RESEARCH REPORT NO. 606-9F

FINAL REPORT
DIAGNOSTIC STUDIES OF HIGHWAY VISUAL COMMUNICATION SYSTEMS

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"Project HPR-2(108), Contract No. FH-11-7031, a pooled funds research project jointly sponsored by the Federal Highway Administration and eighteen participating states."

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KEY WORDS

Driver Communication, Multidisciplinary Teams, Geometry, Design, Expectancy, Signing

INTRODUCTION

The problem of providing safe roadside designs has been attacked on a great many fronts. One significant effort in this area was the multi-state sponsored research project on breakaway sign supports entitled, "Highway Sign Support Research," conducted by the Texas Transportation Institute. The Project Policy Committee of this project, which was composed of representatives of the participating states, acknowledged in their final policy statement that the problem of highway safety was not "solved" by the development of the breakaway sign support and recommended that the entire problem of visual communications with drivers be investigated.

On the basis of this recommendation, the Texas Transportation Institute prepared a proposal entitled "Diagnostic Studies of Highway Visual Communication Systems." This document was distributed to all states by the Federal Highway Administration with a request for an indication of interest in sponsoring the project. A cooperative effort of several members of the Federal Highway Administration staff, several state highway departments, and the Texas Transportation Institute generated sufficient interest in and financial support for the project to permit execution of the basic research plan, and a contract was signed in October 1968 with the following state highway departments participating:

Alabama	Georgia	Nebraska	Tennessee
Alaska	Hawaii	New Hampshire	Texas
Arkansas	Maryland	New Mexico	Wyoming
California	Michigan	Rhode Island	
Connecticut	Mississippi	South Dakota	

A Project Policy Committee, composed of one representative from each participating state, guided the progress of the research throughout the duration of the study. This report summarizes the activities of the project for the time period from September 1, 1968, through February 28, 1972. Listed on the back of the front cover of this report are the various reports prepared on the project. The reader is referred to these technical reports for a more detailed presentation of the concepts, procedures, and findings of this research.

STATEMENT OF PROJECT OBJECTIVES

The primary objective of this study was to develop recommendations for improving visual communication systems, and thereby improving highway safety. This objective was accomplished through evaluation of current practices in highway visual communication systems (that is, signing, delineation, marking, and illumination) in light of known technology. The multi-discipline diagnostic team approach was used as the principal method of research.

LITERATURE REVIEW

A literature review of the factors affecting driver visual communications was conducted, and the results of this survey were presented in three project research reports:

Research Report 606-1 - "A Condensation of the NCHRP 3-12 Draft-Development of Information Requirements and Transmission Techniques for Highway Users," Condensation by Donna McGlamery;

Research Report 606-2 - "A Background Report -- Annotated Bibliography and Summary of Research Needs of the Human Factors Aspects of Driver Visual Communications," by R. L. Street, A. M. Mayyasi, and F. E. Berngen;

