone, or in-vehicle navigation devices).

- Those located off of or away from the roadway altogether (e.g., using television, computer linkages, or kiosks in major traffic generators).

A review of the technologies in each of these three categories is provided later in this module. This review can serve as the starting point for the technology screening process. However, technology in the information dissemination realm continues to change rapidly and should be reassessed each time this point is reached in the decision process.

Initial screening can be used to determine which of the three basic categories can be used to effectively accomplish each of the specified information dissemination functions. More than one of the categories may be useable. Then, within each category, a more detailed screening and evaluation process can help select among the various alternatives of that technology. Screening should include such considerations as the following:[(5)]

- Legibility (for visual information components).
- Reliability.
- Costs to the user and public agency (these should be life-cycle costs, discussed in greater detail in Module 11).
- Potential market size.

If, for some reason, the screening process does not identify technologies that can adequately perform the functions that were established, then the analyst must step backwards and reassess the objectives and/or functions of the information dissemination component of the freeway management system. Objectives and associated functions may have to be scaled back or otherwise modified.

DEVELOP IMPLEMENTATION PLAN

The next step in the process is the development of an implementation plan. Implementation plan development is governed by federal guidelines, and is required for all new or expanded traffic control system projects that utilize federal funds.[(6)] Actually, an implementation plan is a good idea for all traffic control system projects, regardless of whether or not they utilize federal funds.

Module 2 described the general guidelines regarding overall plan development for a freeway management system. In this section, special issues of plan development are discussed that relate specifically to the information dissemination components of a freeway management system.

Because information dissemination must be coordinated among the various partners, a portion of the plan should be devoted to a discussion of the management structure and the agreements that will be utilized to achieve this coordination. Items to be included in this portion of the plan are as follows:

- Names of contact person(s) for each partner.
- Protocols and methods to be utilized to coordinate.
- Definition of each partner's responsibilities regarding information exchange.
- Estimates of each partner's financial contribution to the effort (cash, in-kind exchange of equipment or services, etc.).
- Letters or memoranda of agreement regarding the desire to coordinate among partners.

Additional details may need to be included in the letter of agreement if some of the partners will jointly operate some of the information dissemination technologies to be implemented. For example, a transportation agency may wish to allow law enforcement personnel to access and utilize their dynamic message signs or highway advisory radio equipment for managing major incidents during late-night hours when the transportation agency does not have someone on duty.

A detailed implementation plan is also needed in order to properly coordinate information dissemination within the freeway management system. Whereas the letters of agreement and discussion of the management structure lay out broad administrative boundaries and consensus to coordinate, the implementation plan spells out in detail how this will occur.

An implementation plan may include specific preplanned actions that will be taken in response to certain common or expected situations (i.e., which dynamic message signs will be activated and what will be displayed on them in response to an incident that occurs on a specific section of freeway), as well as more general rules that will be used to decide what information to present for unusual, unexpected situations. For example, the TransGuide Traffic Management System in San Antonio, Texas has over 60,000 preplanned "scenarios" coded into a computerized database. Depending on the time of day, location of an incident, and the number of lanes that are blocked, a specific scenario is selected that defines which dynamic message signs and lane control signals are to be activated and the messages that are to be displayed on each (i.e., "LEFT LANE CLOSED AHEAD"). Most of the time, system operators simply activate one of these preplanned actions. Occasionally, a freeway problem develops for which preplanned actions have not been developed. In these cases, system operators use basic information dissemination rules for the system they have learned to decide what messages need to be displayed, on which signs they should be displayed, etc.

IDENTIFY FUNDING SOURCES

Identification of funding source alternatives actually occurs as part of the plan development process. As with the other components of freeway management systems, the partners involved in information dissemination can share costs through some combination of the following:

- Individual agency hardware purchases and operation/maintenance which is coordinated with another agency's efforts in the region.
- In-kind contribution of equipment and services to a pooled service.
- Establishment of user fee schedules (direct or indirect).

Several different cooperative institutional arrangements have been successfully utilized to distribute information dissemination costs in a rational and equitable manner to public and private partners. For the TRANSCOM organization in New York/New Jersey, cash and in-kind contributions from each member agency fund the operations of the organization.[9] Each partner has an official assigned to the TRANSCOM executive committee, which works together to establish the actual fee structure, management policies, and other matters of concern to the agencies as a group.

In Boston, the SmarTraveler cellular call-in system is sponsored in large part by FHWA and the Massachusetts Highway Department, but is managed by a private-sector limited partnership, SmartRoute.[10] Several other private-sector companies (cellular telephone companies, a paging company, and broadcast media) purchase some of the information being managed and disseminated, which has helped offset some of the costs to the public agencies. [11]

In San Antonio, Texas, both public and private-sector partners have entered into a Cooperative Industry Product Agreement to facilitate the development and implementation of the software that will decode the video and data transmissions from a low-power television station that the Texas Department of Transportation has purchased and will operate. [12] This has allowed the various potential beneficiaries of the system (i.e., media stations, fleet operators, etc.) to contribute to software development for a relatively small price (and risk). Furthermore, it provides a mechanism to allow future partners to enter into the agreement in a fair and equitable manner. [12]

IMPLEMENT

Implementation of information dissemination components in the freeway management system occurs as a natural result of following the systems engineering process. Module 2 described, in general terms, the implementation activities that should occur at this point in the process. In addition to the issues brought out in that module, other concerns that pertain directly to information dissemination include:

- Implementation schedule.
- User training.

