FLASHING ARROW-BAR TRAFFIC CONTROL SIGNS
A Report of Comparison Testing

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ABSTRACT: Flashing arrow-bar traffic control signs fabricated by the Research Laboratory and Traffic Divisions and three models from a commercial producer were visually evaluated. Signs generally could be recognized farther away during daylight than at night. Results generally showed that any unit tested would be effective for traffic control. Maintenance and cost factors affecting selection among the signs are discussed. Suggestions for further research are also given.

KEY WORDS: arrow, traffic control; flashing arrow; flashing sign; traffic control devices; traffic sign visibility; night visibility; sequencing.

FLASHING ARROW-BAR TRAFFIC CONTROL SIGNS
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On August 4, 1966, after meeting with representatives of the Office of Construction, Maintenance, and the Traffic Division, R. L. Greenman requested tests to compare the relative effectiveness of flashing arrow-bar traffic control signs of a type currently being used by the Research Laboratory with a sign proposed by the Traffic Division. Subsequently, on August 24, the R. E. Dietz Company of Syracuse, New York, requested that it be permitted to submit three flashing arrow signs for inclusion in the test. After fabrication of the Traffic Division's sign and completion of arrangements with the Dietz Company, tests were conducted on October 12, 1966.

Test Procedure

Signs evaluated are listed in Table 1. Each of the five could simultaneously flash as a right, left, or double-headed arrow, or as a bar. Further, the lights in the Dietz signs could be flashed sequentially from left to right, right to left, or from the center outward both left and right. Thus, by including the sequential mode of the Dietz signs, there were actually eight signs to be compared.

The signs were placed on the M 66 bridge over the westbound roadway of I 96. The Laboratory's sign was mounted as normally used atop a station wagon and the Traffic Division's sign in a temporary mount on a pickup truck. A trailer was provided to support the three Dietz signs, only one being mounted for operation at any time. All signs faced westbound I 96 traffic as shown in Figure 1.

Tests were conducted by transporting observers toward the signs at a speed of about 50 mph and recording the distance at which a particular

sign message was clearly identified. Only one sign was operated during each test run.

The order for displaying the signs and selected symbols was randomized as much as practical to facilitate statistical analysis. In addition to the conventional arrow and bar signals, meaningless symbols were occasionally displayed to discourage guessing by observers. Tests were conducted during daylight hours and also after dark. Observers participating in the tests included:

P. A. Nordgren, Office of Construction
R. E. Addy, Maintenance Division
P. H. DeCamp, Maintenance Division
A. A. Foster, Safety Section
C. B. Redner, Office of Testing and Research.

TABLE 1
TESTED FLASHING ARROW-BAR WARNING SIGNS

Sign	Voltage	Description of Light Source	Bulb	Mounting Board Size
1. Laboratory vehicle-mounted	12	13 lights (5-in. yellow sealed-beam auto fog lights)	4412 A PAR 46	3' x 5' 4"
2. Traffic Division	110	13 lights (8-in. traffic signal heads with yellow diffusing lenses)	100 watt	5' x 8'
3. Dietz trailer-mounted	12	15 lights (5-in. yellow sealed-beam auto fog lights)	4412 A PAR 46	4' x 8'
4. Dietz vehicle-mounted	12	13 lights (5-in. yellow sealed-beam auto fog lights)	4412 A PAR 46	3' x 5' 4"
5. Dietz 276 trailer-mounted	12	15 lights (No. 276 Dietz turn-signal lamps)	#1156 32-cp bulb	4' x 8'

Figure 1 (above). Position of signs during evaluation, including (from left) Laboratory, Traffic, and Dietz.

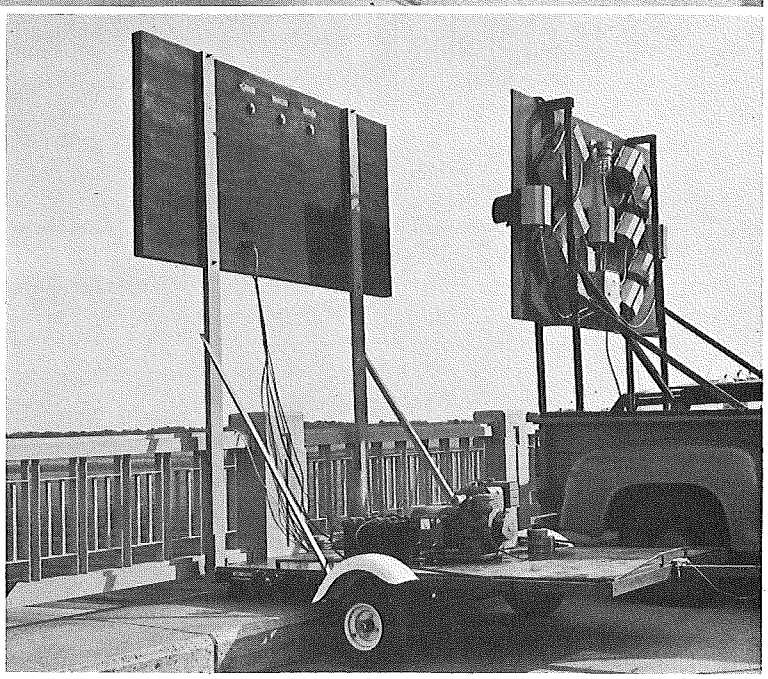

Figure 2 (right). Note difference in bulk between Dietz trailer-mounted sign (left) and Traffic Division sign.

