Sign Backgrounds and Angular Position

DOUGLAS R. HANSON and HENRY L. WOLTMAN, 3M Company

•INCREASING traffic volumes and higher operating speeds combined with the increased frequency of traffic signs place utmost importance on effective signs and signing systems to guide and control traffic safely and expeditiously. Valuable research work has been done in the area of effective signing, particularly on sign legibility, by Forbes, Moskowitz, Solomon, Holmes, Lauer, and others; however, signing literature suggests that further efforts are necessary concerning sign effectiveness, specifically on factors which attract a motorist's attention to the sign. This paper considers sign target value and angular position, two major factors in compelling driver attention (1).

TARGET VALUE

Target value is the ability of a sign to be visible against its background and provide early recognition and discrimination of the sign type which, in turn, prepares the driver for the potential message moments before actual reading of the legend. Major factors affecting the target value of a sign are its color and brightness, producing whatever measure of contrast the natural environmental background permits.

The visual factors of color and contrast are relatively well understood. As shown by Hanson and Dickson (2), the more contrast a sign has with its background, the greater will be the distance for its discrimination and recognition. Forbes (3) found that a given sign color possessed a range of effectiveness depending upon the prevailing background. It is apparent that backgrounds are very influential in the consideration of a proper sign; and, conversely, if strengths or weaknesses of a particular hue or saturation are discovered, they will most likely be closely related to the nature of the background. Both background and sign position are also shown to be dependent on terrain and type of roadway. To maximize sign effectiveness for an entire system on a basis of utilizing a single relatively uniform color, careful consideration of all potential backgrounds should be made. The diversity of backgrounds with which a sign must compete is very broad. There is, however, virtually no published information on the nature or frequency of the various existing backgrounds.

ANGULAR POSITION

Although target value is greatly influenced by background, it is somewhat dependent on the sign's position with respect to the driver's central point of fixation.

Matson (1, pp. 308-309) points out: "The accuracy of identification of traffic signs increases as the angle between the axis of vision and a line drawn from the traffic sign to the motorist's eye decreases." This is supported by Kingslake (4) reporting on research findings of Werheim shown in Figure 1. The acuity of peripheral vision decreases rapidly as angular displacement relative to the fixation point increases. According to Chapanis (5), this is due principally to a heavy concentration of visual perceptors in the immediate vicinity of the fovea. For optimum attention and identification, Matson (1, p. 309) suggests that a sign should fall within a visual cone of 10 to 12 deg on the horizontal axis and 5 to 8 deg on the vertical axis, throughout the intended range of sign effectiveness. This would probably encompass a distance extending from a point just prior to the sign's message becoming legible to approximately 300 ft from a sign. Greenshields (6) states that 5 deg to the left or right is ideal for sign placement but that practical considerations may force a wider visual field and suggests a value of 10 deg to the left or right as maximum angular displacement.

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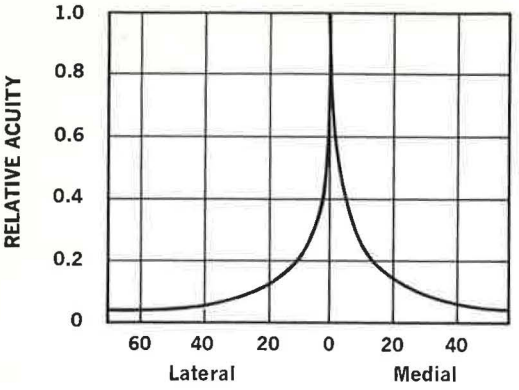


Figure 1. Peripheral visual acutity.

Figure 2. Transparent plastic shield in place with sign positions and driver's visual axis marked.

FIELD STUDY

The field study consisted of recording a sample of sign backgrounds on Interstate highways and other high-quality facilities with simultaneous recording of the angular position relative to the driver's visual axis, including a comparison of these findings with Matson's criteria above. Additional information obtained included sign placement, either overhead or shoulder-mounted; type of facility, whether at-grade, elevated or depressed; and environment, whether rural, suburban, or business. The rural environment possesses little, if any, housing or commercial activity, while suburban is principally residential with occasional abutting commercial property. The business classification has heavy and frequent commercial facilities immediately adjacent to the roadway.

To obtain angular sign position, a screen of rigid transparent plastic was secured in a vertical position between the steering wheel and windshield. As a sign was approached, the driver would mark its location on the transparent screen when it first became legible. The driver's visual axis was located by placing a cross on the screen at a point of infinite distance on the lane ahead. Figure 2 shows the transparent shield in position with sign positions and the visual axis marked.

All data pertaining to both sign backgrounds and angular position were taken at a distance where the sign copy first became legible. This is the earliest common reference for all signs within the range where target value is influential. The driver's vision was corrected to 20/20. The driver marked the sign position while an observer simultaneously recorded the background data.

The sample selection was based principally on consideration of the types of terrain and environmental areas through which Interstate-type facilities would pass. Information was obtained in several major metropolitan areas, in gently rolling as well as flat agricultural terrain, in very hilly regions in the Sierra Nevada mountains, and in the Mojave desert. This included 1560 miles of representative freeway facilities in California, Pennsylvania, New York, Illinois, Minnesota, Wisconsin, and Nevada comprising 4054 destination and distance signs.

