decreased considerably during the flashing operation, they are far from complying with the posted speed of "25 mph when children are present." However, this study indicates that the average speeds were reduced from a high of 38 mph to 31 mph, which is substantially closer to the goal of 25 mph.

The authors suggest that additional studies be conducted regarding the impacts of advance school flashers on the average speeds in school zones. If nothing more, flashers at least serve the purpose of warning drivers about the unusual traffic conditions on the roadway and in the present study, the average driver has reduced speed, which clearly supports the findings of this study.

Acknowledgments

The authors wish to express their gratitude to Mr. Dale Pfeiffer, director of Public Works, for his encouragement during the preparation of this article. Sincere thanks also are due to the staff of Traffic Engineering Division for their assistance in collecting field data.

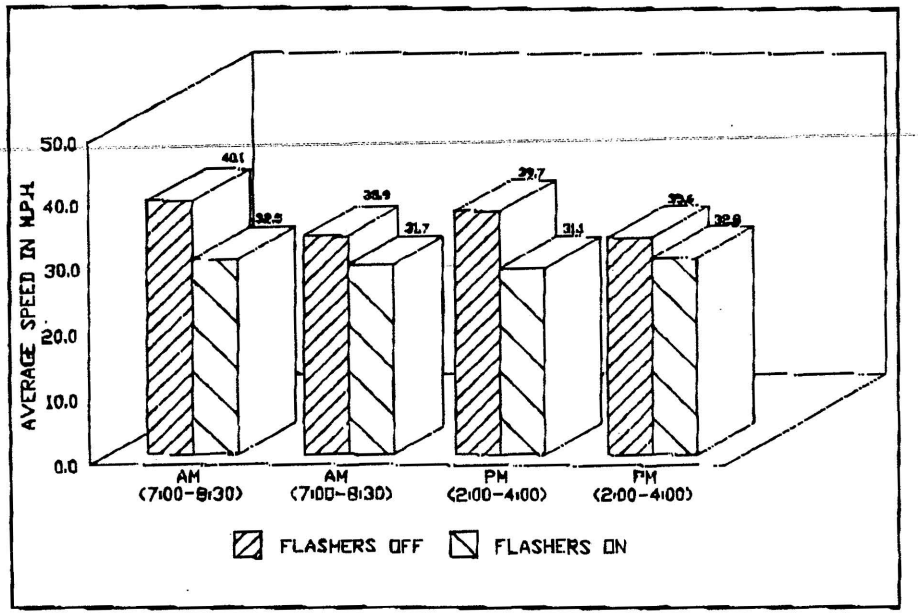


Figure 4. Average speed for southbound traffic.

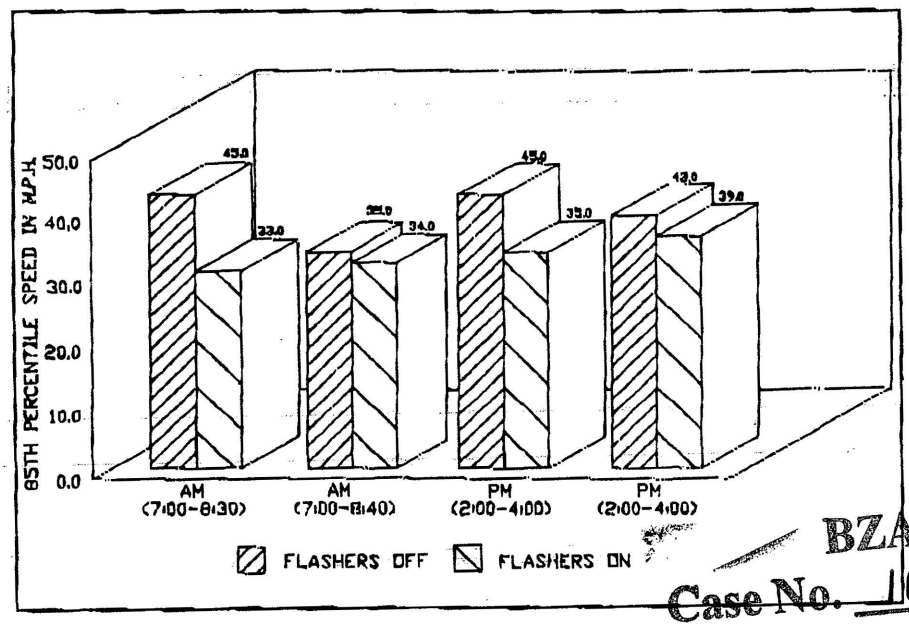
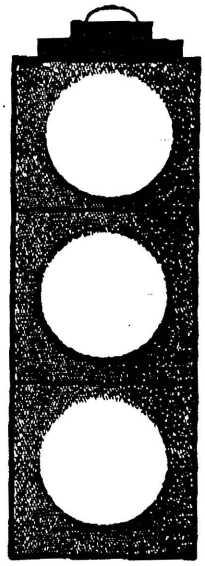