Information dissemination is the main link between the freeway management system and the motoring public. Experience indicates that the implementation of information dissemination devices should occur only after the surveillance and control infrastructure has been installed. Otherwise, the credibility of the overall system with the traveler can be severely degraded by having the devices in place and not using them or by having the devices display wrong information. One of the problems reported by officials of the INFORM project in New York was that the DMSs for the project were installed early on in the contract and then sat there unused for several years as the agencies built the rest of the infrastructure. Since it was not immediately apparent to motorists why the devices could not be used to communicate about downstream roadway and traffic conditions, public opinion about the project suffered.

Another important facet of information dissemination implementation is the development of training necessary to assist travelers in correctly interpreting and responding to some of the information dissemination technologies. For example, the Texas Department of Transportation in Fort Worth displays the meaning of lane control signals mounted over each travel lane periodically throughout the freeway network. As a result, motorist comprehension of the available symbols for the signals are somewhat higher in Fort Worth than in other locations in Texas. [13] Other possible training alternatives include public service announcements or mailing inserts in local utility bills.

EVALUATE

The final step in the design process is to evaluate the effectiveness of the information dissemination component of the freeway management system. However, this evaluation should not be considered a one-time activity, but should be part of a periodic review of the effectiveness of the information dissemination components and of the overall system. As discussed previously, it is rather difficult to measure the impact of information dissemination upon overall traffic measures, because of the stochastic nature of travel demands and behavior in a given freeway corridor, as well as the events which cause disruptions to these demands (incidents, special events, etc.).

Care should be taken not to overestimate the benefits achieved by the implementation of information dissemination components in a freeway management system. Specifically, it is important to recognize that travel patterns in a freeway corridor are quite dynamic, and that some drivers will divert naturally when they encounter freeway congestion regardless of whether or not they receive information beforehand about that congestion. Therefore, information dissemination should be considered as having an *incremental* effect upon traffic conditions by modifying where and how some travelers respond to congestion (where travel routes are changed, how many motorists change departure times, how many changed modes, etc.).

7.3 TECHNIQUES AND TECHNOLOGIES

Information dissemination components of a freeway management system can range from a single device owned and operated by one agency, to an integrated collection of devices and mechanisms under the control of several agencies and several private sector entities. In this handbook, a basic distinction is made between kinds of information depending on which of three main locations it comes from:

- On-roadway information.
- In-vehicle information.
- Off-roadway information (typically at origin of a trip).

Specific technologies available in each of these categories are discussed below.

ON-ROADWAY INFORMATION TECHNOLOGIES

One of the most fundamental technologies available for disseminating traffic-related information from the roadside is that of dynamic message signs (DMS). DMSs are sometimes referred to as changeable message signs (CMS) or variable message signs (VMS). DMSs allow operating agencies to visually disseminate travel information to motorists on a near real-time basis. DMSs use words, numbers, or symbols to convey information. They are extremely flexible and powerful traffic management tools in freeway operations.

DMSs can be either portable or fixed, and can be operated either on a fixed-time basis with on-site control or interconnected with a traffic control center to provide remote control.[14] DMSs can be used to perform the following functions:

- Inform motorists of varying traffic, roadway, and environmental conditions.
- Provide specific information relative to the location and delays associated with incidents.
- Advise motorists on detour routes because of construction or roadway closure.
- Suggest alternate routes to avoid freeway congestion.
- Reassure drivers on unfamiliar alternate routes.
- Redirect diverted drivers back to freeways.

Table 7-5 lists the applications for which DMSs can be used.[14]

Types of DMS

DMSs can be conveniently classified into three categories, namely:

- Light-reflecting.
- Light-emitting.
- Hybrid.

Light-reflecting signs reflect light from some external source such as the sun, headlights, or overhead lighting. Figure 7-2 shows examples of different types of light-reflecting DMSs. In comparison, light-emitting DMSs generate their own light on or behind the viewing surface. Examples of different types of light-emitting DMSs are shown in figure 7-3.

Some manufacturers have combined two DMS technologies (e.g., reflective disk and fiber-optic) to produce hybrid displays that

Table 7-5. Applications of DMSs. [14]

Category	Applications
Traffic management and diversion	• Freeway traffic advisory and incident • Freeway-to-freeway diversion • Special events • Adverse road and weather conditions • Speed advisory
Warning of adverse conditions	• Adverse weather and environmental conditions (fog, smog, snow, rain, dust, wind, etc.) • Adverse road conditions (ice, snow, slippery pavement, high water, etc.) • Low bridge clearance
Control at crossings	• Bridge control • Tunnel control • Mountain pass control • Weigh station control • Toll station control
Control during construction and maintenance operations	• Advisory of upcoming construction/maintenance • Speed advisory • Path control
Special-use lane and roadway control	• Reversible lanes • Exclusive lanes • Contraflow lanes • Restricted roadways • Temporary freeway shoulder use control

Figure 7-2. Examples of Light-Reflecting DMS Technologies.

exhibit the qualities of both. Some agencies have also combined DMSs with static displays to form what can also be considered to be hybrid displays.

Several references are available that describe the operational and performance characteristics of various DMSs (see references 1, 14, 15, 16) The following paragraphs, taken from those references, briefly describe the different types of DMSs in each category.