RESULTS AND ANALYSIS

Background Study

The information obtained for sign background was categorized by six types of terrain, as follows:

TABLE 1

BACKGROUNDS OF SIGNS—OVERALL TOTALS

Background	Number of Signs and Percent of Total					
	Overhead		Shoulder		Combined	
	No.	%	No.	%	No.	%
Sky	603	35.8	174	7.3	777	19.1
Trees						
Dark green	180	10.7	752	31.8	932	23.1
Bright green	15	0.9	106	4.5	121	2.9
Grass						
Tan	23	1.4	152	6.4	175	4.3
Green	11	0.7	91	3.8	102	2.5
Building	123	7.3	98	4.1	221	5.4
Advertising signs	38	2.3	119	5.0	157	3.9
Road	9	0.5	74	3.1	83	2.0
Bridge	333	19.8	295	12.4	628	15.6
Sand	2	0.1	46	1.9	48	1.2
Dark hill	77	4.6	154	6.5	231	5.7
Sky and building	29	1.7	6	0.3	35	0.9
Sky and bridge	109	6.6	56	2.4	165	4.1
Sky and natural						
Dark	127	7.5	171	7.2	298	7.3
Light tan	2	0.1	4	0.2	6	0.1
Bright green	—	—	27	1.1	27	0.7
Red rock	—	—	8	0.3	8	0.2
Grey rock	—	—	40	1.7	40	1.0
Totals	1681	100	2373	100	4054	100

1. Metropolitan—includes suburban and business areas of Chicago, Los Angeles, San Francisco, Minneapolis, and St. Paul.
2. Gently Rolling—principally rural with an occasional town; terrain is gently rolling and used for agricultural purposes.
3. Mountainous—exclusively mountainous, mostly rural, with an occasional town.
4. Flat, Highly Populated, Agricultural—a combination of rural, suburban, and business areas with a fairly high population density; abutting land is quite flat and is used mainly for agricultural purposes. Such terrain is typical of much of the more densely populated areas of the United States.
5. Very Hilly—basically rural with occasional towns.
6. Desert—flat desert country with distant hills and mountains.

Background data for overhead and shoulder-mounted signs were summarized independently for each of the six categories considered. A combined total by background was also obtained for each category. These values were then combined to provide an overall total for the study.

Backgrounds were grouped into 16 different types. These are shown in Table 1, which is the overall sign background summary for the study.

Several of the background types need further definition. The dark tree background is a deep olive drab color corresponding roughly to U. S. Army Engineers Standard Camouflage Color No. 9 (7). The bright tree background is a light, bright-colored green observed occasionally on brush. The building background refers principally to large office buildings of intermediate greys and browns with only occasional buildings

of a residential nature. The road category refers to instances where road curvature or a ramp caused the sign to be seen against the roadway surface. Bridges were generally a dark brown color, particularly in metropolitan areas; however, some fairly new bridges were tan. Substantial portions of the bridge structures were often in the shade resulting in a hue darker than expected. The dark hill background occurred when the hill was at some distance from the sign. At great distance hills became nearly achromatic, appearing to be a combination of deep dark green and brown, almost black. At times the sign would be seen partly against the sky and partly against some other background.

The overall totals in Table 1 show that the dark tree background was encountered most frequently—23 percent of the time—followed by a sky background, which was observed 19 percent of the time. Inspection of the overhead-shoulder breakdown shows that for shoulder-mounted signs the dark tree background was predominant—51.8 percent. The incidence of bridge backgrounds was higher than anticipated—15.6 percent of all sign backgrounds. The frequency of advertising sign backgrounds was a surprisingly low 3.9 percent of the total.

It is possible to group the background types further into sky, dark, and all other background categories which allow comparison with Forbes' (3) preliminary findings regarding sign effectiveness. For the dark backgrounds it is necessary to combine the dark tree and the dark hill backgrounds, one-half the bridge backgrounds, one-half the building backgrounds, and one-half the sky plus other backgrounds. This amounts to approximately 44 percent of the total sign backgrounds. A sky background existed 19 percent of the time and all other types of backgrounds combined occurred 37 percent

TABLE 2

BACKGROUNDS OF SIGNS—METROPOLITAN AREA

Background	Number of Signs and Percent of Total					
	Overhead		Shoulder		Combined	
	No.	%	No.	%	No.	%
Sky	318	34.3	40	9.6	358	26.7
Trees						
Dark green	104	11.2	117	28.2	221	16.5
Bright green	8	0.9	26	6.3	34	2.5
Grass						
Tan	6	0.7	18	4.3	24	1.8
Green	—	—	18	4.3	18	1.3
Building	97	10.5	52	12.5	149	11.1
Advertising signs	13	1.4	12	2.9	25	1.9
Road	4	0.4	14	3.4	18	1.3
Bridge	197	21.2	66	15.9	263	19.6
Sand	—	—	—	—	—	—
Dark hill	5	0.5	6	1.4	11	0.8
Sky and building	29	3.1	4	1.0	33	2.5
Sky and bridge	84	9.1	9	2.1	93	6.9
Sky and natural						
Dark	62	6.7	34	8.1	96	7.1
Light tan	—	—	—	—	—	—
Bright green	—	—	—	—	—	—
Red rock	—	—	—	—	—	—
Grey rock	—	—	—	—	—	—
Totals	927	100	416	100	1343	100