Figure 5. 85th percentile speed for northbound traffic.



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preparing exhibits and typing the manuscript.

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1. Burritt, B.E., R.C. Buchanan and E.I. Kalivoda. "School Zone Flashers—Do They Really Slow Traffic?" *ITE Journal* 60 (January 1990): 29–31.

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Table 1. Speed Studies (Northbound Traffic)

Study #	Day, Date & Time of Study	Flashers Off		Study #	Day, Date & Time of Study	Flashers On		Standard Deviation of the Difference in Means 6d	Absolute Difference in Value |d|	Remarks |d|>2x6d
		Mean Speed ü	Standard Error of Mean			Mean Speed ü	Standard Error of Mean			
I	Tuesday, March 3, 1992 7-7:45 a.m.	40.6 mph	0.6 mph	II	Tuesday, March 3, 1992 7:45-8:30 a.m.	28.1 mph	.5 mph	.7	12.5	Significant
III*	Wednesday, April 15, 1992 7-7:45 a.m.	30.4 mph	0.6 mph	IV	Wednesday, April 15, 1992 7:45-8:40 a.m.	30.7 mph	.5 mph	.8	.3	Insignificant
V	Tuesday, March 3, 1992 2-3 p.m.	40.2 mph	0.6 mph	VI	Tuesday, March 3, 1992 3-4 p.m.	30.3 mph	.5 mph	.8	10.0	Significant
VII	Wednesday, March 4, 1992 2-3 p.m.	40.6 mph	0.5 mph	VIII	Wednesday, March 4, 1992 3-4 p.m.	34.0 mph	.7 mph	.8	6.6	Significant

*This observation for Study III may be ignored because of bad weather conditions.

Table 2. Speed Studies (Southbound Traffic)

Study #	Day, Date & Time of Study	Flashers Off		Study #	Day, Date & Time of Study	Flashers On		Standard Deviation of the Difference in Means 6d	Absolute Difference in Value |d|	Remarks |d|>2x6d
		Mean Speed ü	Standard Error of Mean			Mean Speed ü	Standard Error of Mean			
IX	Tuesday, March 24, 1992 7-7:45 a.m.	40.1 mph	.5 mph	X	Tuesday, March 24, 1992 7:45-8:30 a.m.	32.5 mph	0.7 mph	.9	7.6	Significant
XI	Wednesday, March 4, 1992 7-7:45 a.m.	35.9 mph	.5 mph	XII	Wednesday, March 4, 1992 7:45-8:40 a.m.	31.7 mph	0.6 mph	.7	4.2	Significant
XIII	Tuesday, March 24, 1992 2-3 p.m.	39.7 mph	.6 mph	XIV	Tuesday, March 3, 1992 3-4 p.m.	31.1 mph	0.5 mph	.8	8.6	Significant
XV	Wednesday, April 15, 1992 2-3 p.m.	35.6 mph	.5 mph	XVI	Wednesday, April 15, 1992 3-4 p.m.	32.8 mph	0.6 mph	.8	2.8	Significant

