Abridgment

Dial-in Freeway-Traffic Information System

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To provide travel information to the driver before he or she leaves his or her home or office, a telephone dial-in service was developed. The service was installed as a part of the Dallas Corridor Study, a research and demonstration project concerned with instrumentation, surveillance, and control of urban freeway and arterial facilities (1). The city of Dallas provided funding for the installation and monthly charges, and the design, operating procedures, and evaluation were developed by Texas Transportation Institute under a research contract with the U.S. Department of Transportation. The system was operated for approximately 18 months before it was terminated because of lack of use by the driving public. A detailed documentation of the system is given in the project reports (1, 2).

OPERATING STRATEGIES AND PROCEDURES

The principal object of the dial-in information service was to give drivers accurate, current information to aid them in the pretrip planning phase of an intracity trip. Depending on the amount of information to be given at any one time, callers could receive locations of incidents, suggested alternate routes, current nonincident operating conditions, or a combination of these. In the absence of an incident or of changing conditions, the message was updated at least every 10 min during peak hours and every 30 min during off-peak hours.

Up to 5 (originally 10) callers could receive the message at any one time. The system was capable of handling up to 20 lines without additional equipment. Callers entering in midmessage received a repeat of the total message. After a caller had received one complete message, the mechanism disconnected that call, freeing the line for another caller.

The system imposed a maximum message length that could be adjusted from 10 to 60 s. Messages exceeding the maximum were voided, edited, and rerecorded. When messages were less than the maximum, the current message length was automatically adjusted so that there was no dead time on the recording.

Information Sources

Information that might be of use to drivers using the North Central Expressway was secured from sources that included a closed-circuit television system for incident detection and operating conditions, the police radio scanner for incident location, a real-time computer printout (1, 3) for operating conditions, real-time computer incident monitoring (4) for incidents, and reports from field units for operating conditions and incidents.

Design of Message Formats

To design message formats and to put the available information in priority order within the limited message time, a human-factors study (5) was made to determine the requirements of urban freeway motorists in the Dallas area. The study involved survey questionnaires administered to 303 motorists employed in seven firms in the central business district.

This questionnaire was designed to establish the degree of interest in the service and to develop design and operational criteria for the messages. Seventy-five percent of the respondents stated that they would use such a service. Their greatest interest was in information about the location and degree of congestion, alternate routes, the reason for congestion, and whether or not a lane was blocked. On bases of the survey results, other studies (6), and day-to-day operational experience in the control center, a set of messages for various traffic situations and other design criteria were specified.

The message formats for various operating conditions during the morning peak periods are given below. If there are no incident messages, the following conditions are reported:

1. At (time), North Central traffic inbound is [moving well [>56 km/h (35 mph)], moderately congested [48 to 56 km/h (30 to 35 mph)], congested [32 to 47 km/h (20 to 30 mph)], or heavily congested [<32 km/h (20 mph)]] between (LBJ, Loop 12, or Mockingbird) and (Loop 12, Mockingbird or downtown).
2. Traffic outbound is [moving well [>64 km/h (40 mph)], moderately congested [48 to 63 km/h (30 to 40 mph)], congested [32 to 47 km/h (20 to 30 mph)], or heavily congested [<32 km/h (<20 mph)]] between (downtown, Mockingbird, or Loop 12) and (Mockingbird, Loop 12, or LBJ).
3. No lane blockages are reported.

If there are incident messages in the peak direction, the following conditions are reported:

1. At (time), there is (an unidentified blockage, a stalled automobile, an accident, or spilled debris) on North Central inbound at (location).
2. Traffic is backed up to (location).
3. Inbound traffic is moving well south of (location).
4. An alternate route is advisable.
5. Traffic outbound is [moving well [>64 km/h (40 mph)], moderately congested [48 to 63 km/h (30 to 40 mph)], congested [32 to 47 km/h (20 to 30 mph)], or heavily congested [<32 km/h (<20 mph)]] between (downtown, Mockingbird, or Loop 12) and (Mockingbird, Loop 12, or LBJ).