Test Results

Table 2 lists the order and results for both day and night testing. The preceding list of observers is not necessarily in the same order shown in Table 2. In late afternoon the sky suddenly became heavily overcast, significantly changing the ambient daylight conditions. Consequently, day tests were suspended before testing of the Dietz vehicle-mounted sign, and before completion of all planned tests on the Traffic and Laboratory signs. Test results indicate, however, that significant rankings can be determined with the data obtained. Signs are ranked for each observer with the sign mode identified farthest away being ranked 1 and the sign mode resolved closest having the highest numerical rank.

Data from the meaningless forms were not included in computing final rankings. These meaningless signals did show that some observers occasionally guessed the identities of messages rather than waiting until a mode could be positively identified.

A statistical analysis of sign ranks showed a highly significant degree of agreement between observers. Therefore, the signs were rated by using the average sums of ranks for all modes tested on each sign. The final rankings are as follows:

Day	Night
1. Dietz Trailer (sequential)	Dietz 276 (sequential)
2. Dietz Trailer	Dietz Trailer
3. Dietz 276	Dietz Trailer (sequential)
4. Dietz 276 (sequential)	Traffic
5. Traffic / Laboratory	Dietz 276
6. --	Dietz Vehicle (sequential)
7. --	Laboratory
8. --	Dietz Vehicle

TABLE 2
SUMMARY OF TEST RESULTS

	Test Run	Sign	Mode	Recognition of Sign Message										Sum of Ranks
				Observer A		Observer B		Observer C		Observer D		Observer E		
				Distance, miles	Rank	Distance, miles	Rank	Distance, miles	Rank	Distance, miles	Rank	Distance, miles	Rank	
Day Test	1	Laboratory	→	0.539	8	0.735	8	0.729	10	0.896	8	0.730	9	43
	2	Dietz Trailer	→ (a)	0.713	3	0.839	6	0.968	7	0.819 (d)	10	1.150 (d)	1	27
	3	Laboratory Dummy	> (b)	0.274	11	0.283	11	0.277	11	0.465 (d)	11	0.431 (d)	11	55
	4	Dietz Trailer	→	0.840	1	1.124	1	1.095	3	1.383	1	1.140	2	8
	5	Dietz Trailer	←	0.766	2	0.945	3	1.133	2	1.020	4	1.033	6	17
	6	Traffic	—	0.635	4	0.711	9	1.012	5	0.860	9	0.440	10	37
	7	Dietz 276	→ (b)	0.433	10	0.694	10	0.918	9	0.978	5	1.058	5	39
	8	Dietz 276	→	0.576	7	0.760	7	0.943	8	1.030	3	1.103 (d)	4	29
	9	Dietz 276	←	0.595	5	0.877	5	1.156	1	1.150	2	0.955 (d)	7	20
	10	Laboratory	—	0.440	9	0.883	4	0.974	6	0.925	7	1.113	3	29
	11	Dietz 276	—	0.590	6	1.019	2	1.091	4	0.939	6	0.944	8	26
Night Test	1	Laboratory Dummy	> (a)	0.275	13	0.205 (d)	16	0.344 (d)	16	0.262 (d)	16	0.449 (d)	15	76
	2	Dietz Vehicle	—	0.335	7	0.418	8	0.426	13	0.312	12	0.173	17	57
	3	Traffic	→	0.270	14	0.472	5	0.851	2	0.625	1	0.224	16	38
	4	Traffic	←	0.330	8	0.433	7	0.858	1	0.500	5	1.007	2	23
	5	Dietz Vehicle	→ (b)	0.239	17	0.274	14	0.595	9	0.304	13	0.640	10	63
	6	Dietz Vehicle	← (c)	0.295	10	0.340	13	0.526	11	0.355	9	0.645	9	52
	7	Dietz Vehicle	← (a)	0.280	11	0.397	9	0.425 (d)	14	0.264 (d)	15	0.619 (d)	12	61
	8	Traffic	→ (a)	0.265	16	0.370	11	0.201 (d)	17	0.332 (d)	11	0.720 (d)	6	61
	9	Dietz 276	→	0.266	15	0.264	15	0.413	15	0.346	10	0.608 (d)	14	69
	10	Dietz 276	←	0.418	2	0.385	10	0.606	7	0.407	8	0.712	7	34
	11	Laboratory	←	0.315	9	0.370	11	0.488	12	0.259	17	0.637	11	60
	12	Dietz 276	→ (b)	0.340	5	0.593	1	0.597	8	0.449	7	0.678	8	29
	13	Dietz 276	→	0.340	5	0.446	6	0.767	3	0.600	2	0.949	3	19
	14	Laboratory	→	0.276	12	0.200	17	0.533	10	0.304	13	1.129	1	53
	15	Dietz Trailer	→	0.352	4	0.521	3	0.673	6	0.463	6	0.858	4	23
	16	Dietz Trailer	← (b)	0.426	1	0.515	4	0.693	5	0.578	3	0.772	5	18
	17	Dietz Trailer	←	0.363	3	0.527	2	0.717	4	0.572	4	0.613	13	26