TABLE 3

BACKGROUNDS OF SIGNS—GENTLY ROLLING AREA

Background	Number of Signs and Percent Total					
	Overhead		Shoulder		Combined	
	No.	%	No.	%	No.	%
Sky	37	33.9	52	15.5	89	20.1
Trees						
Dark green	19	17.4	123	36.8	142	32.2
Bright green	—	—	1	0.3	1	0.2
Grass						
Tan	—	—	9	2.7	9	2.0
Green	—	—	40	12.0	40	9.0
Building	2	1.8	6	1.8	8	1.9
Advertising signs	4	3.7	1	0.3	5	1.1
Road	—	—	1	0.3	1	0.2
Bridge	17	15.6	27	8.1	44	9.9
Sand	—	—	—	—	—	—
Dark hill	—	—	—	—	—	—
Sky and building	—	—	—	—	—	—
Sky and bridge	6	5.6	12	3.6	18	4.1
Sky and natural						
Dark	24	22.0	38	11.4	62	14.0
Light tan	—	—	1	0.3	1	0.2
Bright green	—	—	23	6.9	23	5.2
Red rock	—	—	—	—	—	—
Grey rock	—	—	—	—	—	—
Totals	109	100	334	100	443	100

of the time. The predominance of dark backgrounds in the natural surround was unanticipated, particularly for the overhead situation. Although Forbes' investigation is still in progress, early findings reported that a dark green sign was seen "first and best" against a sky background and that a highly saturated bright green was seen "first and best" against a dark hill background. Studies are in process to evaluate other pertinent factors; however, the results reported are not unexpected since contrast with the background should be an influential factor.

Analysis of the type and frequency of various backgrounds by each of the six basic areas studied provides further knowledge of existing sign background conditions. The summary for the metropolitan area (Table 2) shows a high incidence of sky backgrounds (26.7 percent) and bridge backgrounds (19.6 percent), particularly for overhead installations. The ratio of overhead to shoulder installations was slightly greater than 2 to 1. The percentage of dark tree backgrounds was fairly high—16.5 percent of the total. Table 3 summarizes the backgrounds of signs in the gently rolling area. Dark tree backgrounds are predominant, occurring 32.2 percent of the time. As expected, the desert area totals (Table 4) show that sand backgrounds were most common. The terrain in the desert was very flat and the freeway traveled was overpassed by crossing roads which resulted in sand embankment backgrounds.

Sign backgrounds for the flat, highly populated, agricultural area are shown in Table 5. Background percentages for this area parallel quite closely those for the overall study totals. Because the terrain is quite flat, the incidence of overhead signs with a sky background is high (41.7 percent). However, in the combined overhead and

shoulder totals, dark tree backgrounds are predominant. In both the very hilly area (Table 6) and the mountainous area (Table 7) the frequency of sky backgrounds was extremely low, particularly in the mountainous area where only 1 sign out of 337 was seen against the sky. In the mountains, a dark tree background occurred 44 percent of the time. In the hilly area, a tan grass background was encountered at the time the study was conducted. In other climates similar backgrounds would obviously be green.

The data were summarized by facility type to determine what effect this variable would have on sign background. Table 8 indicates that 81 percent of the signs were installed on at-grade facilities; 42 percent of the sign backgrounds for depressed facilities possess either bridge or combined bridge and sky background. On at-grade facilities, dark tree or dark hill backgrounds occur 31 percent of the time.

A further analysis of the background information was made, summarizing the data by roadway environment (Table 9). A majority of the total signs, 57 percent were in either a suburban or business environment. In general, the majority of sign backgrounds for both rural and suburban areas consists of trees, whereas the majority of sign backgrounds in the business areas consists of bridge backgrounds.

During the field stduy, information regarding the average number of signs per mile was obtained. For rural areas the average was 1. 4 signs per mile, and for metropolitan areas, 5. 3. The number of signs per mile averaged 2. 6 for the entire study.

Seasonal Variation

All of the data for this study were collected during the summer months. Obviously the season of the year would affect sign backgrounds to a certain degree, particularly in the northern latitudes where seasonal color changes are relatively great. For an accurate determination of the effect of seasonal change, each locale would require independent consideration.

In areas having predominantly deciduous trees, the turning leaves would create a multicolored effect for a brief period during the fall and then as the trees shed their leaves, backgrounds become almost black in color until spring. Little seasonal change would occur for conifers. The incidence of grass sign backgrounds was not high; therefore, seasonal changes would have little overall effect. Snow in the mountainous areas would be expected to have a greater effect on sign backgrounds because of the high frequency of signs being viewed against natural backgrounds. In the metropolitan areas signs had either a sky background, a bridge background, a building background, or some combination of these 66. 8 percent of the time. Because of this, seasonal variations would seem to have little effect in metropolitan areas.

During the field study it was noted that the motorist is often confronted with numerous signs at one time. Although unrelated to the objectives of this study, a sample was taken of the number of signs which were in very close proximity. Percentages are not available, but it was frequently noted that five and six signs required concurrent attention in metropolitan areas. In rural areas, longitudinal spacing of signs prevented this situation.

Angular Position

Distribution patterns obtained from the field study of angular sign position relative to the motorist's visual axis are shown in Figures 3 through 6. Median points for each distribution are indicated, total angular span is shown, and the 8-deg vertical and 12-deg horizontal optimum angular span suggested by Matson (1, p. 309) is defined. Table 10 lists the percentage of signs which fall outside the optimum angular range by type of installation for each of the four terrain types. Inspection of the distributions and Table 10 indicates that, with the exception of flat terrain, a significant number of signs have greater than optimum angular displacement. This situation is most severe for shoulder-mounted signs in the mountainous area (Fig. 6) where 53 percent are outside the optimum range. This is caused by the winding roads and deep cut banks which, in many cases, hide a sign until the motorist is very close and angular displacement great. All median points are, however, well within the optimum angular range. As would be expected, the median point for overhead signs was above and to the left of shoulder-mounted signs in all cases.

