Developments in Highway Signs and Markings

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An interesting approach to a study of the development of U. S. standards for highway signs and markings is along historical lines.

The first effective step toward national standardization of highway signs was taken by the Mississippi Valley Association of State Highway Departments in 1922 when the Association appointed a committee of five to study the subject. The Association adopted the committee's report in January, 1923.

The Mississippi Valley standards established one feature of the present national standard signs. Distinctive shapes were prescribed for the several classes of signs, viz., a circular railroad crossing sign, an octagonal stop sign, a diamond-shaped warning sign, a square caution sign, rectangular information signs, and a characteristic route marker to be designed by each state. All these signs, with the exception of the route markers and the rectangular information signs, were to be 24 inches across. All of them were to be white with black lettering and border.

This initial step by the Mississippi Valley Association greatly speeded subsequent progress toward national uniformity. Within a year Indiana, Minnesota, Wisconsin, Michigan, and Ohio started erection of signs conforming to these standards on their state highway systems and several of the other states were planning to do so.

A situation created by the activities of numerous "trail associations" in promoting the marking of sundry and miscellaneous routes led to the adoption of a resolution by the American Association of State Highway Officials at its meeting in 1924 requesting the Secretary of Agriculture to appoint a board to select and designate a system of interstate routes and to devise a system of numbering and marking the highways of that system. In 1925 the Secretary of Agriculture appointed a Joint Board on Interstate Highways with 21 members from state highway departments and three from the U. S. Bureau of Public Roads. The Board made its report in October of that year, covering the proposed system of U. S. Highways, the route-numbering system, and a comprehensive set of sign designs based for the most part on the Mississippi Valley stand-

ards, and the now familiar "shield" marker for the U. S. Highways. However, a yellow background was adopted for all warning signs, including the stop sign.

The Joint Board did not recommend luminous or reflectorized signs because it was felt that the activities of inventors and manufacturers might be seriously limited if the Board undertook to standardize either the form or the type of such devices.

In 1926 the Joint Board developed its sign standards in detail and published in 1927 the first edition of the *Manual and Specifications for the Manufacture, Display and Erection of U. S. Standard Road Markers and Signs,* which cover signs for rural highways only.

The original *Manual* was reissued in 1929 with an appendix on "Use of Luminous and Reflecting Elements with Standard Signs and Markers". It authorized the use of a luminous element mounted below a standard sign on the same post, or on a separate mounting in advance of the standard sign. The use of luminous letters in certain signs was also permitted.

A Second Edition, Revised, was issued in 1931 with a number of new signs added.

In 1929 the Committee on Street Traffic Signs, Signals, and Markings of the American Engineering Council made a national survey of existing practices, and in its report made to the Third National Conference on Street and Highway Safety in 1930 accepted most of the standards of the American Association of State Highway Officials, but with some exceptions and qualifications. In addition to signs the *Manual* covered traffic signals, safety zones, and markings for pavements, curbs, and objects in or near the roadway. Parking and numerous other signs particularly adapted to city use were also added.

The American Engineering Council report was approved by the Third National Conference on Street and Highway Safety in 1930 and recommended for adoption by municipalities. As a result there were in existence two national Manuals, the *Manual of the American Association of State Highway Officials* for rural use and the *National Conference on State and Highway Safety Manual* for city use.

In 1931 the National Conference on Street and Highway Safety and the American Association of State Highway Officials each took action resulting in the formation of a Joint Committee to combine the two codes and to make such additions as might seem necessary to produce a complete code for both rural and municipal use.

To determine the answers to questions that had been raised regarding the yellow color code and the most effective use of reflector buttons, a co-operative study was conducted by the U. S. Bureau of Public Roads

and the National Bureau of Standards covering visibility and legibility of several alternative color combinations by day and by night, with and without reflector buttons. The investigations definitely confirmed the advantage of the black-on-yellow combination over both black-on-white and white-on-black. Other data were adduced as to the effectiveness of reflecting buttons in various sizes and spacings.

A preliminary draft of the new *Manual on Uniform Traffic Control Devices for Streets and Highways* was issued in 1934. It was approved in this form by the Secretary of Agriculture as the standard code for application on Federal-aid highways. It was revised and brought out in printed form in November, 1935. It was approved as an American Standard by the American Standards Association in 1935.

