THE USE OF LANE CONTROL SIGNALS AND CHANGEABLE MESSAGE SIGNS ON TEXAS HIGHWAYS

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I. INTRODUCTION

One of the challenges faced by Traffic Engineers is how to provide motorists with timely information regarding impending changes in the usual driving environment. The problem may be as simple as a horizontal curve, a change in the speed limit or the crossing of another highway; but it could also be a warning for a closed ramp or possibly a detour around an accident scene. Unexpected deviations from normal roadway conditions are confusing and can result in driver hesitation and indecisiveness.

The objective of roadway signing is to provide motorists with enough time to concentrate their attention on the driving task and to mentally and physically prepare to deal with the conditions ahead. There are sometimes temporary occurrences taking place on the roadway that require short term expedient signing. In these situations, changeable message signs (CMS) and lane control signals (LCS) can be used to supplement the normal signing.

II. CHANGEABLE MESSAGE SIGNS

CMS are dynamic electronic billboards that can display almost any brief message. The more sophisticated sign systems are computer-controlled and can be programmed to display a sequence of messages at a specific time and to maintain a log of the sign's activities. They can also monitor the performance of a group of signs and sound an alarm in the event of a failure.

District 2 uses stationary and portable CMS to provide motorist information for a variety of situations. The portable units are used to assist with traffic control in maintenance and construction zones and for special events. The stationary signs are part of the District's new Freeway Traffic Management System and are used primarily to advise motorists of lane closures for construction and maintenance work and for incident management.

The primary differences between the various types of CMS are in the technology used to display the message and the data communications medium. The flip-disk and the incandescent bulb-matrix signs are probably the most popular type for highway use at this time; however, several districts have

expressed an interest in obtaining signs with fiber optic displays. There are other sign display designs that utilize light-emissive diodes (LED) or liquid-crystal display (LCD) technology or mechanical systems, such as rotating drums. These designs may be unique, but they are not as well suited for highway use or as aggressively marketed as the flip-disk and bulb matrix types.

The two-position flip-disk displays coordinate a matrix of reversible reflective disks to form the characters on a contrasting background. The bulb-matrix type units selectively illuminate combinations of incandescent light bulbs to form letters or numbers. The fiber-optic signs utilize plastic or glass fiber bundles and a system of electromechanical shutters to convey the light from an internal source to specific locations on the display.

There are advantages and disadvantages for each of the sign designs. For example, the electromagnetic flip-disk displays require little power, are easy to read in bright sunlight and require little maintenance. However, they must be externally lit at night and there is a slight time lag when messages are set or cleared. The newer versions of the bulb-matrix sign systems have excellent visibility under most conditions, the message can be flashed if desired and they are fairly simple in operational concepts. However, they use a lot of electricity, require frequent bulb maintenance and can not be used in a static (no power) mode.

District 2 has five stationary CMS and five more are scheduled for delivery within the next few months. We expect to have at least 45 of these signs within the next 10 years. The four signs located on IH-35W in Fort Worth and the one sign on SH-360 in Arlington were supplied by the Tele-spot division of FP Displays Inc. They are attached to concrete "T" mounts located in the median of the highway. Most of the problems that we have had with this equipment has been related to the data communications system and to variations in the commercial power source.

The Tele-spot signs are 6 feet 8 inches high by 30 feet 11 inches long, weigh in excess of 3300 pounds and cost approximately $80,000 each. They can display a total of 60 characters arranged in three lines of 20 characters each. Each character is formed from a 5X7 matrix of 2.2 inch in diameter disks; for a total of 35 disks per character module. The signs are controlled from the District headquarters using leased telephone lines and a AT&T Model 6300 microcomputer. Each sign has it's own microprocessor system, so they can also be operated as a "stand-alone unit" or be controlled in the field by a Tandy Model 102 laptop computer.

The sign control software for the AT&T machine is written in the "C" programming language and operates in a non-DOS, multi-tasking environment called QNX. This operating system was developed by a company in Canada and we are unable to transfer it to any of the other computer equipment in the District. This means that we are not able to run the sign program on another computer if the AT&T 6300 fails or download the sign operational logs into a database program for future analysis. Since the QNX operating system is capable of performing many tasks almost simultaneously, the AT&T micro can continually monitor the performance of up to 32 signs. The Tandy laptop software, which is written in the BASIC programming language, is loaded via a cassette tape recorder and stored in the machine's 32 k-byte RAM internal memory.

The District plans to continue the practice of using leased telephone lines for data communications until it is possible to connect the equipment to our 50-pair twisted-wire traffic management system trunk line. We have also experimented with dial-up lines and hope to try cellular telephone, radio, fiber-optic cable and a microwave link in the future. Use of the dial-up configuration eliminates the option of constantly monitoring the signs for equipment failures. Radio and microwave systems require an FCC license and, it has been our experience, that obtaining an FCC license in a "communications-intense" urban area is not as easy as the product sales personnel imply.