Appendix

Average mean of speed:

$$\ddot{u} = \frac{\Sigma f_n \cdot u_n}{N}$$

where,
$\ddot{u}$ = mean or average speed
f_n = number of observations
u_n = speed
N = total number of vehicles observed
Standard Deviation:

$$\sigma = \sqrt{\frac{\Sigma f_n \cdot (u_n)^2}{N-1} - \left(\frac{\Sigma f_n \cdot u_n}{N}\right)^2}$$

where,
σ = standard deviation
Standard Error of Mean:

$$\sigma_{\ddot{u}} = \sqrt{\frac{\sigma^2}{N}}$$

where,
$\sigma_{\ddot{u}}$ = standard error of the sample mean
If, σ_d is the standard deviation of the difference in means,

$$\sigma_d = \sigma_{\ddot{u}1}^2 + \sigma_{\ddot{u}2}^2$$

where,
$\sigma_{\ddot{u}1}^2$ = variance of the mean for Study 1
where,
$\sigma_{\ddot{u}2}^2$ = variance of the mean for Study 2

If the absolute of the difference in sample mean speeds is greater than twice the standard deviation of the difference in mean, that is, if

$$| d = \ddot{u}_1 - \ddot{u}_2 | > 2\sigma_d$$

where,
$\ddot{u}_1$ = mean speed of Study 1
where,
$\ddot{u}_2$ = mean speed of Study 2 ∎



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Tables 3 and 4 are shown on page 30

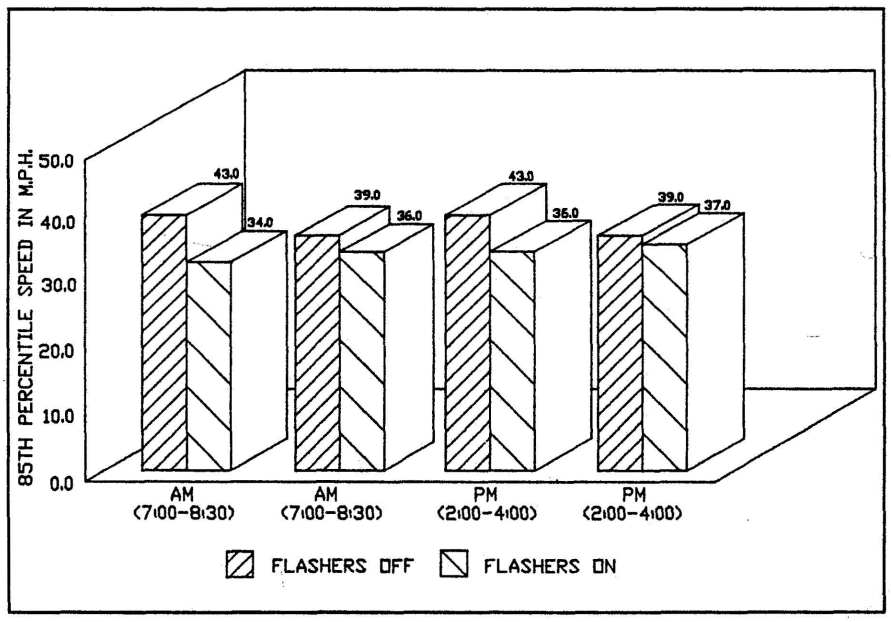
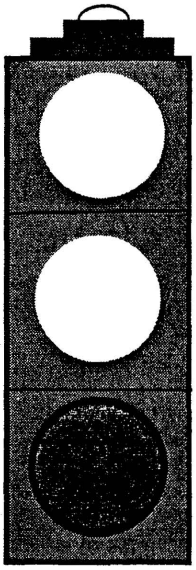


Figure 6. 85th percentile speed for southbound traffic.