In the preparation of this *Manual,* the Joint Committee took into account the recommendation of the Sixth International Road Congress held in Washington, in 1930, that consideration be given to the more extensive use of symbols and eliminated the former word messages from the CURVE, TURN, CROSS ROAD and SIDE ROAD signs.

The Committee also recommended illumination by reflector buttons of the outlines of the circular railroad sign, the octagonal stop sign, the diamond-shaped warning signs, and the square caution sign on the theory that it would tend to make motorists conscious of the meaning of the shapes of such signs and instinctively obedient to them.

In 1938 the Joint Committee recommended numerous revisions in the *Manual* and a supplement was issued in 1939. The most important change concerned reflectorization. The Joint Committee agreed that experience had shown that drivers did not grasp the significance of the shape and that illumination of the outline of a sign to show its shape was not a sufficient warning to motorists. It recommended that the symbol or main message of the sign should be illuminated instead. This meant that sign shape was finally subordinated to the symbols or word messages.

It is interesting to review the changes in our ideas as to sign design and effectiveness by following the changes made in a few of our more important signs:

(1) The stop sign has always been octagonal in shape. The Mississippi Valley Association recommended a white background with 6-inch black letters. In 1924 the Subcommittee on Traffic Control and Safety of the American Association of State Highway Officials recommended a white sign with a red panel across the center to introduce the conventional "stop" color. The Joint Board on Interstate Highways went to the solid yellow background with black letters. The American Engineering Council standard in 1929 called for red letters on a yellow back-

ground, and the Joint Committee in 1934 accepted this as an alternative to the black-on-yellow combination. The optional red letters were dropped from the 1939 revision of the *Manual*.

The Appendix to the second edition of the sign *Manual* in 1929 permitted the use of crystal or amber reflector buttons in the stop sign, while the 1934 *Manual* prescribed red reflector buttons in the letters and crystal buttons outlining the border. The 1939 revisions dropped the reflecting border and prescribed clear buttons in the letters.

The size of the standard stop sign has been 24 inches across the flats of the octagon. The Joint Committee has finally recognized the fact that this size octagon has considerably less area than a 24-inch square or diamond-shaped sign and has increased the size to 30 inches. This size permits the use of 10-inch or 12-inch letters. The increase in the size of this sign and the increase in the height of the letters greatly increases its visibility and legibility.

(2) The original Mississippi Valley Association curve and turn signs carried only the word "Curve" or "Turn", on the theory that if the direction of the curve or turn were to be indicated by an arrow the driver would not slow down but would forge ahead at the same speed, and the encouragement to do this given by showing the direction of the curve would defeat the purpose for which the sign was erected.

The Joint Board on Interstate Highways, however, was of the opinion that the direction of the curve or turn should be shown and a bent arrow was placed below the word "Curve" or "Turn".

The Joint Committee in the 1924 *Manual* went all the way to symbols including a "reverse curve" symbol with a double bend. In the same *Manual* it was recommended that reflector buttons be used to emphasize the shape of the sign.

The 1939 *Manual* abandoned reflectorization of the border and recommended reflectorization of the symbol itself.

(3) The railroad advance warning sign was at first a 24-inch circular sign with a vertical and horizontal cross-bar and the letter R in each of the upper quadrants. The color combination was black on white.

The Joint Board on Interstate Highways recommendation called for a yellow background and for a double horizontal bar when there was more than one track to be crossed. The 1934 *Manual* finally adopted diagonal cross-bars to resemble more closely the standard railroad crossbuck sign and to avoid confusion with the ordinary intersection sign. The reflectorized letter R appeared in each side of quadrant.

In the 1939 *Revised Manual* reflecting buttons were specified in the cross-bars also, rather than around the border.

The original railroad advance warning sign was 24 inches in diameter. As in the case of the stop sign, the Joint Committee finally realized that the area of a 24-inch circle is considerably less than that of a 24-inch square or diamond, and the 1939 *Manual* increased the size to 30 inches.

