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CHANGEABLE MESSAGE SIGNS
A STATE-OF-THE-ART REPORT

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A. INTRODUCTION

In order to keep pace with the increasing demands placed on the highway transportation system, the traffic engineer and allied interests have had to develop more flexible and more sophisticated highway sign systems. In the past decade, significant advances in sign technology have brought about the changeable message concept of roadway signing.

As a step toward the report, the subcommittee identified

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the following potential applications for Changeable Message Signs:

I. Regulatory Applications
- A. Speed Limits
  - (1). Legal Speed Limits
    - a. Speed limit by lanes
    - b. School zones
    - c. Changeable limits due to traffic conditions
  - (2). Advisory Speed Limits
    - a. Exit speeds
    - b. Reduced speeds for adverse weather
    - c. Reduced speeds due to traffic conditions
- B. Regulatory Signing
  - (1). School zones
  - (2). Reversible lanes
  - (3). Truck weigh stations
  - (4). Parking restrictions
  - (5). Intersection or ramp control
    - a. Traffic signal
    - b. Ramp signal and merge system
  - (6). Pedestrian control
    - a. Walk-wait signal
    - b. Message and information
  - (7). Reserve lane for mass transportation (bus) units
  - (8). In connection with diversion strategies
    - a. Turn control
    - b. Truck or bus diversion

II. Warning Applications
- A. Unexpected Road Conditions
  - (1). Adverse Conditions
    - a. Ice, rain, snow, fog, smoke, sand, etc.
    - b. Debris
    - c. Disabled vehicle
    - d. Slow moving vehicles
  - (2). Unusual Conditions
    - a. Geometric deficiencies causing:
      1. Occasional stoppages, or
      2. Changes in traffic control
    - b. Construction causing:
      1. Occasional stoppages, or
      2. Changes in traffic control
    - c. Downstream maintenance activities
- B. Traffic Conditions
  - (1). Heavy Congestion
  - (2). Accidents
  - (3). Visibility Problems
    - a. Stop ahead

b. Signal ahead
c. Lane reductions

(4). Special Needs for Traffic Control
a. Railroad crossings
b. Tunnel controls
c. Drawbridge control

III. Guide Sign Applications

A. Special Events
(1). Stadium parking
(2). Amusement parks
(3). Major fairs
(4). Other special events

B. Conventional Guide Applications
(1). Route designation
(2). Destination signs
(3). Service signing

IV. Information Sign Applications

A. Road Conditions Ahead
(1). Ice, rain, snow, fog, smoke, sand, etc.
(2). Construction ahead

B. Motorists Services
(1). Gas, food, lodging, camping
(2). Phone, hospital

C. Motorists Information
(1). Detour ahead
(2). Temporary route ahead

B. SURVEY ONE

In 1972 the Changeable Message Sign Subcommittee conducted a large scale survey to establish the state-of-the art in use of CMS.

In part one, three hundred (300) traffic engineers throughout the United States were polled concerning their application,* if any, of changeable message signs. Twenty-four (24) percent of the 280 who replied indicated that their agency either has used or plans to use changeable message signs. The most frequently reported applications for CMS were to inform the motorist of (1) turn prohibition at street intersections and (2) reversible lanes. The following is a tabulation of application and agency for the more frequently reported uses of the various changeable message signs.

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*Questionnaires were prepared with the help of Slade Hulbert, Research Psychologist.

I. Regulatory Applications	State	City	Other	Total
Reversible Lanes	8	15	3	26
Turn Prohibitions	6	18	2	26
Weighing Stations	21	0	1	22
School Zones	7	6	1	14
Pedestrian Information	3	4	0	7
Exclusive Bus Lane	2	2	2	6
Ramp Metering	4	0	1	5
One Way Streets	1	4	0	5
II. Warning Applications				
Adverse Weather Condition Usage:				
Notification of Weather Condition	15	2	2	19
Ice Warning on Bridge	13	1	3	17
Reduce Speed Adverse Weather	8	1	3	12

In addition, the following listing contains other reported ways that changeable message signs have been employed to a lesser extent.

