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SEVEN EXPERIMENT DESIGNS ADDRESSING PROBLEMS OF SAFETY AND CAPACITY ON TWO-LANE RURAL HIGHWAYS
Volume VI: Experimental Design for Comparative Evaluation of Warning-Advisory and Regulatory Traffic Control Devices

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FINAL REPORT

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16. Abstract This is Volume VI. The overuse of regulatory type signing on highways has been found to cause motorists to ignore all signing. In this experimental design, advisory-warning signs, regulatory signs and a combination of the two types will be tested in four experiments. The first experiment will compare curve signing; the second, intersection signing; the third, no passing zone signing; and fourth, signs for steep downgrades. A state-of-the-art survey and bibliography are included. A questionnaire for use in the no passing zone and downgrade experiments is appended. This Technical Report consists of seven other volumes. They are:

Vol.	pp.	Title
I	38	Introduction, Description of Experiments and Common Elements
II	70	Develop and Evaluate Dynamic Aids for Narrow Bridges
III	72	Evaluation of MUTCD and Other Traffic Controls for Highway Construction and Maintenance Operations on Two-Lane Highways
IV	58	Develop and Evaluate Remedial Aids to Warn Drivers of Slow Moving Vehicles on a Grade
V	62	Vehicle Equivalency and Capacity Including Effects on Commercial and Recreational Vehicles on Rural Non-Controlled Access Highways
VII	50	Develop and Evaluate Measures for Reducing Effects of Roadside Friction
VIII	70	Remedial Aids for Intersections with Inadequate Sight Distance

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1. INTRODUCTION

This report contains the Experimental Design entitled "Comparative Evaluation of Warning-Advisory and Regulatory Traffic Control Devices."* This is Volume VI of an eight-volume report. Volume I contains background information and a discussion of those elements common to each of the seven experimental designs.

This volume includes:

- Background and Objectives,
- A State-of-the-Art Review,
- The Experimental Design,
- A Bibliography.

1.1 Background

The present experimental design was developed in response to a detailed problem statement which stated:

> "There appears to be a lack of specific guidelines for the proper use of regulatory and warning-advisory signs and a wide variation in the application of these two types of traffic control devices. At locations where enforcement is difficult and/or no legal requirements exist, warning-advisory signs may be more effective devices. Drivers may regard warning-advisory signs with greater respect than mandatory regulatory signing. Combinations of the two types to warn of the potential hazards and to spell out the regulations may or may not be more effective in some situations. There is a need to determine the relative effectiveness of these signs for specific locations and to improve upon the guidelines for their use."

1.2 Objective of Experiment

The objective of this Experiment is to determine the relative merit of warning-advisory and regulatory signing used individually or in combination for speed zones, intersections, and other problem locations on two-lane rural highways. The signing treatments that will be tested for each problem location are mixtures of different signing systems. These systems emerged from a thorough literature search and state-of-the-art

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*This report is referred to as Experiment E in Volume I.

2. STATE-OF-THE-ART

A summary of the State of the Art is presented below. In addition to the specific area of the research problem and pertinent aspects, the following topics are also addressed:

- General Aspects of Signs;
- Symbols versus Words;
- Regulatory Signs;
- Warning-Advisory Signs;
- Other Control Measures.

2.1 General Aspects of Signs

The United States standards for highway signing are contained in the Manual of Uniform Traffic Control Devices (MUTCD) (33). The most recent issue of the MUTCD was issued in 1971. The MUTCD states:

> "The basic requirements of a highway sign are that it be legible to those using it and that it be understood in time to permit proper response."

At the present time, U.S. signing is a composite of the old U.S. word message signing and of the international symbol signs that are used abroad (14). Both systems rely on color and shape to transmit to the motorist the primary intent of the sign, i.e., guide, regulatory, warning. The message, symbol, or both on the sign then informs the motorist of the specific purpose of the sign.

The U.S. system uses a rectangle, ordinarily with the long dimension vertical, color black on white, to define most regulatory signs. A diamond shaped sign, black on yellow, is prescribed for warning signs. A general comparison of the U.S. and European signing is given in Table 1. There are exceptions to each class. For instance, U.S. stop signs are white on red.

One of the greatest differences between the two systems lies in the use of both abstract and pictorial symbolism in the International system. The United States system is still primarily verbal although a number of the more easily recognized pictorial symbols have been adopted. These may be shown with or without a word message plaque beneath. The MUTCD encourages the adoption of symbols in preference to word message signs as a step toward safety and facilitation of traffic.