Off-peak messages were similar, but with the speed levels slightly higher. These formats served to guide the operators in the type and order of information to be given, so that consistency for various conditions would be maintained. Departure from the prescribed format was necessary from time to time to adequately describe special situations, such as weather conditions or police enforcement activity. Information of lower priority (the higher numbers above) was eliminated as necessary to keep the message within the time constraints.

SYSTEM COMPONENTS

The dial-in system hardware had five primary components:

1. The recording and monitoring instrument, which had the outward appearance of a conventional dial telephone with push buttons for six lines, was the mechanism for recording and checking messages. The six push buttons allowed for dictating and checking messages and indicated when there was an incoming call.
2. A three-position switch was used to select the message that would be output to the caller. Placing the switch in the left or right position caused the message recorded on channel 1 or 2 respectively to be output. Placing the switch in the center position caused incoming calls to be unanswered, although they continued to ring and would receive the message when the switch was moved.
3. A handset was provided to override the recorded message, so that callers receiving a current operating message could be informed that an update was being made. This was necessary because moving the channel selector from one channel to another cut off current callers.
4. A digital readout recorded cumulatively the number of calls received. Pulling a small plunger reset the meter to zero, so that the number of calls received each day could be determined.
5. A recording and playback unit was provided for each of the two channels. These units required no direct operation or adjustment by the operator.

PUBLICITY

To adequately publicize the availability of the service and to obtain a basis for evaluation, several methods of advertising the dial-in service were used. Because the degree to which the system might be used was not known, not all of these methods were used initially. This was due to the fear that overloading the system with callers, many of whom would be curiosity callers outside the service area, would cause some legitimate callers to receive busy signals and discourage them from trying again. The sequence used was (a) to provide mail notification to a control group (303) selected from the questionnaire respondents, (b) to publicize the system in the news media, (c) to mail information to major downtown buildings, (d) to include mail notification in some water bills sent to areas whose residents might logically use the service, and (e) to mail information to a sample of motorists who might use North Central (as determined from a license-plate survey). In some of these publicity efforts, evaluation data were also sought.

EVALUATION

Although approximately 75 percent of the control group indicated that they would use such a service, experience has shown that what drivers say they will do in the abstract and what they do in actuality may differ. Therefore, it was essential to have a positive, mechanical count of the number of calls received per day as well as to secure comments from a sample of those actually using the service.

Evaluation of the effectiveness of the dial-in system, therefore, was accomplished by two methods. First, the daily count of the number of callers was recorded and second, an attempt was made to contact and elicit comments from actual users of the system.

Number of Calls Received

Daily records of calls received were kept by the control-center personnel. On the first day of operation, 3315 calls were received. This was a result of the extensive coverage in the news media and certainly included a large number of curiosity callers. A record of the calls showed that the number declined steadily to about 115/d by the end of the first month. The average number of calls received during the first year of operation was 83/d, but the number of calls received on any single day was as low as 30.

It is difficult to make an absolute comparison of the operation from one day to the next because of the highly variable nature of the operating conditions and characteristics. Accidents may go undetected; rain may be falling in a residential area and not on the freeway; and the variability of driver schedules due to holidays, illness, or vacations is a factor. However, it was possible to make a relative comparison from one day to the next by realizing that the absolute change may be affected by any one of several unknown or unmeasurable factors. A trend or indicator is evident from such comparisons.

Publicity

The initial coverage in the news media had the greatest effect on the number of calls received. However, the number of calls decreased decidedly after the initial surge. Direct mailings to drivers had the next greatest effect. For example, the water-bill mailings increased the load as much as tenfold. A lesser, but measurable, effect was the mailing to drivers who might use North Central (as determined by their license plates). About 500 notices were mailed, and less than 5 percent were returned as undeliverable. Comparing the Thursday and Friday a month before with the Thursday and Friday after the mailing showed that calls approximately doubled (from 49 to 106), but in another month dropped to their previous range. Mailings to office building managers had no discernible effect on the number of calls.