Light-Reflecting DMSs

The basic categories of light-reflecting DMSs are as follows:

- Fold-out.
- Scroll.
- Rotating drum.
- Reflective disk matrix.

Basic operations and characteristics of each are described below.

Figure 7-3. Examples of Light-Emitting DMS Technologies.

Fold-out. A fold-out sign is a conventional highway sign with a hinged viewing face. This type of sign can either display two messages (one with the hinged face closed, one with it open) or show a message only when the hinged face is open (no message is displayed when the hinged face is closed). Typically, signing materials that conform directly to the *Manual on Uniform Traffic Control Devices* (MUTCD) are used to make each message. For freeway applications, they are most often used to indicate icy bridge or other hazardous roadway conditions, or to indicate whether truck weigh stations are open or closed.

Scroll (or Tape). A scroll sign uses a tape or film upon which desired messages are imprinted. The tape is then rolled one way or the other (or up or down) to place a desired message within a display window. As with fold-out signs, scroll signs can use colors and other message characteristics that conform with the MUTCD. Typically, up to 8 to 12 messages can be stored on the tape. The inclusion of more than 12 messages can create long change-times if one or more of the messages is at the opposite end of the tape.

Rotating Drum. Rotating drum signs are made up of one to four multifaced drums, each containing two to six messages. Each face of each drum portrays one line of a fixed message, and pivots about its axis in order to display the appropriate face for a given message. Colors and lettering characteristics that conform to the MUTCD can also be used on rotating drum signs.

Reflective Disk Matrix. These types of DMSs were very popular for freeway management purposes in the 1970s due to their low energy requirements relative to light-emitting DMS technologies. The viewing face of a reflective disk matrix DMS is comprised of an array of permanently magnetized, pivoted indicators that are flat matte black on one side and reflective yellow or a similar color on the other. The indicators may be square, rectangular, or circular in shape. An electrical current activated when a given pixel is to be turned flips the indicator from a black matte finish to the reflective side. The sign itself can exist of a series of arrays of these indicators (e.g., 5 pixels by 7 pixels, or similar grid for each letter position), or a continuous grid or matrix over the entire sign face. The latter provides more flexibility to operators, but at a higher purchase price.

Light-Emitting DMSs

The following types of light-emitting DMS technologies are described in this section:

- Neon or blank-out.
- Lamp (incandescent mulb) matrix.
- Fixed-grid or shuttered matrix fiber-optic.
- Fixed-grid or matrix light-emitting diode (LED).

Neon or Blank-Out Signs. Neon signs use neon tubing to form characters and messages that are to be displayed. Two basic sign designs are possible:

- Separate each message on the sign face.
- Stack the neon tubing for each message one over another.

The stacked design has reported drawbacks, in that emitted light will be diffused as it passes through the overlayed neon tubing, reducing its legibility. Conversely, the separate message design will require a fairly large sign face in order to display even a moderate number of messages.

Lamp (Incandescent Bulb) Matrix Signs. A lamp matrix DMS relies on an array of incandescent bulbs affixed to a dark background to create the characters needed for a given message. The DMS can be a continuous array of bulbs, or a series of array modules, each of which can display a single character in the overall message. This design provides considerable message flexibility, limited only by the size of the sign (typically 4 lines of text, each comprised of 12 to 20 characters).

Fixed-Grid or Shuttered Matrix Fiber-optic Signs. Fiberoptic DMSs funnel light energy from a light source through fiber bundles to the sign face. For a fixed-grid fiberoptic sign, the ends of these bundles (pixels) are positioned on the sign face to create a given message. Sets of bundles and a separate light source are then used for each message portrayed on the sign. Conversely, the shuttered matrix fiberoptic DMS positions the ends of the fiber bundles on the sign face in an array similar to that used for other matrix signs. The light sources for all of the fiber bundles remain on constantly, and shutters at the ends of the bundles open and close to create the characters needed to display each message. As with the lamp matrix DMS, the shuttered fiberoptic signs can be either a continuous array of pixels or a series of array modules, each of which portrays a single character. Because of its flexibility, this tends to be the more common type of fiberoptic DMS utilized for freeway traffic management purposes.

Fixed-Grid or Matrix Light-Emitting Diode (LED) Signs. Light-emitting diodes (LEDs) are semiconductors that glow when voltage is applied. Recent advances in LED technology have allowed DMS manufacturers to utilize this technology to construct both fixed-grid and matrix style DMSs. Typically, several individual LEDs are "clustered" together in order to create each pixel. Early versions of the LED DMSs experienced difficulties in maintaining acceptable performance levels over time. However, LED manufacturers have strived to alleviate many of these types of problems in the next generation of DMSs that have been developed. [16]

Hybrid DMSs

Two of the most common types of hybrid DMSs are the following:

- Reflective disk with fiberoptics/LEDs.
- Static sign/DMS combination.

Reflective Disks with Fiberoptics/LEDs. To combat the times of the day and environmental conditions when reflective disk DMSs are not very visible, some manufacturers have combined fiberoptic or LED technologies into these types of signs to give them the visual boost they need. During the times of the day that the sun shines upon the sign and provides adequate visibility, the light sources are turned off by the sign. In addition to providing the additional visual boost during nighttime conditions, this technology also eliminates the need for external lighting on the sign. This eliminates the potential for glare off of the sign face as well. Some agencies are retrofitting reflective disk DMSs with hybrid reflective disk/fiberoptic technology.[15]

Static/DMS. The other major type of hybrid DMS currently in use employs components of both static signing and one of the DMS technologies into a single sign. This can reduce costs in situations when part of a message will be constant and another part of the message will be changed.[1] Also, the static components can be constructed to conform to MUTCD principles. However, this approach does limit the use of the sign to the specific situations addressed by the static component of the message.