TABLE 4

BACKGROUNDS OF SIGNS—DESERT AREA

Background	Number of Signs and Percent of Total					
	Overhead		Shoulder		Combined	
	No.	%	No.	%	No.	%
Sky	8	27.6	11	10.2	19	13.9
Trees						
Dark green	—	—	5	4.6	5	3.6
Bright green	—	—	—	—	—	—
Grass						
Tan	—	—	9	8.3	9	6.6
Green	—	—	4	3.7	4	2.9
Building	2	6.9	2	2.0	4	2.9
Advertising signs	—	—	4	3.7	4	2.9
Road	—	—	6	5.6	6	4.4
Bridge	6	20.7	6	5.6	12	8.8
Sand	2	6.9	28	25.9	30	21.9
Dark hill	2	6.9	23	21.3	25	18.2
Sky and building	4	13.8	2	1.8	2	1.5
Sky and bridge	—	—	—	—	4	2.9
Sky and natural						
Dark	3	10.3	7	6.4	10	7.3
Light tan	2	6.9	1	0.9	3	2.2
Bright green	—	—	—	—	—	—
Red rock	—	—	—	—	—	—
Grey rock	—	—	—	—	—	—
Totals	29	100	108	100	137	100

TABLE 5

BACKGROUNDS OF SIGNS—FLAT, HIGHLY POPULATED AGRICULTURAL AREA

Background	Number of Signs and Percent of Total					
	Overhead		Shoulder		Combined	
	No.	%	No.	%	No.	%
Sky	208	41.7	54	6.6	262	19.9
Trees						
Dark green	45	9.1	263	32.3	308	23.6
Bright green	4	0.8	54	6.6	58	4.4
Grass						
Tan	12	2.4	24	2.9	36	2.8
Green	9	1.8	17	2.1	26	2.0
Building	20	4.0	29	3.6	49	3.7
Advertising signs	17	3.4	85	10.4	102	7.9
Road	1	0.2	14	1.7	15	1.1
Bridge	89	17.9	132	16.2	221	16.9
Sand	—	—	4	0.5	4	0.1
Dark hill	55	11.0	45	5.5	100	7.7
Sky and building	—	—	—	—	—	—
Sky and bridge	15	3.0	33	4.1	48	3.5
Sky and natural						
Dark	23	4.7	6	7.5	84	6.4
Light tan	—	—	—	—	—	—
Bright green	—	—	—	—	—	—
Red rock	—	—	—	—	—	—
Grey rock	—	—	—	—	—	—
Totals	498	100	815	100	1313	100

TABLE 6

BACKGROUNDS OF SIGNS—VERY HILLY AREA

Background	Number of Signs and Percent of Total					
	Overhead		Shoulder		Combined	
	No.	%	No.	%	No.	%
Sky	32	31.3	16	4.2	48	10.0
Trees						
Dark green	9	8.8	98	25.9	107	22.3
Bright green	—	—	13	3.4	13	2.7
Grass						
Tan	5	4.9	71	18.7	76	15.8
Green	2	2.0	9	2.4	11	2.3
Building	2	2.0	4	1.1	6	1.2
Advertising signs	4	3.9	12	3.2	16	3.3
Road	—	—	17	4.5	17	3.5
Bridge	20	19.6	47	12.4	67	13.9
Sand	—	—	4	1.1	4	0.8
Dark hill	15	14.8	64	16.9	79	16.5
Sky and building	—	—	2	0.5	2	0.4
Sky and bridge	—	—	—	—	—	—
Sky and natural						
Dark	13	12.7	21	5.4	34	7.1
Light tan	—	—	1	0.3	1	0.2
Bright green	—	—	—	—	—	—
Red rock	—	—	—	—	—	—
Grey rock	—	—	—	—	—	—
Totals	102	100	379	100	481	100

TABLE 7

BACKGROUNDS OF SIGNS—MOUNTAINOUS AREA

Background	Number of Signs and Percent of Total					
	Overhead		Shoulder		Combined	
	No.	%	No.	%	No.	%
Sky	—	—	1	0.3	1	0.3
Trees						
Dark green	3	18.8	146	45.4	149	44.2
Bright green	3	18.8	12	3.7	15	4.5
Grass						
Tan	—	—	21	6.6	21	6.2
Green	—	—	3	0.9	3	0.9
Building	—	—	5	1.6	5	1.5
Advertising signs	—	—	5	1.6	5	1.5
Road	4	25.0	22	6.9	26	7.7
Bridge	4	25.0	17	5.3	21	6.1
Sand	—	—	10	3.1	10	3.0
Dark hill	—	—	16	5.0	16	4.7
Sky and building	—	—	—	—	—	—
Sky and bridge	—	—	—	—	—	—
Sky and natural						
Dark	2	12.4	10	3.1	12	3.6
Light tan	—	—	1	0.3	1	0.3
Bright green	—	—	4	1.2	4	1.2
Red rock	—	—	8	2.5	8	2.4
Grey rock	—	—	40	12.5	40	11.9
Totals	16	100	321	100	337	100