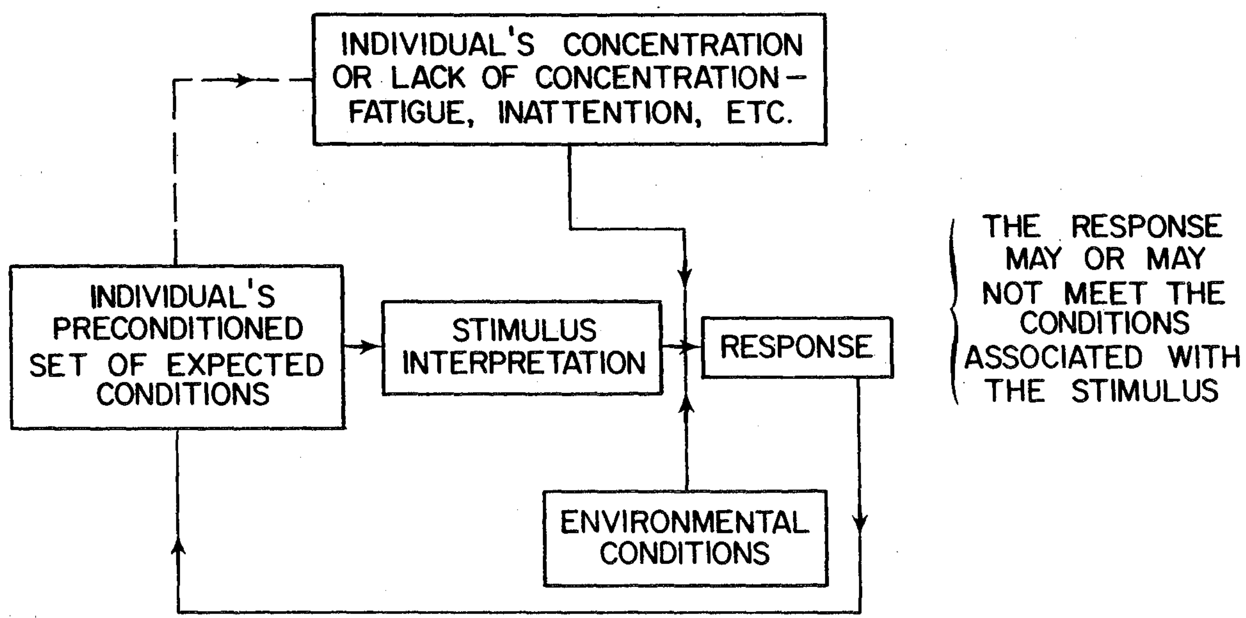
Research Report 606-3 - "Psychophysiological Measurements as Related to the Operation of a Motor Vehicle," by Newton C. Ellis and Donna McGlamery;

A brief review of the findings presented in these three documents is presented in the following paragraphs.

During the initial stages of the literature review, the work of the Airborne Instruments Laboratory (AIL) on NCHRP 3-12 "Development of Information Requirements and Transmission Techniques for Highway Users" came to the attention of the research staff. As the literature review continued, it became apparent that the research staff was, in fact, duplicating the efforts of the AIL staff, and a basic decision was made by the Project Policy Committee to utilize the AIL report as the basic literature review document. However, the Project Policy Committee felt that the original version of the AIL report was unnecessarily long and complicated (particularly in the use of unfamiliar language) and asked that the project staff prepare a brief version for use by the staff and participating states. This document (Research Report 606-1, Texas Transportation Institute) identifies many of the points which are important in driver visual communications. Among these are the concepts of expectancy, formal and informal information sources, and primacy.

Expectancy as a Behavioral Concept - The general term "expectancy," as applied in the behavioral sciences, relates to the process in which an individual with an established set of ideas and concepts is presented with a stimulus of some type (visual, tactile, auditory, etc.) and responds in some fashion to this stimulus. The response may be directly related to the stimulus or may be totally unrelated to it, except that the stimulus serves to trigger the response. The set of ideas and concepts of the individual (predisposition) is very influential in determining the nature of his final response to the stimulus and is referred to as his expected set or simply "expectancy." The general sequence is illustrated in Figure 1.

Driver expectancy is the application of the general expectancy concept to the operation of a motor vehicle. The expected situation is continually changing, and the environmental influences are very pronounced, thus reducing the predictability of the response. Driver expectancy could be defined as follows:



SIMPLIFIED EXPECTANCY-RESPONSE SYSTEM

Figure 1

which are primarily designed to convey information in the driving environment:

(1) Formal information sources

  (a) Traffic signs

  (b) Pavement markings and/or markers

  (c) Traffic signals

  (d) Vehicle taillights

  (e) Roadside advertisements

  (f) Road maps

(2) Informal information sources

  (a) Roadway geometry and roadside appurtenances

  (b) Landmarks

  (c) Personal directions

  (d) *A priori* knowledge

  (e) Other vehicles

The lists of formal and informal information sources presented above are certainly not exhaustive but illustrate the wide diversity of information sources available to the driver. Messages from these various sources to the driver are combined with certain preconceived ideas regarding the features of the roadway to form the expected set upon which the decision will be based when a stimulus is presented.