Adverse Traffic Conditions
Accident
Occasional Stoppage or Heavy Congestion
Maintenance Activities
Stoppage in Tunnel or on Bridge
Construction Activities
Drawbridge Vehicular Traffic Control
Disabled Vehicle
Slow-moving Vehicles

III. Guide Sign Applications
Special Events (fair, stadium, race track)
Route Designation (for traffic diversion)
Destination Signing (tunnel diversion, least congested, river crossing)

IV. Information Sign Applications
Motorist Service Signing
Available Bus Service
Special Event Parking Direction

The Inventory questionnaire also elicited information concerning types of changeable message signs (other than school signs) which responding agencies have in use. These were as follows:

Ground Mounted Signs
Variable Matrix (29)
Drum Type (14)
3M Varicom or Similar (6)

Other (16) including Ve-ped, Blankout Neon, Folding or Flip, Roller Shade, Double Grid, Magnetic Buttons

Overhead Signs
Variable Metrix (23)
Drum Type (12)
Other (12) including Ve-ped, Neon Blankout, Hinge

Only 11 of the 67 reporting agencies indicated that they have a standard specification on changeable message signs.

The questionnaire elicited some interesting data on maintenance. Forty-five agencies indicated that their maintenance of changeable message signs is done by their own forces. Eleven indicated that it is on a contract basis.

Some agencies have considered relamping of variable matrix signs to be a nuisance. The questionnaire sections on maintenance did not reflect this attitude, however. Most agencies utilizing these signs relamp only on an "as-necessary" basis, and most agencies consider the longevity of the illumination source to be adequate.

Questions on the characteristics of various types of changeable message signs elicited response indicating that most users are satisfied with their visibility, vandal resistance and ease of maintenance with the particular type of signs they are currently using.

A number of agencies took the opportunity to comment. Some agencies objected to the expense of changeable message signs on the basis of the need for more development, better visibility in sunlight, short effective messages, and a need for development of symbols. Other suggested uses are actuated flashers that supplement a sign which may say, "Too Fast for Curve", "Too High for Bridge", "Too Fast for Hill"; to warn of adverse conditions not readily apparent to the motorist; diversion for special events; display with reference to travel conditions; the use of fiber optics for signs and other methods for displaying messages to the driver.

C. SURVEY TWO

In part two, the subcommittee conducted a survey of all known manufacturers of changeable message signs in order to identify the types of CMS presently being manufactured and used.

Eight (8) companies responded to this survey. Five (5) of the eight (8) companies who responded are actively engaged in the production of CMS for highway application. The remaining three (3) companies either have plans for installation of their CMS on the highway or are actively considering it. The variable matrix type CMS is the most popular type which is produced by six (6) different companies. The drum type is produced by two (2) companies, one company also produces the variable matrix type. One (1) company manufactures the Varicom CMS.

Typical existing installations of the three (3) different types are summarized in the following section.

I. Variable Matrix Type CMS

Seven (7) different existing installations of Variable Matrix CMS for strictly highway application were reported by three (3) different companies. These locations include:

A. Pennsylvania Turnpike at East Portal Allegheny Tunnel (installed 1970)
Messages Displayed:
(1) CAUTION
(2) REDUCE SPEED/ACCIDENT
(3) REDUCE SPEED/ONE LANE AHEAD
(4) REDUCE SPEED/ROAD WORK AHEAD
(5) REDUCE SPEED/FOG AHEAD
(6) REDUCE SPEED/ROADWAY WET
(7) REDUCE SPEED/PLOWING - CINDERING
(8) REDUCE SPEED/ICY

B. Delaware Memorial Bridge - Variable Matrix Sign and Variable Speed Signs (Installed 1970)
Message Displayed:
(1) SLIPPERY ROADWAY
(2) ACCIDENT - OBEY SIGNALS
(3) LANE CHANGE - OBEY SIGNALS
(4) MEN WORKING
(5) FOG AHEAD
(6) SNOW
(7) REDUCE SPEED