In the past several years there have been numerous advances in materials for reflectorizing signs. Sign sizes have been the subject of much discussion. Average speeds on our rural highways have been gradually moving upward, thus indicating the need for greater sign legibility through the use of larger signs with correspondingly larger letters and symbols and with more attention to the influence of letter width, height, and spacing on legibility. The location of the sign with respect to the point at which the driver's maneuver is to be completed, and the placement of such signs as directional signs so that they may be readily read are important.

Recognizing the fact that changing conditions had made it advisable to review the present *Manual,* the American Association of State Highway Officials, the Institute of Traffic Engineers, and the National Conference on Street and Highway Safety, by concurrent action in 1942 provided for the appointment of a new Joint Committee to be composed of seven members named by each group to review the *U. S. Manual* and bring it up to date. The Committee was appointed in May, 1942.

A condensed war emergency edition of the *Manual* was issued in November, 1942, covering (1) normal conditions and (2) special data for blackout conditions.

The Joint Committee through four Subcommittees on Signs, Markings, Signals, and Islands has been at work since 1943 on the preparation of a post-war manual. The Subcommittees completed their work and their reports were reviewed by the full Joint Committee in Washington in December, 1945. At this meeting some differences of opinions were disclosed and referred for further investigation and determination before the post-war edition of the *Manual* is printed, which will be in 1946.

While no radical changes in the general design of the standard signs were made, some important changes approved by the Joint Committee should be noted.

Perhaps the most important change is the use of rounded letters instead of the former standard block letters. At the instance of the Joint Committee, a comprehensive study of the relative legibilities of block letters and rounded letters was made by the Division of Traffic and Safety of the Ohio Department of Highways in co-operation with the Public Roads Administration. These tests covered both day and night conditions and included reflectorized and unreflectorized signs.

The Ohio studies established the fact that signs with words made up of rounded letters have generally a greater legibility than the same words made up of block letters of the same size. The difference was not great percentagewise, but it was there. While preliminary tests on individual letters indicated there was no great difference in legibility between block letters and rounded letters when viewed individually, it was found that rounded letters can greatly change the pattern created by two adjacent letters in a word.

In the Ohio studies the effect of spacing was investigated also. The spacing study indicated that wider spacing will apparently increase legibility, particularly when block letters are used. Wider spacing does not result in as great an improvement in legibility when rounded letters are used because rounded letters do not tend to run together as much as block letters when closely spaced. The tendency of block letters to run together when closely spaced is due to the frequency of adjacent parallel strokes.

In this study the problem of reflectorizing was also investigated. Tests were made (1) to compare black letters on a white reflectorized background, and white reflectorized coating letters on a black background; and (2) to test a theory that rounded letters are better adapted to reflectorizing with reflector buttons because of greater freedom of arrangement.

The principal discovery in these tests was quite unexpected. Four-inch white, reflectorized-coated, rounded letters on a black background were 20.1 percent more legible by night than were 4-inch black rounded letters on a white reflectorized background. With 8-inch letters the reflecting letters on a black background were 12.7 percent better.

Another interesting result of this study was that reflecting button letters in rounded style were found to be 5.3 percent more effective by day and 10.7 percent more effective by night than were block letters. The advantage of the rounded letters in daylight was about that found for unreflectorized letters in previous tests, but at night the advantage was greater than any found elsewhere, thus indicating that rounded letters are better suited than block letters to reflector buttons.

Another change adopted by the Joint Committee was the elimination of the theoretical distinction between the meaning of the diamond-shape or so-called slow-type sign, and the square or caution-type sign.

It has been shown that the meaning of this distinction is not understood by the driving public and probably never will be understood. Therefore as the distinction has proved to be meaningless, the square shape was eliminated and the diamond-shaped sign has been made the standard shape for all signs in the warning-sign classification except the stop and

the railroad sign. The shapes of these two signs—round and octagonal—have been so well standardized through usage and are so well adapted to these signs that it was not thought advisable to change them even though the majority of drivers may not distinguish them by their shapes.

As has been previously pointed out, the Joint Committee increased the size of the standard stop sign from 24 inches to 30 inches. This is one of the most important signs, but in the 24-inch size it had 17 percent less area than a 24-inch square or diamond-shaped sign.

