DESIGN, OPERATION, AND UTILIZATION OF CHANGEABLE-MESSAGE SIGNS WITH EMPHASIS ON THE ROTATING-DRUM TYPE

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It is now generally agreed among highway traffic engineers throughout the world that, although static signs are indispensable for routing and controlling traffic, they exhibit a number of limitations in advising, forewarning, and giving regulatory instructions to the motorist.

Table 1 gives 3 essential, though sometimes overlapping, functions of a variable-message sign and the elements of each. Table 2 gives descriptions of current types of variable-message signs now in use. A combination of the types of variable-message signs in one package or incorporated with a static sign may be utilized to take advantage of the best features of each type. Any system of changeable-message signs must incorporate a 100 percent positive, reliable, and independent feedback system capable of indicating the actual message displayed on the sign and not merely the message selected.

At Fosco Fabricators, Inc., we are particularly concerned at this time with the rotary drum type of variable-message sign even though we have the capability of designing and furnishing variable-message signs using other modes of display and operation.

The drum sign in its simplest form consists of a triangular-shaped drum pivoted on each end and mounted in a suitable enclosure. Attached to each face of the rotor is a sign plate bearing the required legend. The rotor is driven at about 6 rpm by means of a gear reducer coupled directly to the rotor spindle, which is supported by flanged ball bearings mounted on ½-in. thick plate bulkheads. Coupled directly to the shaft also are multiple cam-operated microswitches individually adjustable to locate any selected face in the exposed position. An indexing, weighted roller attached to a vertical pull magnet locks into a 3-lobe auxiliary cam also rigidly attached to the shaft. This magnet is electrically connected in parallel with the motor so that, when the microswitch opens the motor control relay, the magnet drops the roller into a curved slot that inhibits any further movement of the drum. To overcome the inertia of the moving drum and driving mechanism, a dynamic brake is incorporated into the motor circuit and effectively prevents overrun and thus contributes to the accuracy of the indexing system and the perpendicularity of the rotor face.

Where the possibility of ice formation would tend to lock or interfere with the rotation of the drum, ice-melting heating coils are incorporated into the periphery of the drum opening. These coils are activated automatically when icing conditions prevail.

Table 1. Functions of variable-message signs.

Motorist Warning	Advisory	Command
Accident ahead	Anticipated delay time	Clear lane for emergency vehicles
Lane closure	Alternate route	Give weigh station instruction
Congestion	Use low gear	Modify permissible speeds as road conditions dictate
Construction	Use chains	Close 1 lane for snowplowing and sanding
Fog	Freeway entrance	Close 1 lane for repair or maintenance
Ice	Other	Reverse center lanes during peak one-direction traffic flow
Snow		Divert traffic to secondary roads
Slippery		Other
Bridge closure		
Other condition		

Table 2. Types of variable-message signs.

Mechanical or Motor-Operated	Mechanical-Matrix Disk[a]	Electrical
Window-shade type such as VARICOM in single or multiple units	Magnetically motivated	Blank-out with incandescent, fluorescent, or neon lights
Single or multiple drums individually or jointly driven having 2 to 8 faces on a drum, vertical or horizontal orientation, and drums in parallel or in-line alignment	Electrostatically motivated	Neon-tube alphanumeric characters superimposed in front of one another or sectional-element configurations individually activated
Flip-over panel type operated either manually or by motor	Pneumatically operated	Matrix multiple-bulb with modular character units or with individual bulb socket configuration 5 by 7 using incandescent or glow discharge bulbs with screw-in or bayonet sockets
		Matrix light-emitting semiconductor diodes (LED)[b]

[a]One surface identical with the sign background, and the alternate surface covered with white or reflective coating. [b]Not yet commercially available.

In areas subject to severe icing or snow conditions, integral heating coils may be embedded in the bottom panel of the cabinet to prevent buildup of such materials, though this represents a most unusual situation.

For areas subject to occasional power failure, provision is made to operate a 12-V dc auxiliary drive unit from the ground by means of an automobile or portable 12-V battery so that the sign may, when necessary, be rotated to a new position. An arrangement for manual rotation of the rotor or rotors is also incorporated into all drum signs.

There is no limit to the sign face size other than practical overall size considerations. We are prepared to design a rotating sign face 6 ft wide by 50 ft long. A sign 3 drums high by 2 drums wide or 6 individual hexagonal drums (each with 6 faces) is now in the process of manufacture. We offer the following options:

1. Multiple faces on each drum with as many as 7 live faces and 1 blank face directly driven by 1 motor;
2. Multiple drums in 1 cabinet as high as 4 rotors and as wide as 2 rotors with individual motors on each drum; and
3. Multiple drums, chain driven by 1 motor.