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School Zone Flashers— Do They Really Slow Traffic?

BY BENJAMIN E. BURRITT, RICHARD C. BUCHANAN, AND ERIC I. KALIVODA

School crossing controls in Arizona are among the most restrictive in the nation. At official Arizona school crossings, a temporary speed limit of 15 miles per hour (mph) is imposed on motorists by portable signs that are placed in the roadway during approved school hours (see Figure 1). The undisputed success of Arizona's school crossing program over the past 30 years is largely attributable to the restrictive controls and their rigorous enforcement by police agencies throughout the state.

Flashing beacons, or flashers as they are commonly known, are not a part of the official control plan for Arizona's school crossings. However, school jurisdictions often request that flashers be installed to augment the already stringent controls. Over the years, the Traffic Engineering Section of the Arizona Department of Transportation (ADOT) has aggressively fended off such requests to use flashers on state highway system crossings. Their position is based on the fact that when flashers are installed in locations where they are not warranted, they soon lose much, if not all, of their effectiveness. More important, improper usage greatly reduces the effectiveness of other flashers installed in areas where there is a real, demonstrated need.

The case history that follows began with a request in 1986 for the installation of flashers at two existing school crossings on a state highway within the city limits of Tucson. Flashers have become standard installations at school crossings on arterial streets within Tucson. However, flashers had never before been installed at school crossings on state highways within Arizona—regardless of the political jurisdiction.

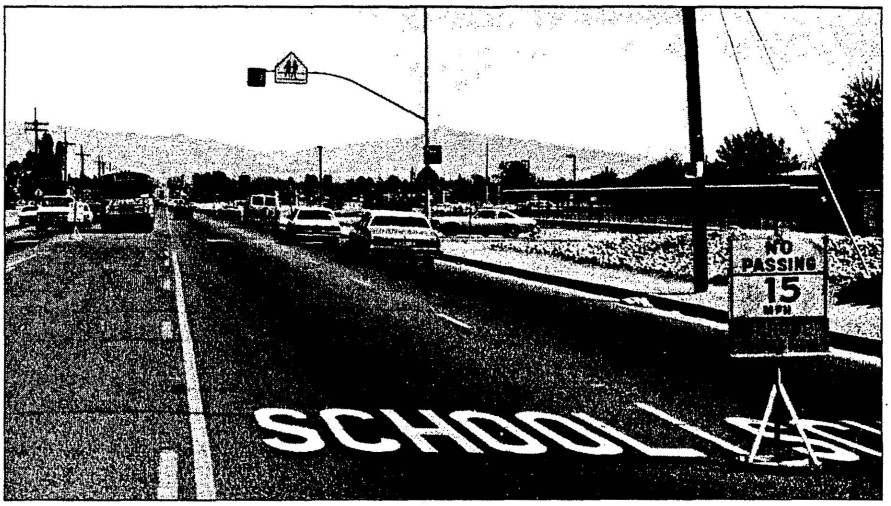


Figure 1. A portable sign indicating a temporary 15-mph speed limit is placed in the roadway as part of the school crossing program in Arizona.

The request led to a comprehensive study by ADOT in January 1987, which resulted in a recommendation that flashers not be installed.[1] Despite the study findings, the flashers were installed and became operational in April 1987. During the one month remaining in the school year after the flashers were activated, ADOT undertook an evaluation to determine the flashers' effects on traffic speeds.

Evaluation

The evaluation was based on the analysis of speed samples collected before and after the installation of flashers. Speeds were sampled at each school crosswalk during the last week of May 1987. These samples were compared with similar size samples collected during December 1986, before the flashers were installed.

Vehicular speeds were first sampled during non-school hours, when the standard Arizona school crossing traffic controls were not in place. These samples were collected for comparison with before period samples to determine whether base conditions, i.e., operating speeds, had changed. The results are presented in Table 1.