TABLE 8

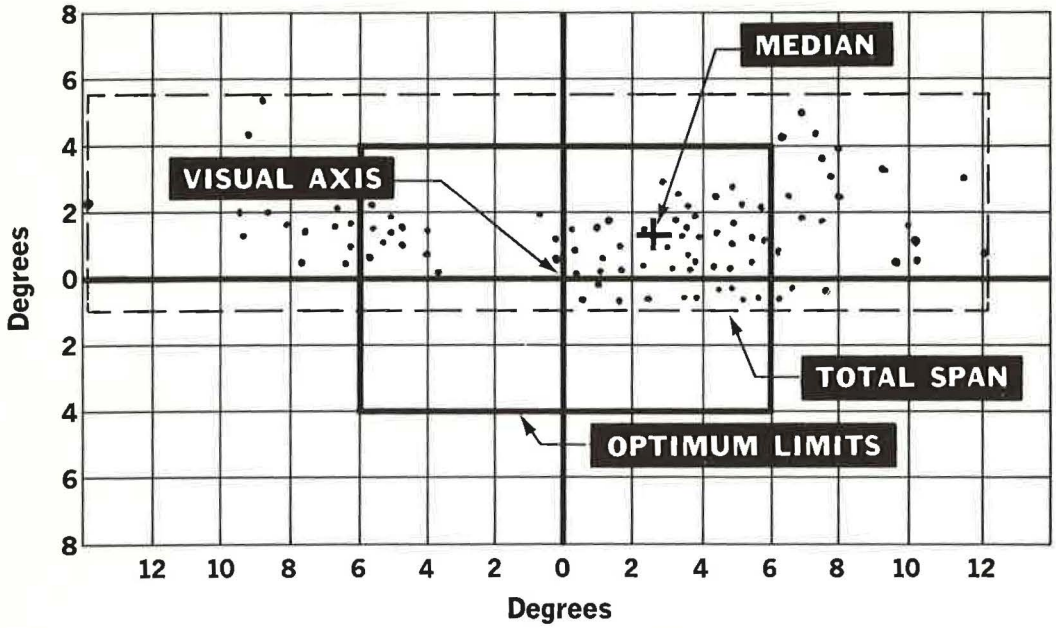
BACKGROUNDS OF SIGNS BY FACILITY TYPE

Background	Facility Type					
	At Grade		Depressed		Elevated	
	No.	%	No.	%	No.	%
Sky	602	18.3	61	17.6	114	29.0
Trees						
Dark green	820	24.8	38	10.9	74	18.8
Bright green	111	3.3	3	0.8	7	1.8
Grass						
Tan	163	4.9	2	0.6	10	2.5
Green	101	3.0	—	—	1	0.2
Building	111	3.3	59	17.0	51	12.9
Advertising signs	138	4.2	8	2.3	11	2.8
Road	72	2.2	8	2.3	3	0.8
Bridge	450	13.7	115	33.2	63	16.0
Sand	47	1.4	—	—	1	0.2
Dark hill	222	6.7	1	0.3	8	2.0
Sky and building	8	0.2	15	4.3	12	3.1
Sky and bridge	120	3.6	32	9.2	13	3.3
Sky and natural						
Dark	267	8.0	5	1.5	26	6.6
Light tan	6	0.2	—	—	—	—
Bright green	27	0.8	—	—	—	—
Red rock	8	0.2	—	—	—	—
Grey rock	40	1.2	—	—	—	—
Totals	3313	100	347	100	394	100

TABLE 9

BACKGROUNDS OF SIGNS BY ROADWAY ENVIRONMENT

Background	Roadway Environment					
	Rural		Suburban		Business	
	No.	%	No.	%	No.	%
Sky	247	14.2	491	24.8	39	11.6
Trees						
Dark green	498	28.7	418	21.2	16	4.8
Bright green	32	1.8	83	4.2	6	1.8
Grass						
Tan	120	6.9	53	2.7	2	0.6
Green	55	3.2	47	2.4	—	—
Building	21	1.2	118	6.0	82	24.4
Advertising signs	35	2.0	98	4.9	24	7.1
Road	47	2.7	26	1.3	10	3.0
Bridge	190	10.9	322	16.3	116	34.6
Sand	43	2.5	5	0.3	—	—
Dark hill	156	9.0	75	3.8	—	—
Sky and building	2	0.1	17	0.8	16	4.7
Sky and bridge	50	2.9	91	4.6	24	7.1
Sky and natural						
Dark	164	9.4	133	6.7	1	0.3
Light tan	6	0.3	—	—	—	—
Bright green	27	1.5	—	—	—	—
Red rock	40	2.3	—	—	—	—
Grey rock	8	0.4	—	—	—	—
Totals	1741	100	1977	100	336	100