(a) Meaningless signal.
(b) Sequential.
(c) Meaningless signal sequencing left to right.
(d) Distance at which sign was correctly identified, after initial incorrect identification at greater distance.

From these rankings, it appears that the best sign for both day and night use is the Dietz trailer-mounted. Although the Dietz 276 (sequential) was the best sign at night, it ranked significantly lower during the day.

Similar modes were compared for each of the three Dietz signs to determine whether sequencing lights were of any general benefit. A statistical analysis of Table 3 data shows sequencing to be of general value during daylight, and it appeared to improve the Dietz 276 sign after dark, although it had no apparent good or bad effect on the other two.

TABLE 3
COMPARISON OF DISTANCE OF RESOLUTION OF SIMILAR MODES FOR DIETZ FLASHING ARROW SIGNS

	Sequential Best	Flashing Best	Total Tests
Daytime	9	1	10
Nighttime	7	7	15*

*One test showed no difference.

Signs generally could be recognized farther away during daylight than after dark. They were recognized during daylight at an average of about 1.7 times the night recognition distances.

Discussion

Field experience of Research and Maintenance personnel has shown the Laboratory's vehicle-mounted flashing arrow sign to be very effective in controlling high-speed traffic. Since almost every sign tested had distances of resolution equalling or exceeding the Laboratory's sign, it appears that any unit selected would be effective for traffic control. However, in addition to distance of resolution, maintenance and cost factors should be considered in selecting the best sign for field use. The Dietz signs and

the Laboratory's sign were relatively lightweight, and even the Dietz trailer-mounted (4 by 8 ft) sign was easily and rapidly trailer mounted and dismounted by two men. If a tilt-up mechanism now being developed is completed, any of the 12-volt signs could be easily set up by one man, as is currently done with the Laboratory's sign. Six men were required to mount Traffic's 110-volt sign and four men to dismount it. Figure 2 shows a comparison of the bulk of Traffic's sign with the Dietz traffic-mounted sign.

Another consideration in selecting the most practical sign would be the convenience of obtaining replacement parts in the field. Automobile sealed-beam fog lights, used in the Laboratory's sign and the Dietz trailer-mounted and vehicle-mounted signs, can be purchased at any auto parts store. Parts for the heads used in Traffic's sign are relatively uncommon and difficult to obtain in the field. The lenses used in the Dietz 276 sign are apparently obtainable only from Dietz or its representatives.

When used on construction sites, heavy dust accumulations on the lights must be frequently removed. Sealed-beam lights can be dusted by merely wiping off the face of the unit. The heads used on Traffic's sign are known to "breathe" and thus must be disassembled; both the inside and outside of the lens must be dusted, as well as the bulb and reflector. Further, the 12-volt units can be operated in emergency on batteries, which is virtually impossible with the 110-volt units.

On the basis of distance of resolution, together with ease of handling and convenience of maintenance, it appears that the Dietz trailer-mounted sign should be selected for most uses. However, where it is important to have a sign that can be easily transported and set up for use atop an automobile, Maintenance and Research Laboratory field experience has shown the Laboratory's sign to be effective for controlling high-speed traffic.

Additional Research

Although an effective arrow-bar traffic control sign can be selected on the basis of the preceding discussion, answers to a number of questions that developed during comparison testing might lead to significant improvements in performance of this type of sign. These questions, which might be researched by the Spectroscopy and Photometry Section, include the following:

1. What are the optimum flash rate and dwell time for the flashers?

2. Lights of what color are most effective? (During the field tests, it appeared that darker-colored lights were easier to resolve at night.)

3. What night sign brightness is most effective? (Although the brightest lights might attract a driver's attention first, messages on any sign were more readily resolved when relatively dim lights were used. This suggests that a compromise must be developed between maximum attention and maximum resolution.)

4. Should different night sign brightnesses be used according to varying ambient light conditions? (A brighter light might be required in urban areas having higher ambient light levels than in rural areas.)

5. What is the optimum angle of light diffusion? (Although very narrow beams project farther, signs must also be used on hills and curves where a wide diffusion is necessary.)

6. What limiting distance of resolution is required for traffic control signs?