Widespread use of symbol signs has led to the emergence of many symbolic messages and a number of variations of specific messages. Some systems (U.S., European, etc.) use regulatory signs that prohibit action (symbol inside a red ring with a red diagonal slash through symbol). The Canadian system includes permissive (symbol surrounded by green ring) signs which are used primarily for turn controls to indicate permitted movements.

A common error in interpreting the diagonal slash prohibitive sign is reversal. Brainard et al. (4) found that this code was often misinterpreted by U.S. subjects, unaccustomed to this type of sign, as permitting an action rather than prohibiting it. Mackie (31), in a survey of driver knowledge of existing British signs, found that only 8 percent knew that the red ring indicated prohibition. Two symbols using this code (No Passing and End of Divided Highway) produced a sizable number of opposite interpretations.

There has not been much research in the permissive-prohibitive aspects of traffic signs. Dewar and Swanson (12) compared four turn message signs (No Right Turn, No Left Turn, No U-Turn and No Turns) presented as word alone, symbol alone, and symbols with words. Slides of the signs were shown by means of tachistoscopic projection at various speeds. The results showed that the permissive turn restriction was more easily recognized than either the prohibitive symbol or words alone. A field study was also conducted with both permissive and prohibitive No Left Turn signs. Using illegal left turns as a measure, the permissive sign was tentatively shown to be better.

2.2 Symbol versus Words

A number of researchers have examined the effectiveness of symbol signs compared to word signs. Walker et al (53) found evidence that favors the use of symbols over word messages. A tachistoscope was used to project three prohibitive-word signs and their symbol counterparts on the screen. Subjects had been familiarized with the meaning of the symbol signs before the experimentation. Performance was found to be considerably better for the symbols than for the words and retention of the symbol meanings were found to be high.

nized by the use of verbal message plaques beneath a new or unfamiliar symbol sign. As of yet, however, there has been little attempt at mass education of the driving public. Mackie (31, 32) illustrated the need for education in two studies of comprehension of British traffic symbols. The initial study (1966) found recognition poor. The follow-up study (1967) found improvement after public education efforts in various media. The implication of the studies is that the verbal message plaques beneath a symbol sign may not be the most effective method of driving public education.

A more thorough treatment of the above research and other pertinent literature may be found in Dewar (10).

Up to this point, the examined literature has been concerned with the comparisons between word and symbol type signs. Another question is whether drivers can perceive and recognize any type of sign. In Swedish studies (24, 25) conducted in 1966 and 1970, subjects were seated in a car and driven over a roadway. They were asked to press a button when they saw a sign. Under these optimal conditions, 90 percent of the signs were recorded. In another part of the same experiment, drivers were stopped and asked to identify the last sign recognized or remembered. Only 47 percent of the drivers were able to do this. The percentages for different signs are as follows:

Sign	% Remembering
Speed Zone Ahead	78
Police Control Ahead	63
Frost Damaged Road	55
Non-Specific Warning	18
Pedestrian Crossing	17

The authors conclude that the road sign system is not fulfilling its intended or assumed functions. In the 1970 study, the rank ordering of the tested signs did not change. In a comparison study, Summala (51) had subjects drive over 256 km. They were instructed to drive as safely as possible and name all traffic signs along the route. Subjects saw 97 percent of the signs in urban areas and almost 100 percent in rural areas. Summala concludes that earlier results on traffic sign inefficiency was probably primarily due to deficient driver motivation to utilize the signing.

however, showed a correlation with posted advisory speeds. Fast moving vehicles approached a curve with a lower speed when a 30-mph advisory speed sign had been installed.

The computation of an advisory speed limit is dependent on lateral acceleration, approach speed and a variable that describes driver differences. Ritchie (43) gives the formula and results of tests on curves with and without curve and speed warning signs. He found that lateral acceleration was higher in curves with a curve warning sign than without. For advisory speed signs, Ritchie found that below 40 mph, the advisory speed is exceeded and above 40 mph, it is not. For curves with a 15-35 mph advisory speed, the recorded speed was at least two standard deviations faster than the advisory speed. When the advisory speed was 45-50 mph, the record speed was very close to the advisory. Ritchie concludes that in this context the role of advisory speed signs is to reduce uncertainty and increase confidence with which the driver proceeds.