Accidents

Accidents classified as minor had little effect on the number of calls received. Although accidents of both minor and major natures were reported over commercial radio, reports of the more spectacular accidents, such as automobiles on fire or overturned in the roadway, seemed to spur additional calls. For example, on May 4, 1976, it was widely reported on commercial radio that a multiple automobile accident had occurred, and three vehicles were on fire. The number of calls tripled from the previous day. (Some of these could have been repeats from those who, on learning of the accident, called for updated information.) However, on October 16, a minor accident was reported, and there were fewer calls than on the same day of the previous week and the same number as on the following day. Increases in the number of calls of 29 to 155 percent were recorded on days of major accidents.

Weather

As with accidents, less severe weather conditions had little or no effect on calls received. However, severe weather (lightning or heavy rain) reported on radio and TV alerts generated more calls. There were increases in calls from the same day of the previous week of 20 to 110 percent.

Time of Day Versus Day of Week Profile

Calls received during the first year of operation were categorized as to day and time. There was no particular pattern for day of the week, except that approximately 12 percent more calls then the average were received on Fridays. More calls were received in the afternoon peak period, except on Fridays when more calls were received in the off-peak period (afternoon), possibly indicating that more drivers were leaving work early for the weekend. Overall, 29 percent of calls were received in the 6:45 to 9:00 a.m. peak period, 30 percent in the 9:00 a.m. to 4:00 p.m. off-peak period, and 41 percent in the 4:00 to 6:15 p.m. peak period.

Questionnaire Evaluation

To evaluate the dial-in service and obtain some insight into its positive and negative aspects, an evaluation questionnaire was developed. Because it was not possible to know the identity of callers, several approaches to obtaining evaluations by users of the system were attempted. These questionnaires were sent to the design control group, to tenants of office buildings on the North Central Expressway, and to a sample of drivers using it as determined from license plates.

There were only 103 returns from about 700 direct mailings. Of these, 42 percent indicated that they had used the service. Fifty-eight percent said that they had not, although all those receiving the questionnaire had also received information on the system, including its purpose, the telephone number to call, and a request to try the service. When asked why they had not used the system, 34 percent indicated that they did not know about it or forgot about it. Twenty-three percent stated that they did not need it. Sixteen percent indicated that they felt conditions would change between the call and their arrival at the freeway, 14 percent said that North Central was the only route available, and 5 percent used commercial radio.

Of drivers using the system, 36 percent indicated that they used it less than in the first week of operation. Reasons given were (a) forgot or did not know the number (50 percent), (b) the time lag between information and freeway arrival (25 percent), (c) not helpful (17 percent), and (d) use automobile radio (8 percent).

Of the users of the service, 72 percent did not indicate a need for additional information, 9 percent indicated the need for a delay estimate, 7 percent wanted more detail, and 5 percent wanted the time of the report.

The system was described as always accurate by 29 percent of the users, usually accurate by 51 percent, seldom accurate by 15 percent, and never accurate by 5 percent. Only 18 percent of the respondents actually indicated the specific inaccuracies, 12 percent of these being that the conditions had changed between the call and the freeway arrival.

The respondents were also asked what conditions induced infrequent callers to use the service when they did. Of these, 36 percent used it when in a hurry, 23 percent used it when the weather might affect traffic operation, 14 percent used it when traffic was observed (as from an office window) to be backed up, and the remainder used it for miscellaneous reasons.

SUMMARY AND CONCLUSIONS

1. General public apathy toward the pretrip dial-in traffic information service was demonstrated by both the number of calls received daily and the response to direct mail questionnaires. Despite the fact that those receiving the survey questionnaires were among the group receiving information on the service, over half had not even tried it.
2. An average of 83 calls/d were received during the first year of operation; some days there were as few as 30.
3. The primary reason given for not using the service was that the respondent did not know about it or forgot about it, despite the fact that all of them had received at least one letter describing the service and in many cases a stick-on label with the service number printed on it.
4. The next most frequent reason for not using the service was that conditions would change between the call and the time of the driver's arrival at the freeway.
5. Eighty percent of the questionnaire respondents described the information as either always or usually accurate, and 95 percent described the 30-s message as about the right length.
6. Direct mail publicity was the most effective means of increasing the number of calls, but any increases were temporary.
7. The dial-in traffic information service did not sustain an acceptable level of use.
8. Although it was not substantiated totally in the data, it appeared that routine nature of messages on nonincident days caused callers to lose interest in the service and discontinue calling. However, unusual weather or accidents appeared to remind some drivers that the service was available.
9. If a dial-in service is offered, it should be in conjunction with other information-dissemination modes to eliminate the time-lag problem cited by questionnaire respondents.
10. Much human-factors research has been directed toward the driver or user of information systems. Such research should also be directed toward those who operate the system to determine techniques for sustaining interest and attention where much of the operation may be of a routine or repetitive nature.