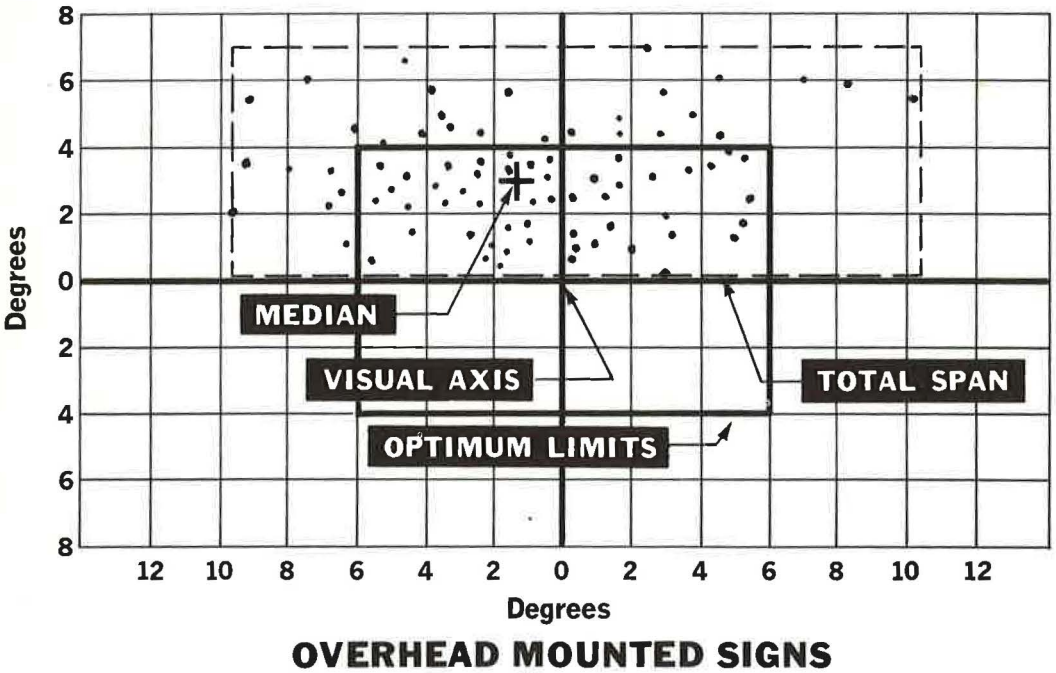


Figure 3. Angular position of traffic signs—gently rolling area.