Advantages and Disadvantages of the DMS Technologies

The selection of appropriate DMS technology is a complex task requiring analysis of trade-offs between display capability to fulfill a specific need and display cost (including operating and maintenance considerations). Further complicating the selection process is the large number of signing techniques available, each possessing quite different design and operating features. Tables 7-6 through 7-8 present a summary of the advantages and disadvantages that have been reported for each type of DMS technology (see references 1, 14, 15, 16).

Table 7-6. Advantages and Disadvantages of Light-Reflecting DMSs.[Adapted from 1,2,14-16]

Type	Advantages	Disadvantages
Foldout	Simple operation Can conform to MUTCD regulatory and warning signing principles	Limited capacity (1 or 2 messages) Higher potential for environmental and mechanical failures (i.e., panels jamming)
Scroll	Simple operation Can conform to MUTCD regulatory and warning signing principles	Limited capacity (8 to 12 messages) Time to change messages may be significant
Rotating Drum	Simple operation Can conform to MUTCD regulatory and warning signing principles	Limited character size Limited message capabilities (but more than fold-out or scroll)
Disk Matrix	Total message display flexibility Wider angle of legibility than fiberoptic or LED DMSs (see Table 7-7) Low power consumption relative to light-emitting DMSs	Visibility typically lower than similar size light-emitting matrix DMSs Disks sometimes stick or fail prematurely due to excessive dirt or moisture Illumination is required at night, sometimes causing glare or blurring problems

Too often agencies will purchase DMSs before signing objectives and messages are determined. Often, this causes disappointment in the DMSs when these agencies cannot display the desired messages, or when the signs provide lower than expected target value and legibility for the environmental conditions present at the site.[2] Conversely, agencies may end up purchasing a more expensive DMS with capabilities that exceed their actual needs.

IN-VEHICLE INFORMATION

Another realm of information system technologies available are those located within the vehicle itself. In-vehicle information can be disseminated to the motorist by audio or visual means. The following sections describe the basic types of in-vehicle information technologies.

Auditory In-Vehicle Information Technologies

Highway Advisory Radio

Although not as widely used as dynamic message signs, Highway Advisory Radio (HAR) is another means of providing highway users with information in their vehicles. Traditionally, information is relayed to highway users through the AM radio receiver in their vehicles. Upstream of the

Table 7-7. Advantages and Disadvantages of Light-Emitting DMSs.[Adapted from 1,2,14-16]

Type	Advantages	Disadvantages
Neon (blank out)	Simple operation	Limited message capacity Requires a fairly large sign for even moderate number of messages Current designs to not allow for nighttime dimming
Lamp (Incandescent) Matrix	Simple, proven operation High target value Message flexibility	Continuous energy supply required to display message High operation and maintenance costs (energy, bulb replacement)
Fixed Grid Fiberoptic	Low power usage Can display symbols and messages	Narrow cone of vision Limited message capacity
Shuttered Matrix Fiberoptic	Simple operation Message flexibility Low failure rates reported	Narrow cone of vision Mechanical component (shutters) increases potential maintenance costs
Fixed Grid LED	Low power usage Solid state devices (no bulbs) Reported reliability of LED lamps is very high	Narrow cone of vision Limited message capability Intensity adversely affected by high temperatures Long-term performance not known Super-bright LED lamps must be used for adequate daytime visibility
Matrix LED	Low power usage Solid state devices (no bulbs) Reported reliability of LED lamps is very high	Narrow cone of vision Intensity adversely affected by high temperatures Long-term performance not known Super-bright LED lamps must be used for adequate daytime visibility

Table 7-8. Advantages and Disadvantages of Hybrid DMSs.(Adapted from 1,2 14-16)

Type	Advantages	Disadvantages
Disk Matrix with Fiberoptics or LEDs	Some energy conservation (light-emitting technology is turned off in daytime conditions) Eliminates need for nighttime illumination of sign	Use of LED technology limited to date (long-term performance not known) More complex operation (maintenance may be more costly)
Combined Static/DMS	Portions of sign can conform to MUTCD regulatory and warning signing principles Some cost savings is possible relative to full-matrix DMSs	Static portions of sign limits message flexibility Light-emitting DMS technology may wash out static portions of sign if too bright

HAR signal, users are instructed to tune their vehicle radios to a specific frequency via roadside or overhead signs. Usually, the information is relayed to the users by a pre-recorded message, although live messages can also be broadcast.

Message transmissions can be controlled either on-site or from a remote location through telephone or radio interconnects. Most HAR systems operate at the 530 or 1610 kHz frequency level; however, any available frequency can be used as long as a low enough power level is used. A license from the Federal Communication Commission is required to operate a HAR system at high power levels (10 watts or greater).

HAR is used in many different applications. With respect to freeway management, uses of HAR are similar to those of DMSs, and include the following:

- Warning of roadway incidents or congestion.
- Warning of adverse environmental conditions (fog, ice, etc.).
- Notification of highway construction or maintenance.
- Alternate route information.
- Advisories within and regarding transportation terminals (airports, special events, and other major traffic generators, etc.).