An Australian study by Kneebone (29) found that there was a marked reduction in the accident rate at curves where advisory speed signs are erected. The reduction is most pronounced in the reduction of fatal and injury accidents (62%). He recommends the use of advisory signs in "derestricted" speed areas while cautioning against the use in posted 30 mph zones. While differentials between approach and curve speed were found to be generally lower, the mean speed through the curve was slightly higher.

Studies in New Zealand by Palmer (38,39) showed that there was a marked reduction in vehicle speeds through a curve. The following table shows typical reductions before and after installation of advisory speed signs:

Speed Around Curve (mph)	% of Vehicles in Speed Range Before	% of Vehicles in Speed Range After
36-40	8	0
31-35	55	20
26-30	32	57
21-25	5	20
<21	0	30

This speed reduction has been shown to be significant, as is the reduction in accident rate, particularly on sharp curves.

Using a regular advisory speed plaque, Rutley found that the mean speed in the curve tended to move up or down in the direction of the recommended speed.

Another device proposed by Rutley uses delineating markers on the outside of a curve. He suggested that the change in height of the markers indicate to the driver the severity of the curve. The number of markers would be kept constant so that spacing would also indicate a change in radius of curvature of the road.

Another device using visual patterns to indicate apparent speed increase has been investigated by Denton (8,9) and Rutley (47). The phenonema of speed adaptation causes a driver to tend to underestimate his speed, after traveling at the same speed for a time. At a constant speed in a roadway environment, a number of objects flash past at approximately the same rate. However, if the road environment is deliberately distorted so that the objects appear to be passing at an increasing rate, the cues used to evaluate speed are distorted. In this case, the observer has the impression of acceleration. Early experiments by Denton (8) used a laboratory simulator and white transverse roadway markings whose spacing decreased exponentially. Field experiments in England have shown promise in reducing speeds and accidents on the approaches to and in traffic circles using this device.

In recent years, the use of active warning signs has increased. Goldblatt (17) in a report on flashing traffic control devices tested two active warning signs. The first sign was a curve speed control device mounted on a span wire across the roadway with a 12-inch flashing beacon on both sides of the sign. The legend on the sign was "When Flashing Too Fast for Curve." The beacons were activated by a pair of loop detectors 275 feet upstream of the sign location. The sign was tested at two sites and speeds were recorded at three positions. A significant reduction in mean speed was found at all positions at one location and one position at the other. There was no reduction in speed variance.

The second sign was a speed violation indicator. Experiments in Maine by Mengert and Koziol (34) showed that the use of speed violation signs and beacons lead to consistently lower speed throughout the test town. Using the same type of signs in North Carolina, Goldblatt (17) found that while there was no reduction in speed variance, both mean speed and 85 percentile speeds were significantly reduced.

3. EXPERIMENTAL DESIGN

As discussed in the introduction of this report, the objective of these experiments is to determine the relative merit of warning-advisory and regulatory signing used individually and/or in combination at particular problem locations on two-lane rural highways.

Advisory-warning, regulatory and combinations of these signing types will be tested. Only those signing conditions which are permitted under current Maine DOT regulations and are in accordance with the requirements of the Manual of Uniform Traffic Control Devices (MUTCD) (33) will be considered.

The design calls for four subexperiments. Each subexperiment investigates a signing system at a different type of problem location:

- Curves,
- Intersections,
- No Passing Zones,
- Downgrades.

The signing treatments that will be tested in the subexperiments will be mixtures of different signing systems. The majority of the signs are to be found in the current MUTCD (33). In the case of the downgrade experiment, MUTCD changes proposed at the January 1977 meeting of the National Advisory Council will be tested. A modified European grade sign will also be tested in this experiment.

3.1 Subexperiment No. 1

The first subexperiment will investigate signing for horizontal curves. The experiment will compare four signing configurations at two different locations.