The data in Table 1 clearly indicate that operating speeds had not changed significantly since December 1986. This fact established that no significant

Table 1. Average Speeds (mph)—Non-School Hours

School	Speed Limit	Before Installation: Average Speed	Before Installation: Sample Size	After Installation: Average Speed	After Installation: Sample Size	Difference	Significant Change[a]
Mary Lynn	45	40.10	226	40.75	228	+0.65	No
Hollinger	35	33.60	238	33.71	220	+0.11	No

Installation = Installation of Flashers. [a]95% Confidence Level, Student's *t*-Test

Table 2. Average Speeds (mph)—School Hours

School	Speed Limit	Before Installation: Average Speed	Before Installation: Sample Size	After Installation: Average Speed	After Installation: Sample Size	Difference	Significant Change[a]
Mary Lynn	15	16.13	207	20.33	208	+4.20	Yes
Hollinger	15	14.86	299	16.71	198	+1.85	Yes

Installation = Installation of Flashers. [a]95% Confidence Level, Student's *t*-test

Table 3. Violation Rates—Non-School Hours

School	Speed Limit	Before Installation (%)	After Installation (%)	Significant Change[a]
Mary Lynn	45	13.3	15.8	No
Hollinger	35	33.6	36.8	No

Installation = Installation of Flashers. [a]95% Confidence Level, Student's *t*-test.

Table 4. Violation Rates—School Hours

School	Speed Limit	Before Installation (%)	After Installation (%)	Significant Change[a]
Mary Lynn	15	57.0	78.4	Yes
Hollinger	15	39.1	54.0	Yes

Installation = Installation of Flashers. [a]95% Confidence Level, Student's *t*-test.

changes in base conditions had occurred. The only change in conditions was the addition of flashing beacons, which are operational only during school crossing periods. Therefore, any significant change in traffic speeds during school periods could be directly attributable to the flashers. A two-tailed *t*-test was used in the evaluation. The *t*-test was employed because it is particularly well suited to large sample sizes where the data are approximately normally distributed.

Vehicular speeds were next sampled during school hours, when the school crossing traffic controls were in place. These samples were collected for comparison with period samples taken prior to the use of the flashers to determine the effects of the flashers on traffic speeds. The results are presented in Table 2.

The data show that a significant increase in operating speeds occurred *after* the flashing beacons were added to the standard school crossing controls.

Violation rates (the percentage of all vehicles traveling above 15 mph) for the after period were computed and compared with the before period violation rates. A comparison of the violation rates during the non-school hours is presented for both the before and after periods in Table 3.

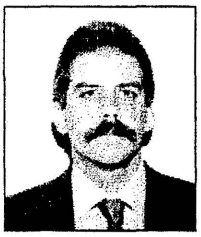
The data in Table 3 indicate that the violation rates in the before and after periods were quite similar. The rates changed less than 4 percent, and the changes were not statistically significant at the 95 percent confidence level.



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Violation rates during school hours for the after period were also computed. A comparison between the before and after violation rates is presented in Table 4.

The results of this analysis clearly show that a statistically significant increase in the violation rate occurred *after* the flashing beacons were installed.

Conclusion

From this analysis, it is concluded that flashing beacons at school crossings in Tucson, Arizona, fail to reduce vehicle speeds and the number of violations of the 15-mph speed limit. On the contrary, it is apparent that, when flashing beacons are used, operating speeds and the number of violations increase significantly. While the driver psychology behind this documented phenomenon can only be hypothesized, the study indicates that there is a 95 percent probability that the changes are not due to random variation. Any device that causes such a pronounced disregard for the standard Arizona school crossing controls certainly cannot be viewed as an enhancement to pedestrian safety at schools.

Reference

1. Arizona Department of Transportation. *Traffic Engineering Study—State Route 86 (Ajo Way), Mary Lynn and Hollinger Schools*. Phoenix, Ariz.: ADOT, 1987. ▮

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