The Joint Committee also approved the use of either black letters on a white background or white letters on a black background for all signs of an informational nature, such as directional and distance signs. The Ohio studies showed that signs with white letters on a black background have considerably greater legibility than in the reverse combination. The tests which established this were for legibility only, however, and there remains the question as to the relative "target" value of the two color combinations. Signs with black background and white letters do not have quite the attention-compelling value of signs with light backgrounds and are generally more difficult to locate, especially if they are in shadow. Once spotted, however, they are quite legible.

The size of the auxiliary junction sign was increased and the word abbreviated to JCT to permit the use of 6-inch letters which can be reflectorized by buttons. The word "junction" was abbreviated so that the length of the sign in 6-inch letters would not be too great for practical purposes.

A controversial question confronting the Joint Committee was with respect to the proper method of indicating changes in direction of marked routes by advance turn markers. The previous *Manuals* specified the use of an "R" or an "L" in advance of a turn to indicate that the route turned right or left. Some members of the Committee argued that turns should be indicated by a straight arrow erected in advance of the turn. This, however, was objected to by other members, who contended that the straight arrow should be used only at the point of actual change in direction and not in advance because a straight arrow might, if its location were not carefully chosen, turn traffic into secondary streets or alleys. To avoid such a situation it was suggested that a modification of the turn-sign arrow be used instead to indicate that traffic should proceed directly ahead to the point of turn, which would be marked by a straight arrow. This question is one which is to be settled after further study by the Joint Committee.

Having discussed the early history of the development of standards for signs and markings, we have reached a logical point for the more

practical considerations on the most efficient uses of these essential aids to traffic control.

Uniformity in design and consistency in application of signs and markings are essential, and their importance cannot be too strongly stressed.

Closer state supervision over the design and use of traffic-control devices is essential if any practical degree of uniformity is to be attained.

To effect state control there must be enabling legislation, which many if not most of the states now have, requiring that all traffic-control devices erected by any political subdivision must conform to the state manual and specifications.

Legislation alone is not enough, however. There must be strong state and local administrative organizations composed of personnel trained and experienced in the field of traffic control and with sufficient authority to command respect. Definite responsibility must be fixed in one person or group in either local or state government. It is not a part-time job for someone whose major interest is other phases of street and highway work and who, therefore, subordinates traffic control work, or who is uninformed or indifferent regarding the importance of adequate traffic control. The administrative personnel should be fully conversant with standard practices in the field of traffic control and interested in the most efficient use of standard traffic-control devices.

With the return to peacetime conditions, we are entering upon an era in which there will be greater need than ever before for the judicious use of measures for the control, regulation, and safety of traffic. We need, therefore, to take stock of our present equipment and make plans for modernizing it.

While proper signs and markings are essential to the control and regulation of traffic, their misapplication or excessive use not only wastes public funds but tends to create disrespect for them. Such misuse frequently results from haphazard experimentation on the part of those without training or experience, or on the application of such devices without a proper basis of factual study. The use of traffic-control devices should not be based on guesswork or inexperience.

Because the application of traffic signs in many jurisdictions has been loosely controlled, there has been too often a tendency to oversign. So many unnecessary signs, especially those of a warning nature, have been placed that the average motorist is likely to lose respect for all warning signs. One of the first steps in the rehabilitation of a highway sign system should be a survey to determine what signs are unnecessary and their subsequent removal.

Because of shortages of materials and labor, it proved impossible to maintain street and highway signs properly under wartime conditions. As a consequence, the vast majority of signs and markings are in very poor condition. This should not be permitted to continue any longer than is absolutely necessary. The obedience of a motorist to a sign is in almost direct proportion to the condition of the sign. A battered, rusty, or illegible sign is likely to be assumed to be one which the authority responsible for its erection does not consider very necessary. On the other hand, if the sign is maintained in good condition, the motorist is more likely to be impressed with the belief that there is real need for the sign, and his observance of it is, therefore, correspondingly increased.

If a sign is not of sufficient importance to be read by a motorist at night as well as by day, it has little place on the highway. For this reason at least all warning signs and stop signs should be reflectorized or otherwise illuminated. The exceptions are, of course, signs installed in well-lighted areas where visibility is ample and those signs having daylight application only.