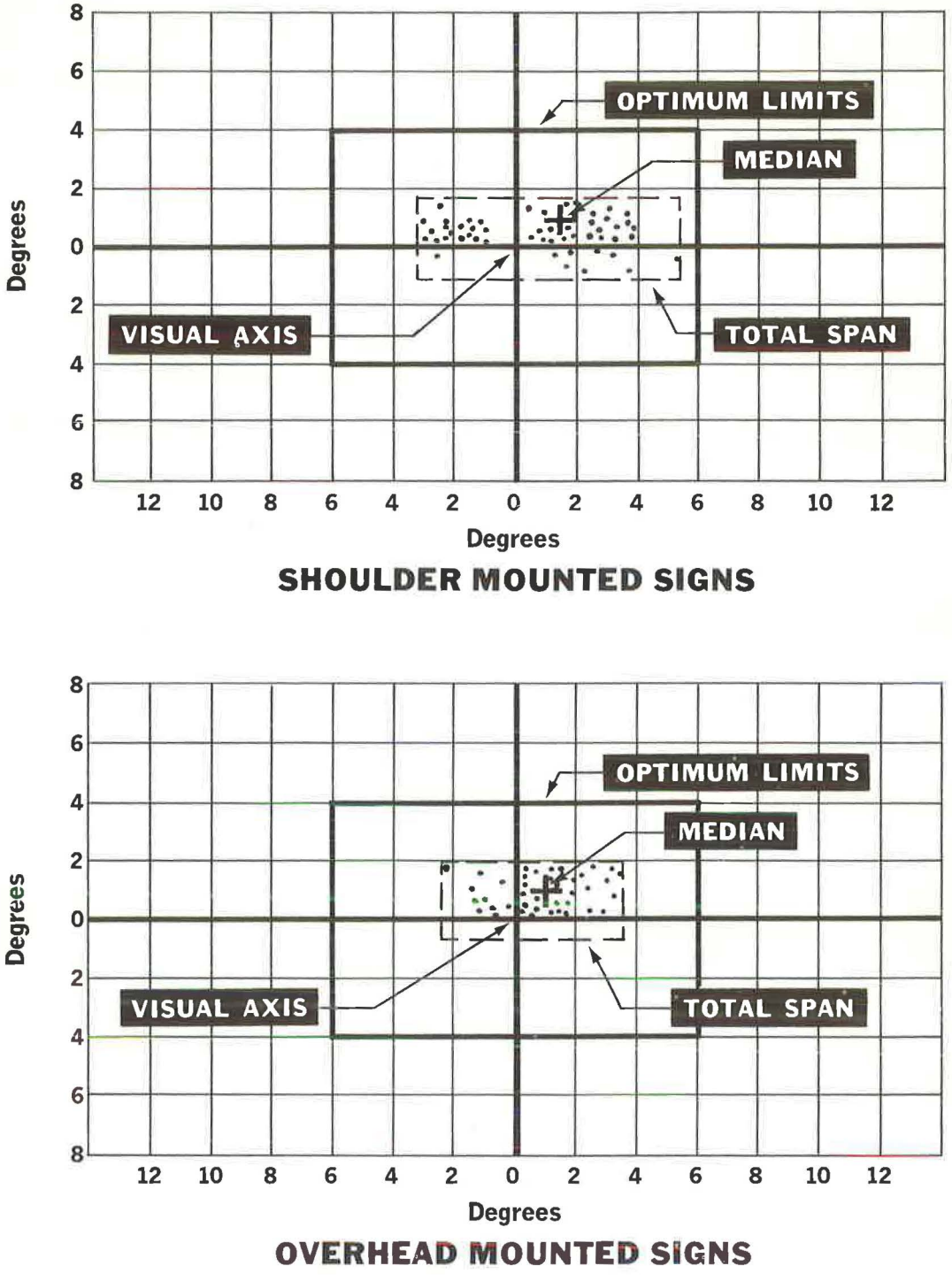
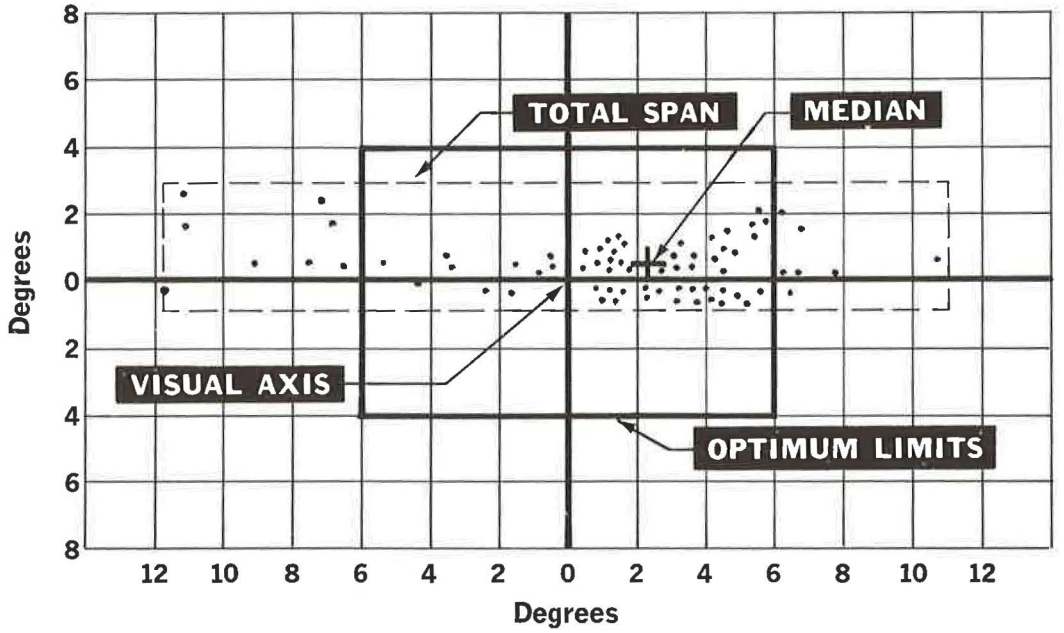
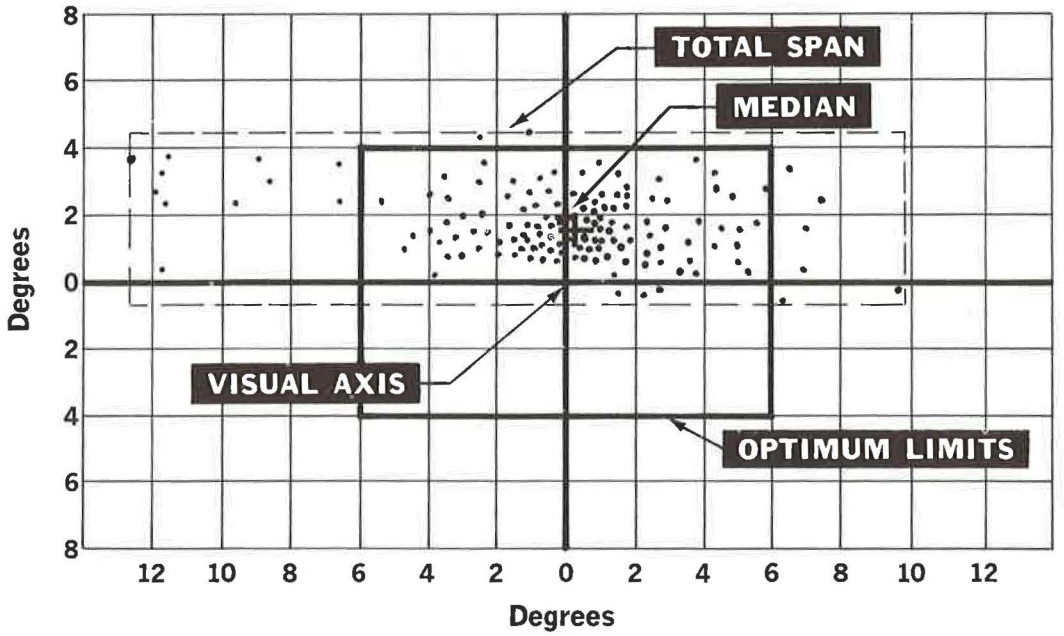


Figure 4. Angular position of traffic signs—flat area.