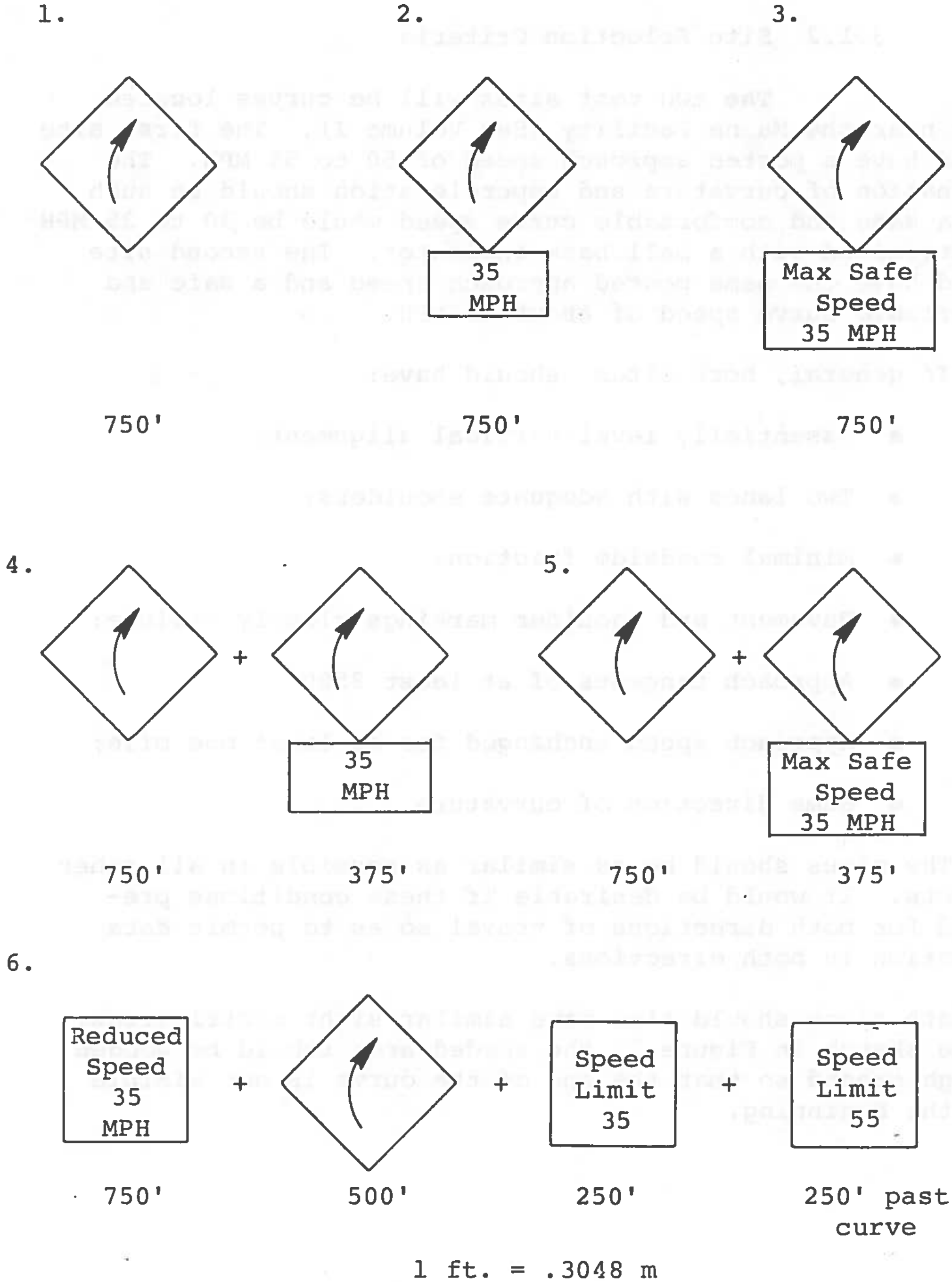

FIGURE 1: Curve Experiment Signing Treatments

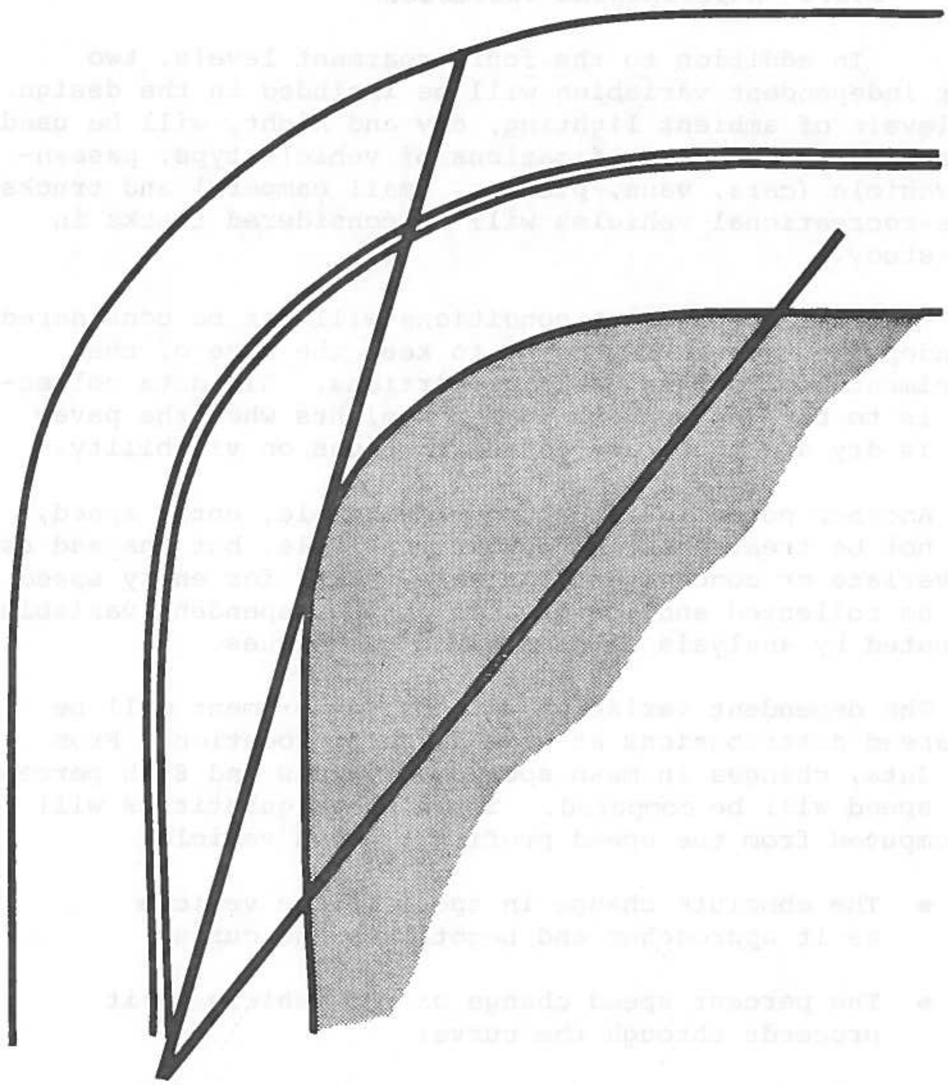

FIGURE 2: Shaded Area: Sight Restriction

lateral placement to detect center line and edge line encroachments. Also, manual collection of brake light application data at points along the approach would contribute to the analysis of speed changes as the vehicle nears the test curve.

The MOE to be investigated is the percentage of drivers that apply their brakes at particular points along the approach of the curve. The least hazardous situation occurs when the driver applies his brakes before entering the curve. An improvement in the safety of approaching the curve can be inferred if there is an increase in the percentage of drivers that apply their brakes along the approach and not along the curve. Cumulative distribution of brake light percentages at points* along the approach will then be constructed. The Komogorov-Smirnov test will then be applied to test for any significant changes a particular sign may have on brake light applications.

A summary of the design for the curve subexperiment is given in Figure 3.

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*The number of points depends on the site location. A minimum of four points along the approach to the point of tangency is recommended. Points are to be spaced approximately 50 feet apart. However, no point should be at a distance upstream on the approach where less than 10 percent of all drivers apply their brakes.

3.2 Subexperiment No. 2

The second experiment will compare regulatory signs, warning signs and combinations of the two types for "blind" intersections.

3.2.1 Experimental Treatments

The first treatment will be the standard MUTCD crossroad sign (W2-1) alone. This sign is to be used at intersections that are obscured from the view of the main road. It is not to be used in conjunction with route signs or other warning signs. The second treatment will use the crossroad sign with the advisory speed plate (W13-1) mounted below. To test the effects of number of signs, the third treatment will have the standard crossroad sign first, followed by the standard crossroads sign with the speed advisory plate, "___MPH" beneath.

The fourth treatment will be a combination of warning and regulatory signs. The first sign in this treatment will be a speed reduction sign (R2-5b) "Reduced Speed _MPH." The second sign will be a standard crossroad warning sign (W3-1). The final sign will be "Speed Limit 55" past the intersection as in the first experiment.

The last treatment will include the same sequence of signs as the above treatment, except the crossroad sign will be deleted. This treatment will be purely regulatory signs. The signing treatments and distances from the intersection to the sign location are shown in Figure 4.