Route markers and destination signs located at critical points where routes change direction and where the motorist may be confused and make the wrong turn because of lack of adequate visibility at night should be reflectorized. It is difficult to reflectorize most route markers and destination signs with buttons because of the lack of sufficient stroke width in the numerals and letters, but glass-beaded coatings make it possible to reflectorize such markers and signs very satisfactorily.

While illumination of parking signs is ordinarily not necessary, it is desirable to reflectorize or otherwise illuminate one-way and other signs which should be readable at night.

It is important that consideration be given to signs of adequate size. Increasing use is being made of oversized signs with large copy and legends to emphasize the warning of hazards on older roads and to meet the demands for greater legibility on modern high-speed highways. Oversized directional signs have particular application at complicated rural intersections to prevent confusion by providing instantaneous readability.

There are many locations where signs considerably larger than the standard, even approaching billboard proportions, with correspondingly enlarged copy, can be used to advantage and in fact are needed. Modern highway speeds make it necessary that the driver be warned of hazards or advised of changes in direction a sufficient distance in advance to allow him sufficient time to prepare to meet the situation and complete the maneuver in safety.

It is calculated that the driver should have at least 10 seconds in which to react to the warning or information on a sign and to prepare to execute the necessary maneuver without hesitation. At a speed of fifty miles per hour, 10 seconds means 733 feet.

Practical sign makers estimate that each inch of letter height has a legibility distance of 50 feet. Studies have shown this rule to be satisfactory for daylight conditions and for standard width letters. For narrow letters, however, the legibility distance in the same studies was shown to be only 33 feet. In each case, the legibility distance for night conditions was reduced 15 per cent.

The night condition is the critical one from the standpoint of legibility and, therefore, the lower legibility value should be used. Based on a distance of 750 feet, which is required for a 10-second warning at 50 miles per hour, a sign placed at the point of hazard would require a Series D (normal width) letter 18-inches high. For a warning sign placed 400 feet in advance of the hazard, a 10-inch Series D or a 12-inch Series B (narrow) letter is indicated. As the standard practice is to locate warning signs in advance of the point of hazard, the larger signs at the point of hazard should be used only when it is advisable to supplement signs located in advance.

Directional signs are as a general rule located at the point to which they apply. However, the practice of locating them in advance is growing in favor. Such signs with copy too small to be read at a glance are frequent causes of confusion. This is particularly true where there is a multiplicity of directions. Therefore, the number of place names should be kept as low as possible and the size of the lettering as large as possible, preferably not less than 6-inches.

Directional signs should be at right angles to the direction of travel they are intended to serve. Signs parallel with the direction of travel are difficult to read, and this practice should be discouraged. Destination signs for places ahead on the route may be placed at right angles to the direction of travel by using vertical arrows to indicate that the direction is ahead.

The arrows on directional signs should be on the side of the sign corresponding to the direction of the arrow, i.e., a left arrow should be on the left side and a right arrow should be on the right side. This will minimize confusion as to the direction in which the arrow points. Vertical arrows should be on the left side.

Pavement Markings

Pavement markings have an important place in traffic control notwithstanding the fact that when painted they require frequent renewal,

may often be obscured by snow, and are not clearly visible when wet. They are especially valuable in helping to keep traffic in its proper lane and in warning the driver of certain conditions without distracting his attention from the pavement. Pavement markings are recognized as essential adjuncts to signs.

The commonest use of pavement markings on rural pavements is the center line on two-lane pavements, lane lines on multiple-lane pavements, and stop lines at intersections. In urban areas, it is now recognized as essential that adequate lane markings and crosswalk markings be provided.

The most common method of applying pavement markings is by the use of paint. Improvements in striping equipment have resulted in greater speed of application with greatly lowered costs and a marked increase in the amount of such marking. Equipment that is capable of painting single, double, or triple lines in one or two colors at 10 to 15 miles per hour has been developed and is in use in several states.

The use of reflector or glass-bead types of paints has resulted in marked improvement in visibility at night as well as increased durability. This type of paint is particularly deserving of consideration for marking pavements in areas subject to frequent fog.

As in the case of signs, uniformity in the design and application of pavement markings is important. Only in this way can the various design features, such as width of line, color, and type of line, whether solid or broken, have a definite meaning to motorists.