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Bulb-Loss Effects on Message Readability of Motorist-Information Matrix Signs

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This study addresses the question of the amount of bulb loss that can be tolerated in an electronic motorist-information sign before the message becomes illegible, misunderstood, or misinterpreted. A representative group of traffic-descriptor and advisory words and route numerals were displayed on a real-time matrix sign. Selected percentages (10 to 50) of bulbs were failed in a random pattern, and slides were taken of the resulting displays. These slides were shown to subjects who were instructed to respond by writing the word if it was legible. From these data, specifications for 85th and 95th percentile correct comprehension were determined for both familiar and unfamiliar motorists.

The object of motorist-information systems, whether audio, visual, static, or dynamic, is to transfer meaningful messages to the motoring public. These messages usually pertain to various tasks associated with vehicular maneuvers and may include information on route guidance, traffic conditions, or hazard warning. In displaying information by electronic variable-matrix signs, the legibility of the words displayed is the critical first step in the message transfer. A designated portion of motorists must be able to effectively read the words shown. If the display fails in this capacity, then it is useless, and message transfer cannot be achieved.

In the operational setting of an electronic display, one or more matrix bulbs in the sign may be lost, but drivers still be required to read the sign before it is deemed necessary that the bulbs be replaced. Manufacturers of these signs recommend that bulb replacement is warranted from a public-credibility standpoint at a level of failure of approximately 10 percent. No published information is available relating bulb failure in electronic matrix signs to message readability. Specifically, in traffic engineering, the criteria for bulb-replacement specifications have followed the lead of the sign manufacturers. Credibility has been the primary control. This study is an evaluation of the experimental question, "How high is the percentage of bulbs that can be lost before a message is misunderstood or misinterpreted?" The emphasis is on the measurement of human comprehension of traffic-condition and advisement words or route numerals of various lengths as displayed on a variable-matrix sign with various degrees of bulb loss.

RESEARCH METHODOLOGY

General Approach

The research approach selected for evaluating the effects of bulb loss in electronic matrix signs on message legibility consisted of laboratory testing by using visual simulations. Slides (35-mm) of a full-scale, trailer-mounted matrix sign were used to increase the fidelity and realism of the laboratory study.

A trailer-mounted matrix sign obtained from an electronics firm in Texas was used in the laboratory studies. The sign was composed of a 7 by 60 array of 25-W bulbs, 0.46 m (1.5 ft) high by 3.7 m (12 ft) long. Any message or symbol not exceeding about 10 characters on a single line could be displayed. Normally, a character was 5 bulbs wide. The sign was programmed by punched paper tape. Characters were formed by one vertical column of bulbs at a time; i.e., each column of holes on the tape corresponds to a column on the sign. The punched tape, therefore, is a replica of the characters that are displayed on the sign.

The laboratory study needed to be as real-world as possible, but experimentation with a large number of human subjects required expediation also. The media-master laboratory on the Texas A&M University campus is an excellent facility for experiments of this nature. The laboratory has remotely controlled environmental testing and evaluation capabilities for approximately 20 subjects.

The slide presentations were projected onto an opaque wall screen by the rear-projection method. Taped voice instructions and the slides were synchronized by a multichannel control system located in the projection room. The laboratory's subject-response evaluation capabilities were not used because written responses were required.

The subjects tested were selected from among residents of Bryan and College Station, Texas. The demographic characteristics of the 226 subjects were stratified as to age, sex, education, and distance driven per year as shown in Table 1. The characteristics of the population pool were formulated carefully to be representative of the national driving public (1).