3.2.2 Site Selection Criteria

There will be four sites used in this experiment, two four-legged intersections and two tee-intersections. At all locations the presence of the side road should be obscured when viewed from a distance of 450 feet (140 m) upstream of the near edge of the side road. The speed reduction to be posted in advance of the intersection should be based on good engineering judgement that a reduction is needed or would be useful at the intersection. Wet pavement stopping sight distance should be one of the criteria considered. One speed zone should be 30 to 35 MPH, the other about 45 MPH. The approach speeds at both sites should be 50 to 55 MPH.

Other site criteria are:

- Essentially level vertical alignment;
- Two lanes with adequate shoulders;
- Approach speed unchanged for at least one mile;
- As similar as possible in all other respects

These criteria should apply for both directions of approach on the main road. This requirement is especially important for the tee-intersection locations.

3.2.3 Experimental Variables

Signing treatment (5 levels) and intersection type (2 levels) represent two independent variables. In addition to these, the experiment will be run under two ambient lighting conditions (day and night) and with two vehicle types (passenger type vehicle and truck, large RV).

The dependent variables for this experiment are the same as for the curve experiment. Speed distributions at each detector will be processed into mean speeds, etc. Absolute change and percent change in speed as well as mean deceleration/ acceleration of the vehicle on the approach will be computed. Entry speed will again be treated as a covariate.

			Signing Treatment									
			1		2		3		4		5	
			Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
4 legged	SITE 1	Pass Veh										
		Truck										
	SITE 2	Pass Veh										
		Truck										
3 legged (tee)	SITE 1	Pass Veh										
		Truck										
	SITE 2	Pass Veh										
		Truck										

Number of cells - 80 = 5 x 2 x 2 x 2 x 2

Dry pavement and good visibility only

<u>Dependent Variables</u>:

- speed distributions at each detector
- variance of speeds
- absolute speed change
- acceleration/deceleration
- mean speeds
- 85%ile speeds
- percent speed change
- brake light application (desirable)

FIGURE 5: Experiment #2 Design

Both sites should be preceded by at least one mile of steady state conditions with no change in speed limits or operating speed and in which passing is both possible and legal.

Other site criteria are:

- Two lanes with adequate shoulders;
- Recently repainted pavement markings;
- Moderate vertical curvature acceptable.

3.3.3 Variables

In addition to the sites, the other independent variable will be two levels of ambient lighting--day and night. Data will be collected for following passenger vehicles when passing would be apparently feasible; i.e., no visible opposing traffic.

The dependent variables will be the change in passing behavior by motorists as they approach the start of the NPZ. The proportion of actual and attempted passes at a number of detector locations preceding and after the start of the NPZ will be recorded (see Figure 7). The number of attempted passes and aborted passes are traffic measures obtainable from the Maine Facility System (5). The speed differential between the lead and following vehicles and the time headway of the following pair at the beginning of the test section will be treated as covariates. As can be seen in Figure 7, data is to be collected 1,000 feet before the sign and for the entire no passing zone. This will assure the collection of all attempted and actual passing maneuvers.

As a proportion decreases from .5 and approaches zero, the necessary sample size increases very rapidly. The proportions of actual or attempted passes will be low due to the low traffic volumes. It is suggested that the experiment be staged. The staged vehicle, a passenger car, would travel the test section at about 10 MPH below the mean speed on the particular section of roadway. The use of a staged vehicle should reduce the running time of the experiment.

All signing in this experiment will be placed at the beginning of the no passing zone. A summary of the no passing zone experimental design is presented in Figure 8.

Signing Treatment

		1	2	3	4
Site 1	Day				
	Night				
Site 2	Day				
	Night				

Number of Cells = 16

Passenger vehicles only as following vehicle

Dry pavement and good visibility only

Dependent Variables - Illegal Passes
Aborted Passing Attempts

Covariates - Speed differentials of vehicle pair
Free speed of following vehicle
Time headway