One of the major advantages of using HAR is that information is received through a different sensory channel (audio), which reduces information overload received visually while driving.(17) Also, longer and more complex messages can be provided to motorists than can be accomplished using DMSs. However, traditional HAR systems have their drawbacks. They require motorist action (i.e., tuning radio to appropriate frequency) in order to receive information. Also, if a motorist misses one part of an HAR message, he or she must listen to the entire message again in order to obtain the missed part.

There are two types of HAR systems: vertical “whip” antenna systems and induction cable antenna systems. Vertical “whip” antenna systems use individual antennas or a series of antennas electronically connected together to transmit information. The signal radiates from the antenna in all directions providing a circular area of transmission. Vertical antenna systems have the following advantages:

- They are small.
- They are easy to install.
- They can be placed within several hundred feet of the roadway.
- They are less costly to purchase and install than induction cable systems.

Vertical antenna systems also have the following disadvantages:

- They are subject to damage by weather, accidents, and vandalism.
- They often require special equipment to ensure that the signal is stable, reliable, and easily tuneable.
- Motorists can lose the HAR signal when traveling through tunnels, canyons, etc.

Induction cable antenna systems use a cable installed either under the pavement or adjacent to the roadway. This type of antenna design produces a strong but highly localized signal within a short lateral distance 30 to 45 m (100 to 150 ft) from the cable. Induction cable systems have the following advantages:

- The signal is strong enough to provide full coverage of a multilane facility without causing interference to other HAR systems.
- Messages can be individualized by direction of travel.
- Interference with other radio systems in the area is minimized.

Disadvantages of induction cable HAR systems include the following:

- Induction cable systems are more expensive to purchase and maintain since the cable must extend the full length of the desired coverage area.
- Once installed, induction cable HAR systems cannot be transported from one location to another.

Automated HAR (AHAR)

One of the disadvantages of HAR systems is that they require advance signing to notify motorists of the availability of information, and an action by the motorist to activate and receive that information. Automated highway advisory radio (AHAR) systems have been proposed that require no actions by the motorist to obtain radio information. These systems emit a special electronic notification signal upstream of an HAR message, which interrupts the specially-designed radio/cassette/compact disc player to broadcast the message to the motorist.

FHWA sponsored the prototype development and pilot testing of an AHAR system in the early 1980s. [18,19] However, the difficulties associated with producing and marketing a receiver within a price range acceptable to motorists hindered further AHAR implementation. However, recent emphasis on ITS has sparked renewed interest in AHAR systems. Michigan is experimenting with alternative AHAR designs at this time. [20] Meanwhile, Europe has been experimenting with a version of these types of systems (termed the Radio Data System [RDS] Traffic Management Channel [TMC]) for the past few years. This system relies on a silent data channel broadcast via FM from existing radio stations. With an appropriate radio receiver, a motorist is then able to receive information from the closest or strongest FM radio signal at that location. (15)

Cellular Telephone "Hotlines"

An in-vehicle communication technology that has seen dramatic growth in the past few years is cellular telephones, which gives the motorist the ability to call special "hotline" systems for traffic information from within their vehicle. Originally, these systems allowed motorists and transit users to call for information to assist in pre-trip decisions from their homes. Information can now be accessed en route via cellular telephone, and decisions can be made whether to alter travel routes. The creation of call-in systems has been a popular traffic impact mitigation strategy for many major urban freeway reconstruction projects in recent years. (21)

One of the more successful examples of this technology is the two SmarTraveler systems now in place in Boston and Cincinnati. (10) Both systems employ special telephone numbers to keep the service free to cellular telephone users. Touch-tone menus allow callers to receive route-specific traffic information (delays, construction activity, recommended alternative routes), bus and train scheduling, and special event transportation information.

This type of in-vehicle communication has the advantage over HAR of giving the motorist some control over the type and amount of information he/she wants to obtain through the touch-tone menus. In addition, it is also possible to generate two-way communication between the motorist and the information source.

Many metropolitan areas have established cellular "hotlines" for motorists to call in and report accident information to the highway agency. Examples include #77 and *SP. The public agency must negotiate with the cellular companies to provide the toll free calls.

Recommendations for establishing cellular telephone "hot-line" systems include the following:

- The call must be toll-free to users.
- The telephone number must be easy to remember and dial.
- The information must be concise.
- If a menu system is used, a long and tedious menu selection process should be avoided.
- A sufficient number of telephone lines should be provided to prevent the majority of users from receiving a busy signal.
- If a system is going to be used to gather information from users, there must be a method of ensuring the accuracy of the incoming information.
- "Official" use of tipster information should include procedures for verifying that information.
- If incident information is to be received, a human operator is recommended so that secondary questions can be asked to clarify confusing or unclear reports.

As with HAR systems, this technology also requires action by the motorist to access information. There are also significant operating costs associated with this technology, as any calls made using cellular telephones must be paid for by either the motorist, or a public agency, or else absorbed by the corporation providing cellular telephone communication capabilities in the region. Finally, there is some concern that cellular telephone usage while driving may degrade motorist attention and operating capabilities. Manufacturers have developed "hands-free" telephones that allow motorists to listen and talk without holding the telephone receiver.