III. LANE CONTROL SIGNALS

Lane Control Signals (LCS) are symbol display devices positioned above freeway or city street lanes to indicate which lanes motorists should use. When installed on city streets they can be used to control the direction of flow in reversible lanes or to show that continuous left turns are allowed from a lane. When used on a freeway, they can be used to control the direction of flow in high occupancy vehicle (HOV) lanes, to warn of lane drops or to assist with lane closures for construction, maintenance and incident management activities.

The LCS on I-35W in Fort Worth have a fiber-optic display system and are attached to the sides of the cross-street bridges. They are controlled from equipment cabinets located at the frontage road intersections, but will eventually be integrated with the District's traffic management computer system.

The District uses a steady green downward-pointing arrow to indicate that a lane has no restrictions and is open for use. A steady yellow "X" warns that that motorists should vacate a lane because it will soon end or is closed ahead and a steady red "X" is used to warn that the lane should not be used. These symbols may have a somewhat different

meaning when used on city streets. For example, the yellow "X" may be flashed to indicate a lane from which continuous left turns are allowed.

The I-35 LCS were made by The Traffic & Transportation Supply Company (TTS) of Fort Worth. The signal head housing is approximately 22 inches square and supports an 18 inch square display face. The housing is made of 6061-T6 aluminum and is painted black. The various symbols are formed by the selective illumination of groups of 55 "dots" formed by the termination of fiber optic bundles. The "X" indication is formed by 32-0.171 inch diameter dots while the arrow shaped indications are formed using 23-0.121 inch diameter dots. The display housing head contains six 50 Watt ENL watt quartz halogen bulbs. The life expectancy of the halogen bulbs is extended to 8000 hours by operating them below their rated voltage. During daylight operations, all six of the lamps are turned on; however, at night, a photocell device cuts off three of the bulbs to reduce the overall brightness of the display.

IV. OTHER ISSUES

The intended function of the District's large stationary CMS is to provide motorist information in support of incident management activities. We have also used them for special event management, but we prefer to use portable units for that purpose.

One of the problems encountered when assisting with the planning for local special events, is the establishment of a criteria to determine if the use of State equipment is appropriate. The District's screening policy is based upon the requirement that an event be accessible to the general public and that it has a strong potential to disrupt traffic or cause an unsafe condition on the State maintained highway system. For example, we have used CMS to advise motorists of an alternate route to Texas Ranger Baseball games held in Arlington Stadium. We have also used them for local air shows, golf tournaments, and the annual Mayfest festival held in Fort Worth.

Lacking specific legal guidelines for the use of CMS and LCS, the District has tried to stay within the general guidance provided in part IV, section 4E of the Texas Manual's on Uniform Traffic Control Devices (MUTCD) for the design and symbolic meaning of the various LCS indications. However, the MUTCD only addresses the use of lane control signals when used on reversible, high-occupancy or continuous left turn lanes. It does not address their use in a freeway-wide environment.

Another point of possible concern is that the LCS used by local governments on city streets are multi-headed units with a consistent position for each symbol. For example, the red "X" is located on the left, the yellow "X" is in the middle and the green arrow is on the right. The LCS device used on the freeways in District 2 is a "composite" design that displays all indications from the same signal head. The MUTCD allows for this type of design, but we are a bit concerned about how a color blind person will be able to distinguish between a red and yellow "X". This may sound like a problem of minor concern, but consider the fact that at least 4 of every 100 men and 1 of every 200 women are color blind and that Tarrant county has an estimated population of over 1 million with about that number of registered vehicles. People with this problem are often able to interpret traffic signals by noting their relative position or intensity. The District may eventually decide to flash one of the two "X" indications to allow motorists with color perception problems to make a distinction between the two.

Equipment compatibility is a major problem. The various equipment manufacturers do not all use NEMA standards and are very secretive about the technical details of their software and hardware design. This proprietary attitude may reduce industrial espionage but it poses a severe technical and maintenance problem for an organization that is obligated to procure equipment on a low bid basis. The problem arises when it is necessary to integrate signs from different manufacturers with a common control media. It may be necessary for the Texas Department of Highways to follow the lead of other states and develop a standard specification for a local control unit (LCU) to unify different brands of CMS and LCS.

V. SUMMARY

Changeable message signs and lane control signals are a versatile and expedient tool for providing motorists with timely information regarding temporary changes in the driving environment. The portable CMS are particularly valuable for managing traffic for special events and work zones and offer a cost-effective alternative to the erection of temporary static signs.