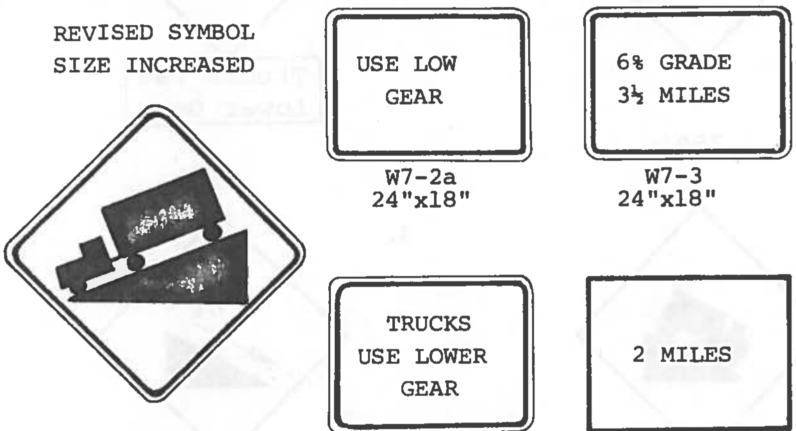
FIGURE 8: Design for Experiment #3

PROPOSED MUTCD CHANGE

2C-25 Hill Sign (W7-1,W7-2,W7-3)

The Hill sign (W7-1) is intended for use in/conjunction with ~~advance of~~ a downgrade where the length, percent of grade, horizontal curvature, or combination thereof, requires special precautions on the part of drivers. ~~The word message HILL (W7-1a) may be used as an alternate legend.~~ Hill signs shall not be used for upgrades.

REVISED SYMBOL
SIZE INCREASED



W7-1 30"x30"

W7-2a 24"x18"

W7-2b 24"x18"

W7-3 24"x18"

W7-3a 24"x18"

The Hill sign should be used in advance of downgrades of 6 percent or more for lengths given in the following table.

Average 6 percent downgrade, more than 2,000 feet long
Average 7 percent downgrade, more than 1,000 feet long
Average 8 percent downgrade, more than 750 feet long
Average 9 percent downgrade, more than 500 feet long
Average 11 percent downgrade, more than 400 feet long
Average 13 percent downgrade, more than 300 feet long
Average 15 percent downgrade, more than 200 feet long
Average downgrade of 16 percent or greater and more than 100 feet long

FIGURE 9: Proposed MUTCD Change

3.4.2 Site Selection Criteria

Two sites will be considered for this experiment. Both sites should be a grade of similar steepness and length. These two parameters should meet the criteria of the proposed MUTCD warrants (Figure 9).

The first site should have an unrestricted view from the top of the grades of the complete downgrade. At the second site, there should be a sight restriction so that the end of the grade is not visible from the top.

Other site selection criteria include:

- Similar approach and downgrade speed limits;
- Two lanes with adequate shoulders;
- As similar as possible in all other respects;
- Speed limit of 50 MPH or more for at least one mile in advance of the grade;
- Approach conditions that permit a large truck to travel at a speed of at least 40 MPH (64 km/h) at the beginning of the downgrade).

3.4.3 Experimental Variables

In addition to the experimental treatments, two other independent variables will be included in the design:

- Ambient illumination (i.e., day-night);
- Type of vehicle - the classification of trucks should be done on the basis of the number of axles. The two levels should represent two axles and more than two axles.

Dependent variables include speed distributions at detectors, velocity profiles, brake light application distributions and the proportion of transmission downshifts. The data for the last two variables will have to be collected manually. The transmission downshifts are

Signing Treatments

			1	2	3	4	5	6
2 Axles	Site 1	Day						
		Night						
	Site 2	Day						
		Night						
More Then 2 Axles	Site 1	Day						
		Night						
	Site 2	Day						
		Night						

Number of Cells = 48

Trucks Only

Dry pavement and good visibility only

Dependent Variables - Speed Distributions
Transmission Downshifts
Speed Profiles
Brake Light Applications

FIGURE 11. Design for Experiment 4

H_0 - There is no change in the dependent variable under the four signing treatments.

The above hypothesis will be tested against the alternative.

H_1 - During Signing Treatment, S_i, there was a decrease in illegal passing maneuvers.

This will be one-sided testing at the $\alpha = .05$ level.

In the fourth experiment, the primary dependent variable will be the transmission downshifts.

The null hypothesis is:

H_0 - The proportion of transmission downshifts is unchanged under signing condition, S_i.

The alternative hypothesis against which the null hypothesis will be tested is:

H_1 - The proportion of transmission downshifts increase under condition, S_i.

Here again, testing will be one-sided and will be at the $\alpha = .05$ level.