C. Verrazano Narrows Bridge in New York City
A number of CMS with various messages

D. New Jersey Turnpike at Lincoln Tunnel
Message Displayed:
DELAY AT HOLLAND TUNNEL USE
LINCOLN TUNNEL OR GEO. WASH. BR.

E. Unidentified Location on Connecticut Highway System
Message Displayed:
REDUCE SPEED
LEFT LANE
CLOSED
ON BRIDGE

F. On I-5 in Seattle, Washington
Message Displayed:
(1) EXPRESSWAY LANES CLOSED - KEEP RIGHT
(2) VARIABLE SPEED LIMITS
(3) CHANGEABLE DIRECTIONS

G. Use of CMS at highway truck weigh-stations
Messages Displayed:
(1) OPEN

(2) CLOSED

II. Rotating Drum Type of CMS

While two (2) companies reported that they produce Rotating Drum Type CMS only one company reported existing installations. These locations include:

A. Interstate 65, Virginia

This installation includes a bolted truss and a rotating drum CMS which is actuated by a fog detection device. Flashers are included on the sign and are turned on when the sign message changes. The warning message is:

REDUCE SPEED
FOG AHEAD

B. Central Expressway Corridor, Dallas, Texas

This installation includes three (3) sign cabinets, each equipped with four 4-sided drums. The messages are:

Cabinet "A" -

Drum 1	OK	Drum 2	1 MILE
	SLOW		3 MILES
	LANE BLOCKED		5 MILES
	BLANK		BLANK
Drum 3	USE SKILLMAN	Drum 4	TO NORTHWEST HWY
	BLANK		TO LOVERS LANE
	BLANK		TO DOWNTOWN
	BLANK		BLANK

Cabinet "B"

Drum 1	OK	Drum 2	1 MILE
	SLOW		2 MILES
	LANE BLOCKED		3 MILES
	BLANK		BLANK
Drum 3	USE SKILLMAN	Drum 4	TO LOVERS LANE
	BLANK		TO MOCKINGBIRD
	BLANK		TO DOWNTOWN
	BLANK		BLANK

Cabinet "C"

Drum 1	OK	Drum 2	1 MILE
	SLOW		2 MILES
	LANE BLOCKED		3 MILES
	BLANK		BLANK
Drum 3	USE SKILLMAN	Drum 4	TO MOCKINGBIRD
	BLANK		TO DOWNTOWN
	BLANK		BLANK
	BLANK		BLANK

III. Varicom Type CMS

One (1) company produces the Varicom type CMS and one sign was installed in New York at the Lincoln Tunnel in February, 1971. Messages used on the sign are:

(1) STOP
(2) PAUSE HERE THEN GO
(3) KEEP IN LANE
(4) MEN WORKING
(5) STOP ACCIDENT AHEAD
(6) LANE CLOSED STOPPAGE IN TUNNEL
(7) PROCEED WITH CAUTION STOPPAGE IN TUNNEL

Proposed or planned installations of the Variable Matrix Type CMS are summarized in the following section.

A. KTVU Display System, San Francisco, California

At the time of this report the system was being installed on a roof top sign board in San Francisco, on the right side of the freeway approach to the Bay Bridge to Oakland. This sign is leased to Channel 2, KTVU San Francisco. Channel 2 uses the sign to announce specials, such as "tonight's feature movie", etc. It will also be used by the California Highway Patrol and the Division of Toll Crossings to alert motorists to traffic conditions on the Bay Bridge. Some of the safety messages include:

(1) ACCIDENT AFTER TUNNEL
(2) ACCIDENT BEFORE TUNNEL
(3) ACCIDENT NMTL N. BDWY
(4) ACCIDENT MCTHR W. GRAND
(5) ACCIDENT E. SHORE S. ASHBY
(6) CAUTION HIGH WINDS
(7) BRIDGE CLOSED
(8) STALL R. LN. BEFORE TUNNEL
(9) STALL CTN. LN. BEFORE TUNNEL
(10) STALL L. LN. BEFORE TUNNEL
(11) STALL R. LN. AFTER TUNNEL
(12) STALL CTN. LN. AFTER TUNNEL
(13) STALL L. LN. AFTER TUNNEL
(14) CAUTION - WORK CREW
(15) TOMORROW AM UPPER DECK MAINT.