Commercial Radio

The public has learned to depend upon the media to provide them with "almost" real-time traffic information. Commercial radio has proven to be a good means of providing travelers with traffic information both in and out of their vehicles. Traffic and roadway condition reports have become standard programming items on many commercial radio stations. Commercial radio has the best potential of reaching the greatest number of commuters, since most of them have radios in the vehicles they drive to and from work.

The primary disadvantage of using commercial radio relates to the accuracy of the information. Traffic reports often are transmitted only when normal scheduling permits. This may cause considerable time delays between when an incident occurs and when it is reported by the media. Often, many incidents go unreported or are cleared by the time they are reported on the radio and television. The accuracy of the information provided by commercial radio is a function of the time between the broadcaster's last communication with the incident reporting source and the number of incidents that have occurred and/or have been cleared during that time.

Some transportation agencies have made substantial efforts to improve coordination and cooperation between themselves and the media traffic reporters. For example, some agencies allow private traffic reporting agencies to place personnel in the traffic management center to obtain information on traffic conditions and expected agency responses in an accurate and timely manner.

Citizen-Band Radio

Even though it was once considered an excellent means of providing motorists with two-way communications from their vehicle, Citizen-Band (CB) radio has declined in popularity in recent years. However, there are still a significant number of vehicles, particularly commercial vehicles and trucks, equipped with CB radios. In the past, CB radios have been used primarily in motorist-aid systems. A disabled or passing traveler broadcasts a request for assistance on channel 9. The channel is monitored 24 hours a day, 7 days a week by a police or volunteer organization, which dispatches aid to the stranded traveler. The primary advantage of a CB radio system is that it permits two-way communication between the traveler and the response agency. The effective range of many CB radios is approximately 32 kms (20 mi), depending upon geographic conditions.

Visual In-vehicle Information Technologies

Video Display Terminals

One of the newer technologies for communicating with motorists in their vehicles is through a video display terminal (VDT) mounted in the dashboard. This is primarily a private sector industry, which has not been used widely for information distribution. These systems can be used to provide motorists with route guidance and navigational information in one of two different formats. One approach is to present the driver navigation and route guidance information in the form of maps or equivalent displays. With these systems, a global picture of the traffic network can be provided. Recommended routes can be highlighted on the video map display as well. In another approach, simple symbolic signals (e.g., arrows, text instructions, or a combination of both) guide the driver along a recommended route. Some prototype systems use a variety of displays depending upon whether or not the vehicle is in motion, the functions selected, and level of informational and navigational displays available.

In-vehicle VDTs offer a number of advantages over available technologies in providing information to motorists while driving. These include the following:

- Travel information is more readily accessible to the driver (providing continuous access to current position, routing, and navigational information).

- Computer-generated navigational maps and displays are logical extensions of traditional forms of providing drivers with route guidance and navigation information.

Information can be displayed in text, graphics, or both and tailored to the needs and desires of each motorist.

There are also limitations to in-vehicle VDTs. These include the following:

- Drivers have to take their eyes off the roadway in order to receive the information.

- In-vehicle VDTs present the driver with complex maps and diagrams that may create a potential to overload the driver with too much information.

- VDTs may also add to the visual clutter already inside the vehicle.

Head-Up Displays

As technology continues to improve, the Head-Up Display (HUD) has become another alternative to in-vehicle VDTs for presenting visual navigational and route guidance information to motorists. Although originally developed for the aviation industry, several automobile manufacturers are beginning to develop HUDs for presenting vehicle status and navigational information to drivers.

A wide variety of options for displaying information may be available using HUDs. Through both icons and alpha-numeric text, navigation and route guidance information may be projected directly into the driver's field of view. This is expected to reduce the need for visual scanning between two information sources (the inside instrument panel and the outside environment), and the associated visual accommodation time.

However, as might be expected, numerous concerns exist regarding the safety and applicability of using HUDs in the driving environment.[23] Currently, most HUDs under development and implementation provide drivers with only relatively simple information, such as speed indications.

OFF-ROADWAY INFORMATION

The final type of information systems discussed in this module are those that drivers access off-roadway, at their homes, offices, shopping malls, etc. A major thrust of ITS development and implementation focuses on putting more information into the hands of motorists and passengers so as to improve departure time, mode choice, and route choice decisions. This emphasis has resulted in increased utilization of a number of traditional information technologies, and has yielded a number of new off-roadway information sources and several new dissemination technologies. Off-roadway information dissemination technologies include the following:

- Television.
- Telephones.
- Pagers.
- Personal Data Assistants (PDAs).
- Computers.
- Kiosks.

Television

Television (together with radio) was one of the first off-roadway motorist information technologies available to motorists. Even today, commercial television stations in most major cities provide traffic reports to viewers as part of their morning programs to indicate incident locations, traffic signal malfunctions, and other traffic "hotspots." These locations are usually shown on some type of wall-mounted or computer-generated map display.

Public access television is a means of overcoming many of the disadvantages associated with privately owned media stations. Many city governments are responsible for franchising cable television service within the corporate limits of the city. As part of awarding the franchise to a company, many city governments offer their own programming on one or more of these dedicated channels. Public access channels can be used by traffic management agencies to broadcast continuous traffic information during peak hours. Either "crawl" messages across the bottom of the screen or map displays accompanied by voice messages can be used to provide users with information. Traffic reports can also be provided by interrupting normal programming. The primary disad-vantage of using public access television is that the information is available only to cable subscribers. Travelers living outside the service area or not subscribing to the particular cable company do not have access to the information.