3.6 Data Collection

Data to be collected for the four subexperiments will include speed related parameters as well as manually collected data. For experiments that will be conducted on the Maine Facility, existing instrumentation will be used to the maximum possible extent. However, the prevailing 200-foot spacing of the permanent detector stations may yield too few points for the construction of meaningful speed profiles. It is recommended that the TDC traffic data recorder be deployed at intermediate locations in the portion of the test section immediately preceding the curve, intersection, etc. In addition to allowing a finer definition of speed and headway profiles, the TDC equipment will permit the determination of time mean speeds and headways.

A sample size of 250 vehicles is recommended for all MOEs which represent proportion. This sample size will allow inferences at $\alpha = .05$ level with the minimum estimate of $p = .3$. The percent of error estimate is ±20%.

3.8 Data Analysis

Speed related parameters will be analyzed using standard statistical techniques. In experiments for which these variables are designated as covariates, analysis of covariance techniques will be employed to test for statistically significant differences. This technique combines the feature of both analysis of variance and regression. In this case, it will be used to adjust the value of the dependent variable for the bias introduced by the differences in entry speeds. While the analysis and interpretation of results is considerably more complicated than a conventional ANOVA, the size of the experimental design is reduced by not using the entry speed as an independent variable. An explanation of analysis of covariance can be found in Snedecor and Cochran (50) or other advanced level text in statistical analysis. The SPSS programming package (37) contains a program for analysis of covariance.

In experiments where covariates have not been designated or it is decided that covariates will not be used, standard analysis of variance techniques and other parametric tests such as the "t"-test and others will be employed. To test for differences in 85 percentile speed, a nonparametric binomial test, the quantile test, will be performed. Binomial tests will also be performed on all proportion data collected to test for significant changes in the proportions.

It is recommended that all hypotheses be tested at the $\alpha = .05$ level. Testing will be two sided, since no prior judgment of which treatment is better can be made.

In the curve and intersection experiments, extra treatments were added to test the effect of the number of signs on driver compliance. To do this, an additonal variable will be added to the analysis of variance. This new variable will be the number of signs on the approach with the various number of signs as treatment levels. The number of observations in each cell will be unequal, but equal cell sizes are not required for the SPSS ANOVA package.

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APPENDIX

Questionnaire Specifications for the Experiment: Comparative Evaluation of Warning-Advisory and Regulatory Traffic Control Devices

This questionnaire is intended to provide measurable data which can be used to analyze and evaluate motorist response to warning signs, regulatory signs and a combination of the two types. It is assumed that many questions can be formulated on a seven- or five-point scale, to obtain quantifiable results. These results can then be used to compare responses to different aspects of several dynamic aid treatments. This information is intended to supplement the data on motorist behavior as measured in the field tests and to aid in evaluating the safety and motorist acceptability of the systems being tested.

The questionnaire will be used as the format of a structured interview of motorists who have just driven through the experimental site in Maine. This will probably be implemented by stopping motorists at the side of the road, or some other safe and convenient location, beyond and out of view of the test site, and having a trained interviewer record their responses to the items on the questionnaire.

Aims

The purpose of the questionnaire is to determine whether the proposed aids are performing their function by attracting the motorist's attention and providing an appropriate warning of a potentially hazardous situation. Such questions as the following must be addressed:

Do remedies induce any response?
Do remedies induce a safe-driving response?
Are they understood?
Do motorists perceive a potential hazard?

In addition, the questionnaire is intended to determine which, if any, of these aids represents an improvement over conventional treatments and, if so, to what extent.

Downgrade Experiment

A. Do truck drivers consider a steep downgrade on a two-lane rural road a hazard?

B. Does the driver normally downshift on long, steep grades?

C. How many gears?

D. Would information on steepness and length, posted at the start of the grade, assist in making decisions?

The remaining hypotheses refer to the signing treatments for each experiment. Each interviewee will be questioned about only one treatment; that is, the treatment through which he has just driven. A sample size of 60 interviews will be collected for each treatment. The following hypothesis will be tested by comparing interview results of different treatments. The hypotheses are:

Treatment X_i gives the motorist more information than other tested signs.

Treatment X_i is more effective in obtaining compliance than other tested signs.

Treatment X_i is more effective, overall than the others.

Treatment X_i poses no significant problem for road use.

Sample questions which can be asked of all interviewees are given below:

A. How would you rate the attention-getting aspect of the signs through which you have just driven? (Very good, good, average, poor, very poor.)

B. How would you rate the visibility of the sign's warning? (Very good, good, average, poor, very poor.)