The advantages of rotary drum signs are as follows:

1. Operation is extremely reliable and simple, and components are not complicated;
2. Sign and system have been proved in operation;
3. Signs are becoming more acceptable and are being specified by more highway agencies and consultants;
4. Total message or legend only can easily be changed or exchanged if messages require modification or substitution in the course of time;
5. Maintenance cost is lowest of all existing changeable-message sign systems;

6. Low maintenance means fewer hazards and correspondingly lower accident probability as a result of maintenance crews working constantly on signs, for instance, replacing bulbs;
7. Operating cost is lowest of all existing systems, and power cost is a fraction of the cost for other systems;
8. Sign looks like a highway sign and not like an advertising or time/temperature sign, is always readable in its entirety because no portions of it are "out" at any given time, and can be seen even if facing the sun;
9. Colored background warns of or indicates different road conditions and situations ahead;
10. Symbols and route markers can be displayed in color;
11. Vandalism damages are less expensive to rectify as compared with those of bulb signs;
12. Motorist will always have a sign available because power failure from underground cable damage, blown fuses, vibrations, or tremors will not affect the sign or make it "disappear";
13. Sign can be hand-operated or, in case of an emergency, can also be operated from ground by car battery;
14. Standard components can be obtained in any city and are easily accessible in sign;
15. Signs can be mounted back to back and still be easily accessible;
16. Maintenance can be by regular maintenance personnel having no electronics background or highly technical knowledge;
17. Remote-control system is much cheaper because of simplicity of design; and
18. System has a 100 percent positive, reliable, and independent feedback system capable of indicating the actual message displayed on the sign and not merely the command or selected message.

We now have rotary drum signs operating in the states of New Jersey, California, and Illinois with units in current production for several other states.

The technical capability required to maintain a rotary drum, changeable-message sign is no more sophisticated than that required to maintain a simple electrical home appliance such as a 110-V washing machine. Experience in simple relays, timers, thermostats, capacitor motors, and microswitches combined in straight-line, hard-wire circuitry and the ability to read and follow a simple circuit drawing are all that are required. Our service experience to date after 2 years of field service on 150 units has been confined chiefly to service calls involving lack of power, low voltage, blown fuses, 4 defective microswitches, and several cases of insects and spiders nesting in the local cabinet push-button switches. For emergency operation during temporary power failure, we provide the option of an overriding 12-V dc motor that can be activated from the ground either by automobile battery jumpers or by a mechanical speed-handle socket wrench that engages an extension of the motor shaft but requires that one climb up on the sign bridge to use it, or the motor can be activated by both jumpers and socket wrench.

We have 2 types of remote control systems. Type 1 involves a buried hard-wire cabling system such as that used by the telephone companies and is entirely adequate for control up to 5 miles. The power supply may be laid in the same trench. A simple, single or chain-coupled double, 4-sided drum sign requires 1 wire for each face, 1 common wire for control, and an equal number of wires for feedback indication making a total control cable bundle of 10 wires. The use of a standard telephone type of 6-pair cable will provide 2 spare wires that may be used for permanent or temporary telephone communication between the sign and the control point for setup, testing, and maintenance purposes. This 19-gauge, multiple-wire cable with its protective casing is about ½ in. in diameter and costs less than $2/100 lin ft. The power supply required for such a sign including de-icing coils and luminaries approximates 2 kW, and a 3-wire 280-V supply with a step-down transformer at the sign to develop 240/120 service is not expensive, depending only on the distance from a source of power.

Type 2 is used either for remote control and status monitoring over long distances or for a large group of separate signs spread over 5 to 50 miles or longer for both

of these. We use a coded time division multiplex digital type of 2-wire communication system either with buried cable or through leased telephone circuits. Time sharing a 2-wire communication circuit permits elimination of costly point-to-point wiring. This time division multiplex involves parallel-to-serial conversion. The input information from a set of parallel 2-state inputs such as switch contacts is sequentially examined by an encoder and then transmitted to the decoder. The samples are transmitted repeatedly one after the other over a narrow-band communication channel using an encoder to handle all inputs. In this manner both commands and verifications may be transmitted over the same pair of wires in either direction. Five hundred or more addresses may be controlled and verified by the addition of modular plug-in components. The economy of such a system over a multiplicity of hard-wire cabling circuitry is obvious.

During the next few years, I believe we will see a rapid proliferation in the number and variety of changeable-message sign systems. The use of these signs should result in greater safety, less traffic congestion, and better utilization of highways, tunnels, and bridges.