One of the most important needs for standardization in pavement markings is in the marking of no-passing zones. The marking of zones on horizontal and vertical curves and at other locations where, because of restricted sight distance, it is unsafe to overtake and pass is an important method of traffic control and should be uniform so that it is readily understood and observed.

In the system of marking no-passing zones, adopted by the American Association of State Highway Officials in 1940, a yellow restrictive or "barrier" line parallel with but separated from the center line is marked on the side from which crossing is prohibited. No-passing zones for two- and three-lane pavements are determined separately for traffic in each direction, and the marking restricts passing to the right lane within the limits of the no-passing zone only but permits passing when the road opens up to view.

On four-, six-, and eight-lane undivided pavements, the center line is marked with two solid parallel yellow barrier lines, providing in effect a continuous no-passing zone to the left of which driving is prohibited.

It is provided that the width of center lines and lane lines in the standard system should not be less than 4 inches nor more than 6 inches, with 4 inches being generally accepted as standard.

This standard system was adopted just before the entry of this country into World War II. Although some states had adopted this system and a total of twenty-three states had indicated their favorable acceptance of this system of marking no-passing zones, the inability to secure paint and the necessary striping equipment during the war has held up the universal adoption of this system.

In the standard system of the American Association of State Highway Officials, it is desirable to have equipment that can paint three lines simultaneously, that is, the center line and the barrier lines on each side. Otherwise, the painting of each no-passing line is a separate additional operation with a corresponding increase in cost. Now that equipment has become available with the ending of the war, it is expected that more states will be able to obtain suitable equipment and we may expect to see a wider adoption of the standard system of marking no-passing zones.

In December, 1945, the Joint Board on Uniform Traffic Control Devices approved, as an alternate to the standard system, the system of marking no-passing zones used in the State of New York. In the New York system a broken white center line consisting of dashes fifteen feet in length, separated by gaps of twenty-five feet, is used. At no-passing zones, a solid white line is painted on the side from which passing is prohibited with the dashed line on the other side. At no-passing zones the center line is discontinued and the solid line and the corresponding dashed line are painted on either side of the center of the pavement.

The advantage claimed by New York for this system is economy in paint and also that the dashed line always indicates where passing is permitted. However, with the yellow barrier line there is no need for indicating by a dashed line, as opposed to a solid line, where passing is permitted. The yellow barrier line indicates where passing is not permitted. Where there is no yellow line passing is always permitted.

It is quite generally agreed that the broken center line, which permits a considerable saving in paint, is about as effective as a solid center line. Equipment can be devised for automatically painting broken lines. However, difficulty is usually experienced in keeping this automatic broken line painting equipment in adjustment so that in repainting broken lines they will be retraced as originally painted without change in the length of the dashes and spacing.

To be distinctive the barrier stripe should differ from the normal stripe in color or type. With regard to type difference, it is submitted

that the barrier line should invariably be a solid line whether it is white or yellow. Where the center line is a broken line, a solid auxiliary line of the same color will stand out by the contrast in type. If the center line is solid, the barrier line should be of another color. Increasing the width of the barrier line in an effort to make it distinctive does not provide sufficient contrast to be effective when both lines are of the same color. The barrier line, however, should be at least equal in width to the center line and should be separated from the center line by a distance equal to at least half the width of the center line.

A uniform, well-placed, and well-maintained system of signs and traffic markings is a valuable aid to facilitation and safety in traffic movement which more than justifies its cost. Visual aids in the form of signs and markings are essential to modern automotive transportation systems.

In its work on the revision of the post-war *Manual,* there was one fact that became clear to the Joint Committee, namely, that there is need for further investigation, experimentation, and research on the design of, and warrants for, the use of various traffic-control devices. The new *Manual* represents the best composite judgment of the Joint Committee, and it will no doubt provide an excellent basis for future study. However, it is admitted that there is need for a more scientific approach to the problem through research. New technological advancement in the field of paints and enamels, plastics, reflecting units, and reflecting coatings may have an important influence on future design.

The design of highway signs and markings is a problem for the traffic engineer with the assistance of the psychologist and the optical scientist, and with contributions also from physical and chemical research. The design and use of traffic signs and markings along with the design, use, and application of other traffic-control devices is not a matter for the amateur. Traffic control is an important function that should have a well-defined place in governmental organization under the direction of engineers trained and experienced in this field.