One freeway traffic management center in the U.S. has developed the capabilities to provide video and digital data directly to television signals. [12] They broadcast live video, a computerized map display, and current control and management actions being implemented (which DMSs have been activated). These signals are scrambled so that only those with the appropriate software and hardware can properly receive the signal. This is believed to reduce the need for censoring the images that are being presented, since they are not available to the public at large.

Telephones

As discussed earlier, telephone "hotlines" can allow both freeway and transit users to obtain pre-trip information via their telephones at home or work, or in their car if they are willing to pay for cellular airtime charges to call the hotline. Information can be provided using recorded messages, synthesized voice messages, or human operators. A touch-tone menu system can be used to tailor information to a specific route or travel corridor. Telephone calls are also a means of developing real-time rideshare matching systems that are being explored in several U.S. locations.

Pagers

A more recent technology now used to help disseminate travel information to users away from the vehicle are personal pagers. In Bellevue, Washington (east of Seattle), alphanumeric pagers provide their owners with hourly information regarding available carpools looking for riders as well as current traffic conditions on the Puget Sound-area freeway system.[24] The Genesis project of the ITS Guidestar program in Minneapolis, Minnesota and TRANSCOM in New Jersey also utilize alphanumeric pager technology to disseminate travel conditions in real-time to its owners. A key constraint of pager technology is that broadcast messages are limited to a small number of characters. Consequently, efforts are underway to determine which information is most relevant to pager owners and how to format that information succinctly, but accurately.[25]

Personal Data Assistants (PDAs)

Personal Data Assistants (PDAs) are the next higher level of sophistication in off-roadway information dissemination technology. PDAs are computer products that have enough power to support applications such as time management and handwriting recognition. By adding radio frequency (RF) communications technology, PDAs allow users to interact directly with travel information systems. This interaction allows users to obtain route planning assistance, traffic information broadcasts, and other pertinent information. Through keypad entry, the user can log on to the information system, request pertinent information, and then log off. PDAs offer the user increased communication and information transmission/receiving power over alphanumeric pagers. However, they are more complex to use and expensive to purchase. [25]

Computers (Internet)

Personal computers, both desktop and laptop/notebook, can also be used to disseminate information to travelers. As with PDAs, two-way communications between the computer user and the travel information center can be established by telephone modem or an RF communication link. This two-way flow of information allows the user to request information specifically tailored to his or her needs (route planning, traffic information on specific roadway links, transit bus schedule and status, etc.).

Kiosks

The last off-roadway information dissemination device to be discussed is the information kiosk. Kiosks are video monitors mounted on a stand-alone cabinet, in a wall, or on a counter-top. They may have input devices such as keypads, track-balls, or touch-screen displays. Kiosks can serve as an important point of access to travel information networks in a variety of public locations, including the following:

- Hotels.
- Restaurants.
- Airports.
- Gas stations (truck stops).
- Retail establishments (shopping malls).

Kiosks are one type of information dissemination technology where private/public partnerships are particularly relevant. For instance, some agencies are looking to the private sector (through advertising revenue) to help defray the operating and maintenance costs of these systems.[26, 27] Proper kiosk placement is also a critical issue. Many kiosks are not well utilized because they are not located where they can draw attention and reach their intended market.[27]

7.4 LESSONS LEARNED

NTCIP STANDARDS

Equipment compatibility, especially with respect to communications, has long been a problem for many transportation agencies operating various components of freeway management systems. Incompatibilities between DMS and HAR hardware from different vendors have required the agency to have separate systems to communicate with each type of DMS or HAR. This has made it difficult to operate the equipment efficiently and in an integrated manner.

In response to these and other problems, a National Transportation Communications Interface Protocol (NTCIP) is under development to reduce the difficulties associated with developing an integrated freeway management system. These protocols establish standard communications linkages between various types of hardware and software used for traffic management purposes. This ultimately reduces the need for an agency to select and stay with a particular vendor or model of equipment.

In the information dissemination arena, standards have been proposed, or are under development, for DMS and for HAR. Standards for other equipment are likely to emerge as the need arises. Partners are strongly encouraged to utilize NTCIP standards where possible.

INFORMATION MESSAGE DESIGN

Although traditionally a concern associated with public agency information dissemination mechanisms such as DMS and HAR, the proper design and packaging of the information being disseminated is critical to successfully meeting the goals and objectives for all components of an information dissemination subsystem. Evidence already exists on some of the newer ATIS technologies that improper message designs have an adverse impact upon customer (i.e., motorist) interpretation of the worth and usefulness of these technologies.[29] Without proper attention to packaging, the intended audience may not be able to adequately perceive, interpret, and respond to the information. The following factors are critical to proper message design:

- Message load.
- Message length.
- Message format.

Message load refers to the quantity of information that is included in a given message. Message load is an important consideration for DMS operations, because the driver must attend to many different tasks at the same time, while trying to read and comprehend a message. If the message presents too much information, message overload may occur. Some transportation agencies have reported traffic slowing down and other adverse operational problems in the vicinity of DMSs when messages are too long. [1]

Message length refers to the number of words or characters that are displayed on one or more lines of a sign or sequence. Obviously, message length and load are related. However, message length and how the message is formatted, or “chunked,” both affect message load.