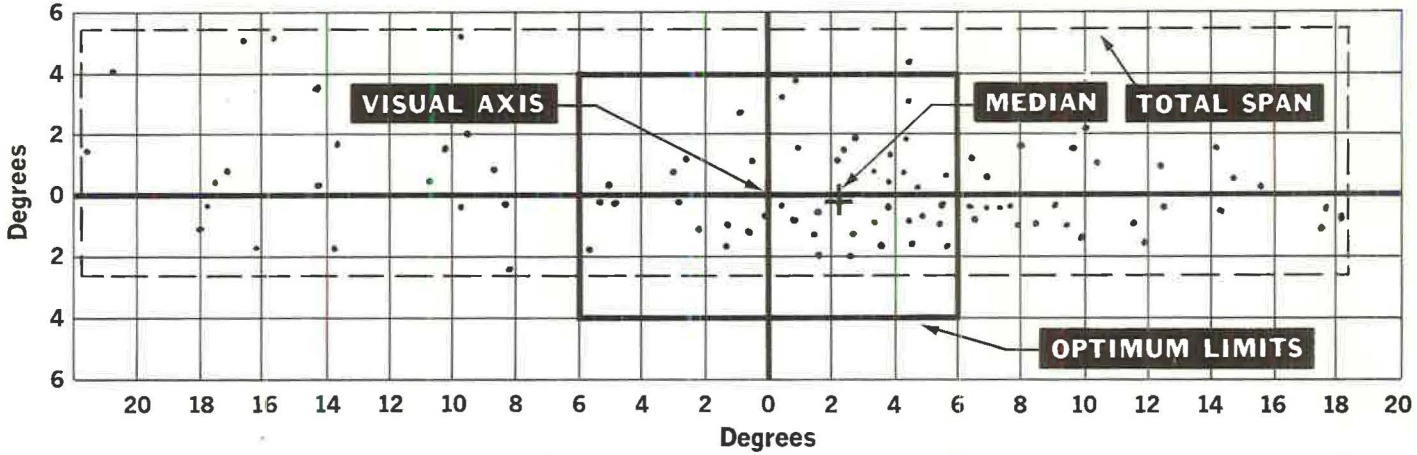


SHOULDER MOUNTED SIGNS



OVERHEAD MOUNTED SIGNS

Figure 5. Angular position of traffic signs—metropolitan area.



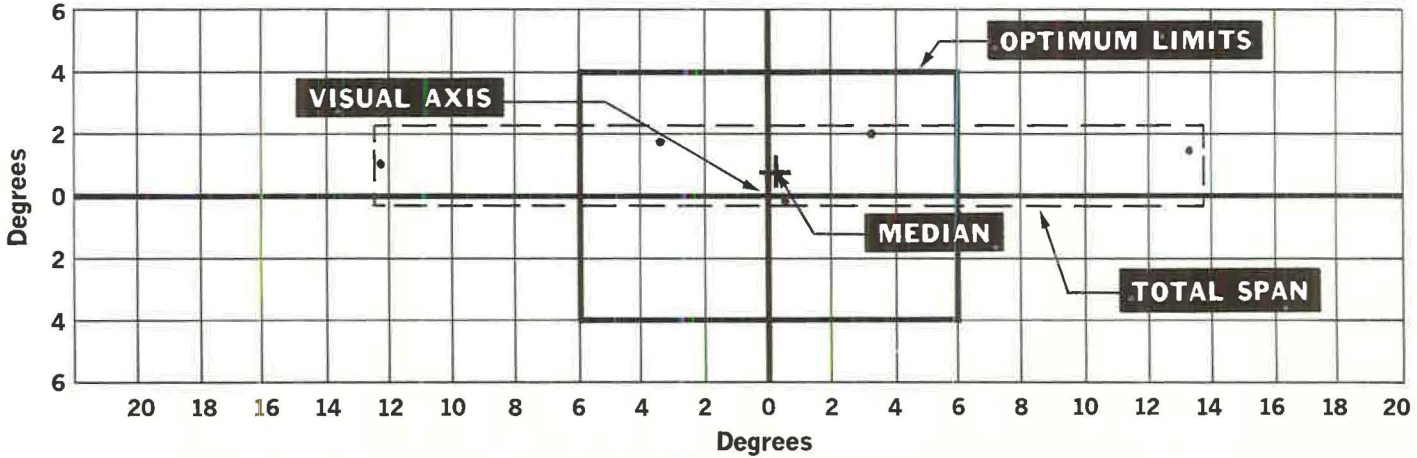


Figure 6. Angular position of traffic signs—mountainous area.

TABLE 10

SIGNS HAVING GREATER THAN OPTIMUM ANGULAR DISPLACEMENT[a]

Area Description	Sign Installation	Percent Having Greater Than Optimum Displacement[a]
Mountainous	Shoulder	53
Mountainous	Overhead	29
Metropolitan	Shoulder	16
Metropolitan	Overhead	10
Flat terrain	Shoulder	0
Flat terrain	Overhead	0
Gently rolling	Shoulder	37
Gently rolling	Overhead	27

[a]Optimum angular displacement is within 4 deg vertical and 6 deg horizontal from the visual axis.

The shoulder-mounted distributions in Figures 3 and 4 exhibit two distinct patterns. A fairly large number of signs were installed in the median area to the left of the motorist, thus explaining the concentration to the left of the visual axis in the distributions.

SUMMARY AND CONCLUSIONS

The ability of a sign to compel a motorist's attention in the daytime is related to the background with which it must compete. The first phase of this study determined the nature and frequency of existing sign backgrounds for representative areas. The results revealed that the most frequent background against which a sign appears is dark trees, occurring 23. 1 percent of the time. A sky background and a bridge background were the next most frequent with 19. 1 and 15. 8 percent respectively. Overhead signs had a somewhat higher incidence of sky backgrounds than shoulder-mounted signs, which were predominantly seen against a dark tree background.

References cited suggest limits for maximum angular displacement of signs relative to the driver's visual axis. The second phase of this study consisted of determining angular position of existing signs and comparing data obtained with the suggested limits specified. In areas where the terrain is flat, sign position falls well within the suggested limits. In metropolitan areas and in gently rolling terrain, the percentage of signs having greater than optimum angular displacement ranges from 10 to 37 percent. The mountainous area is most severe, with 53 percent of the shoulder-mounted signs falling outside the optimum range.

The results of this study provide basic information on the nature and frequency of traffic sign backgrounds and establish the need for improved sign positioning if angular position relative to the driver's visual axis is to be optimum. The information should be of interest in the design and placement of traffic signs for maximum effectiveness and attention value.

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