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The Problem

In the evolution of highway signs, the square or rectangular shape was first used to indicate any conditions which might affect driving on the highway. When it became necessary to differentiate between conditions along the right-of-way from conditions on the right-of-way, it was decided to rotate the square sign 45 degrees and let the diamond-shaped sign stand for curves, dips, hills, and other conditions on the roadway proper. Later, when a sign was needed to indicate STOP someone suggested cutting off the corners and making an octagonal sign of the diamond. The round sign was adopted as the designation for highway-railway crossings.

As a result, the STOP sign became the sign of least area for its size--about 81-83 percent of the diamond-shaped sign. While most important, it is also the least conspicuous, if size is a factor. A need is felt to improve this sign although authorities do not care to change its shape or size. Factors such as background color, letter color, reflectorizations, spacing of letters, structure, shape and size of letters as well as certain other variables are now under experimental investigation to ascertain the optimal conditions for maximum legibility. The present study deals only with two variables, spacing and stroke of block letters.

In an unpublished study, Lauer (1932) found the width-height ratio of numbers and contrast of numbers and background, stroke of numbers and letters, spacing of numbers and letters, and the stroke-width ratio to be the five most important variables in the legibility of license plates. Uhlaner (1941) showed that optimal spacings and stroke could be equated to give the increased legibility of certain letter combinations. It was also shown that a stroke of about .16-.18 per cent the width of letters of narrow width have a maximum legibility when combined into words using certain illumination levels.

From these data it was deemed advisable to set up experiments to determine, if possible, certain conditions which would increase the legibility of the STOP sign. While a number of factors are being studied, this preliminary study deals with only two: (1) the effect of width of strike in relation to spacing of letters and legibility and, (2) the differential legibility of the separate letters S, T, O, and P.

Method and Procedure

Five plates with the word STOP were constructed with spacings ¼", ½", ¾", 1", and 1¼" respectively, with strokes .1875 of the width and .25 of the width respectively. Block letters were carefully drawn

one inch high with India ink. They were mounted on white cardboard and attached to plywood backs for use in the Stoelting flash card exposure device (No. 11320-E) for slow timed exposures. Twenty-three subjects were used to make observations under conditions of scotopic vision and 91 measurements were made of each STOP sign, keeping other factors constant. The order of presentation was rotated to offset any systematic error. Techniques have been described by Uhlaner (1941). A standard visual test was given at which time four additional observations were made of each of the letters, S, T, O, and P.

Apparatus

A dark room described by Silver and Lauer (1941) was used to control the amount of illumination on the test object. The latter were exposed in rotating order and the light controlled by a Ferree-Rand Projector, No. 71-35-50, with mounted diaphragm to vary the light without affecting the wave length. The cards were released as desired by pushing a button to start the motor in the Stoelting exposure device. Ten exposures are placed into the device at once, thus saving a great deal of time. The projected light was gradually increased on each test card until it was legible to the observer. He was asked to use the same criterion of discrimination each time.

The four letters S, T, O, and P, were tested with the Clason acuity meter at the same time acuity measurements were made using the regular slide for acuity. Each letter was isolated with the slide and brought up until it could be read.

Results

The results of stroke-spacing relations so far obtained are shown in Table I.

Table I.

Relationship of stroke and Spacing to Legibility.

Stroke of letters Light units—low best in per cent of width	*Spacing inches* (¼″)	(½″)	(¾″)	(1″)	1½″)
	Light units—low best				
.1875	31.0	24.5	27.5	29.5	29.6
.2500	22.0	28.5	22.0	22.0	20.0

The mean for the narrow stroke was 28.4 while that of the heavier stroke was 24.1. The difference was quite consistent throughout the range with one exception. While Uhlaner's results showed a difference in favor of the narrower stroke, he also used letters having a width-height ratio of 80 per cent or less. Block letters apparently require a heavier stroke.

No very significant difference was noted in spacing. This is to be further investigated.

The comparison made of letters showed considerable difference between the four letters as indicated by Table II.

Table II.

Discrimination Level on Clason Acuity Meter			
S	T	O	P
Clason units or percentage acuity			
87.6	109.3	96.0	101.9

The order of ease of discriminations runs T, P, O, and S in descending order of merit.

Summary and Conclusions

From a preliminary study of two different widths of stroke and of four letter spacings on stop signs using low level illumination, it is shown that the heavier stroke is more legible under the conditions described. It remains to be seen whether this will hold in high illuminations.

The letters S, T, O, and P are not of equal difficulty and it seems the design of separate letters will need to be modified to secure the most effective Gestalt or pattern of letters used in the STOP sign for maximum efficiency.

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