B. Reduced Visibility Speed Regulating System

This system, which is in the planning stage, consists of four (4) CMS spaced one (1) mile apart. Under condition I the signs are black letters on a yellow background, while condition II has the same messages, but the black letters are on a white background. The messages on the four (4) signs are:

SIGN 1 - FOG AHEAD SIGN 2 - 55 MPH
SIGN 3 - 45 MPH SIGN 4 - 35 MPH

C. Southwest Expressway, Boston, Mass.

Variable Matrix CMS were to be installed on Boston's Southwest

Expressway during December, 1972.

In reviewing the material submitted by the aforementioned responding eight (8) companies we found several applications that are worthy of mention. Some may have an immediate use for highway signing, whereas others have limited potential for highway use at the present time. Colors are being used in many applications, especially in advertising signs, sports scoreboards, etc. One company proposes to use various colors for the sign background to emphasize the message. Some CMS manufacturers are attempting to utilize standard traffic signs in their message. Thus, standard color, shape and sign legend are shown to the motorist.

Sequential messages are being tried by some companies in either of two methods. In one method, words or phrases are flashed in sequence until the sign has transmitted a complete message. In the second method, the words in the message move from right-to-left across the sign face until the complete message is presented.

Flashers have been installed either on or near some signs in order to attract the motorist's attention. In some signs, all or part of the sign message may be flashed. In one application a horn was employed with the CMS.

These varied applications indicate on one hand the tremendous potential for the application of CMS, on the other hand it becomes clear that we must be concerned with the problem of uniformity.

D. UNIFORMITY OF CHANGEABLE MESSAGE SIGNS (CMS)*

It is not practicable for CMS to meet all requirements of standardization of signs as provided in the MUTCD, because of the physical limitations involved. However, it is essential that guidelines be established so that CMS do conform to the principles established in the Manual, and to the degree practicable, with the design and application standards therein.

CMS, with few exceptions, are performing functionally, as signs (regulatory, warning, or guide), and uniformity requirements should therefore be related, as closely as practicable, to the MUTCD provisions for signs. Note that lane control signals are <u>not</u> classified as CMS. For convenience, CMS may be divided into Class A and Class B CMS.

Class A CMS are those in which all or a portion of a standard (as shown in the MUTCD), regulatory, warning, or informational sign is changed, and in which the legend or symbol size is no more than 1 1/2 times greater than that of the equivalent fixed message sign. Class A signs do not include freeway guide and directional signs.

Class B CMS are other signs in which a part or all of the message is changed,

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*Submitted by Thomas E. Young, City Traffic Engineer, Cincinnati, Ohio, and does not necessarily reflect the thinking of all members of the subcommittee.

including freeway guide signs, generally larger than Class A signs.

CMS should conform to the following guidelines:

A. Design

1. Shape
   a. Class A CMS should display each message in the shape prescribed for the equivalent fixed message sign.
   b. Class B CMS will, in general, be rectangular, and when displaying a regulatory or warning message, need not display the equivalent fixed message shape.
2. Color
   a. Class A CMS should display each message in the color prescribed for the equivalent fixed-message sign. However, "reverse copy", i.e. clear or white light sources on a black background is acceptable for regulatory and/or informational signs.
   b. Class B CMS utilizing a screen, drum, panel, or other back-lighted self-illuminated, or externally illuminated surface, should conform in color combination for each message displayed to the equivalent fixed message signs.
   c. Class B CMS signs utilizing matrices of lamps, illuminated unit surfaces, or other sources of illumination, need not conform in color combinations for equivalent fixed-message signs. However, no green, yellow, or red illumination shall be displayed unless in the color combination for the equivalent fixed-message sign. Clear or white light sources may be used for any message.
3. Size
   CMS may be of any necessary size to achieve adequate visibility and legibility. However, no Class A CMS shall be smaller than the equivalent fixed message sign.
4. Symbols and Lettering
   a. On Class A CMS, symbols, wording, and lettering should conform to those of the equivalent fixed-message signs in form, size, and stroke width, except for matrix-type or unit-lamp type letters and/or symbols, for which stroke-width requirements are not applicable.
   b. Class B CMS should use symbols and/or letter forms designed for optimum legibility, and where stroke width and letter series are applicable, they should be consistent with those for the same letter height when used on fixed message signs.
   c. Letter height and symbol size for CMS will vary with the application. However, no letter height on a CMS should be smaller than that used for the equivalent message, application and mounting position in a fixed message sign.
5. Illumination
   All CMS should be electrically illuminated. On partially fixed message and partially CMS, at least the changeable portion should be illuminated.

6. Reflectorization
   CMS using a screen, drum, panel, or other illuminated surface should have that surface reflectorized if technically possible.

B. Meaning and Application
   Specific standards are difficult to establish in this area, since each CMS should be engineered for the specific application. However, to the extent possible, CMS should display information in a manner consistent with other signing on the highway. Factors involved would include, but not be limited to:
   1. Sequence of wording
   2. Consistent directional identification
   3. Standardized abbreviations

C. Location
   CMS should, in general, be governed by the same standard location and placement criteria as for equivalent fixed message signs, but these may be modified by the following considerations:
   1. CMS must be accessible for maintenance without excessive interference to traffic, or hazard to traffic or work personnel. Generally, repair or maintenance work on overhead CMS, short of major structural repairs, should require closure of no more than one lane of roadway, (inside lane or outside lane only), and none if possible. As much as possible of the control equipment for overhead signs should be located so as to permit servicing with no obstruction to traffic.
   2. Because of the high economic loss and potential motorist hazard of a vehicle striking a CMS, vertical and lateral clearances should be as generous as practical.
   3. Since CMS normally advise motorists of an abnormal condition or unusual situation, particular attention should be given to locating the CMS so that the motorist has adequate time to respond at the prevailing operating speeds.

E. CONCLUSION

To conclude this report on the state-of-the art of changeable message signs, some general comments are in order. From the two surveys, it is apparent that there are several different types of CMS on the market today. They vary in their initial cost, their flexibility in displaying messages, their cost of operation and maintenance, and the way their message is displayed. In many cases, appurtenances have been employed with the CMS for various reasons with the resulting installation becoming a sign system intended for a specific purpose at a specific location. CMS are being used to guide traffic, regulate traffic, warn traffic, and inform traffic. Some CMS have standard shape, color and message and conform to the MUTCD, but most do not. CMS have been employed with fixed message signs in come cases, but most often are installed by themselves. CMS have been used to treat a specific problem at a single location with limited message flexibility needed or provided. They have also been employed as components of very sophisticated traffic control and driver information systems with almost unlimited message flexibility and computerized system control.

In spite of the varied uses for CMS already explored, it is evident that further development of CMS is needed.

In particular, the following questions should be researched:

1. Should Changeable Message Signs (CMS) meet the uniformity standards of regular static signs? If not, what standards should be met?
2. Should CMS be designed to attract the attention of motorists? Flashing messages, flashing lights, etc.
3. Can the motorists read, understand, and properly react to changeable messages?
4. What are the economics of CMS?
5. What new traffic control techniques are possible with CMS?

The full potential of this traffic control device has not yet been realized and more varied applications by the traffic engineer and even better systems provided by the manufacturer are needed if we are to keep pace with demands on, and achieve full utilization of, our highway system.