Message formatting is a term that refers to the arrangement of message elements (words or lines) on an information dissemination device (e.g., a sign) to form a message. Use of abbreviations also relates to message formatting. Placement of message elements on the wrong line or in the wrong sequence will result in confusion and increased message reading and comprehension times.

The completed and detailed set of guidelines regarding message design from which these paragraphs were drawn are available elsewhere. [2]

ENVIRONMENTAL ISSUES CONCERNING DMSs

Because they are located outdoors next to the freeway, the effectiveness of DMSs as an information source is also affected by environmental factors. Two factors that can be significant are sun position and weathering effects.

Sun Position

Both sunlight falling directly upon the face of a DMS and sunlight located directly behind the DMS adversely affect a driver's ability to see the message. Sign positions with the rear surfaces oriented west-southwest and east-northeast should therefore be avoided if possible. The west-southwest orientation is more problematic, however, because the setting sun tends to be more intense than the rising sun.[1]

Weathering

Because of their proximity to freeway travel lanes, road grime can be a problem for certain DMSs, and significantly reduce the distances at which they are legible. Consequently, DMS manufacturers often place clear Lexan covers over the DMS face to protect the sign from road grime and other environmental effects. One study suggests that legibility distances of a fixed-grid fiberoptic DMS (a freeway lane control signal without a Lexan cover) may be reduced by as much as 25 percent after 18 months in the field. [29] It appears that these losses in legibility can be minimized to a large extent by a regular sign maintenance (pixel lens cleaning, light bulb replacement) program.

"AT-REST" DISPLAY CONDITIONS

Another DMS-specific issue is what to do with the signs when there is nothing special to report to travelers. There are generally two schools of thought regarding when information should be provided in dissemination devices.[2] One perspective is that some type of information such as current time and temperature, an agency slogan, etc., should be provided at all times. Proponents argue that this indicates to motorists that the devices are working. The other perspective is to display information only when there is something new to tell travelers. Proponents of this school of thought argue that, according to human factors principles, trivial or non-traffic specific information should be avoided so that the devices do not lose credibility with the travelers.

7.5 EXAMPLE OF AN INFORMATION DISSEMINATION SYSTEM: TRANSCOM

ORGANIZATION

TRANSCOM (Transportation Operations Coordinating Committee) is a consortium of 14 transportation and public safety agencies in the New York, New Jersey, and Connecticut area whose goal is to provide a cooperative, coordinated approach to regional traffic management. TRANSCOM is funded, staffed, and governed by its member agencies. It has an Operations Information Center (OIC) that is staffed 24 hours per day, 7 days per week. TRANSCOM shares incident information via alphanumeric pager, phone, and fax to more than 200 highway and transit facilities, police agencies, and radio traffic services. It also serves as a forum for incident and special event management planning, construction coordination, and for shared testing and implementation of regional traffic and transportation management technologies.

The planning process for TRANSCOM began at the end of 1984. TRANSCOM began operations in 1986. Originally, the Port Authority of New York envisioned TRANSCOM as a coordinating mechanism to facilitate traffic flow and operations at the Hudson River crossings. However, TRANSCOM's focus quickly expanded to all traffic facilities in the region.

TRANSCOM is managed by a steering committee made up of senior and mid-level managers from each agency. This committee directs the technical and operational focus of TRANSCOM. Meanwhile, an executive committee consisting of the chief executive officer from each agency decides major policies pertaining to TRANSCOM.

Although TRANSCOM is a public sector information dissemination example, it is considering moving towards a public/private partnership. Public/private partnerships are a much more appropriate example of what is likely to occur in the future.

OPERATIONS

The TRANSCOM OIC receives information regarding incidents and transit facilities from all over the metropolitan area. The operations personnel in the OIC are employees of one of the member agencies and generally have some background in dispatch, operations, or media reporting. The TRANSCOM partnership has allowed several projects to be developed and implemented to facilitate information dissemination and incident response in the region. These include the following:

- Regionwide initiatives for coordinated deployment and operation of VMSs, HAR, and enhanced traffic monitoring via CCTV.

- An enhanced traffic advisory/diversion system at the intersection of the New Jersey Turnpike and Garden State Parkway, which will focus on alternative routing for New Jersey transit buses.

- Expansion of traffic monitoring along the I-287 Tappan Zee Bridge corridor.
- Initiation of the TRANSMIT (TRANSCOM's System for Monitoring Incidents and Traffic) Operational Test. This project uses vehicles with transponders on a highway system equipped with readers/antennas.

TRANSCOM receives information regarding incidents and transit facility conditions from all over the area. The OIC is normally staffed with two operators who receive, collate, and disseminate transportation-related information. The information is relayed to the agencies affected by the incident via alphanumeric pagers, facsimile machines, and voice communications. This information is then disseminated by the various agencies according to their capabilities. In some instances, TRANSCOM has been granted authority to operate the information dissemination technologies for certain agencies. [9]

TRANSCOM operations are fully funded by its member agencies. This funding consists of both monetary contributions and in-kind services such as providing operators to staff the OIC.

FUTURE ACTIVITIES

The executive and steering committees are looking at a number of issues relating to future TRANSCOM operations. TRANSCOM will continue to pursue research and testing of advanced technologies to help the region more effectively manage travel in the congested northeast corridor. The TRANSMIT system is an example of this commitment to future operations. [30] TRANSCOM is participating with other agencies in the development of a computerized Information Exchange Network (IEN) to automate the information retrieval and dissemination process.

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