There are three critical considerations:

(1) The expected set (or expectancy) is an aggregation of past experiences, perception of the current situation, and expectations regarding events

in the immediate future.

(2) Since expectancy involves learning, it is subject to the problems of retention and recall.

(3) Since expectancy involves perception of the current situation, it is subject to the fallibility of human sensory functions:

(a) One sees what he wants to see, and

(b) The same object may be perceived in several entirely different ways, depending upon the situation and/or environment.

Primacy - The concept of primacy involves the obvious fact that some information needs are of greater importance to the driver than others. For simplicity, the several levels of driving performance have been stratified into three categories for the normal driving task. These are:

(1) Positional Performance - Those routine steering and/or speed adjustments necessary to maintain a desired speed and to remain within the lane.

(2) Situational Performance - Those maneuvers (i.e., change of speed, direction of travel, or position on the roadway) required as a result of a change in the geometric, traffic and/or environmental situation.

(3) Navigational Performance - Those maneuvers required in order to follow a route from the origin to the destination of a trip.

Under normal driving conditions, the positional maneuvers are the highest level of importance, situational the second most important, and navigational performance is the lowest level. This indicates a hierarchy of driving task performance levels and, thus, the concept of primacy. The degree of complexity of the information necessary to perform the three levels also follows a hierarchy. Positional performance maneuvers are virtually involuntary and are carried out with a minimum of conscious recognition of the fact. Navigational performance, on the other extreme, depends totally on the cognitive abilities of the driver and, therefore, represents a rather complex mental task. The reversal of the degree of driving task complexity hierarchy with respect to the primacy hierarchy is indeed fortunate. If the critical task (i.e., positional maneuvers) also were the most mentally demanding, it would be virtually impossible to effectively communicate with the driver. This also emphasizes the fact that the roadway (i.e., the geometric features) is the primary source of information, and that formal communication devices are supplementary in function to the information provided by the design engineer through his design.

The initial reaction of the research staff to the concepts presented above was somewhat indifferent. This was undoubtedly due to the terminology used in the original AIL report. The language was psychologically oriented rather than engineering oriented. As the diagnostic studies described below were completed, it became increasingly apparent that many of the problems uncovered could only be explained through concepts similar to those presented above.

In the initial stages of the research effort, it was apparent that human factors input to the total project effort would be necessary if the project was to be successfully completed. The principal investigator assembled an interdisciplinary team which included human factors engineers. These team members were assigned the responsibility of preparing an annotated bibliography on the human factors aspects of driver visual communications. Research Report 606-2, entitled "A Background Report -- Annotated Bibliography and Summary of Research Needs of the Human Factors Aspects of Driver Visual Communications" is the culmination of the effort.

The report notes that most of the research in driver communications has been under very restricted, unrealistic circumstances, and the number of subjects is frequently too small to enable the researcher to draw unambiguous statistical conclusions. For this reason, the authors suggest that a more detailed scientific approach to the study of the driving task should be undertaken. The major factors involved in determining the driver's visual inputs are as follows:

(a) The psychological state of the driver

(b) The physiological state of the driver

(c) The environmental conditions (which may include economic and social environments)

These three major factors were further subdivided and studied. On the basis of this effort, the authors reached the following conclusion:

> "Based on the literature surveyed, it can be stated that the total research effort that has been applied to date (July, 1970) to the problems of visual communications systems is insufficient for the designer's needs. The present body of information does not provide an understanding of the problems involved. None of the factors influencing the communication problem have been investigated in sufficient detail to permit effective and efficient action by those responsible for highway systems design. A more <u>scientific</u> approach to all levels of this problem is needed.
>
> To reiterate, the visual inputs available to the driver are numerous, but the input accepted for processing depends on that upon which the operator is focusing his attention at that particular instant in time. Only those events in the center focus (the focus of attention should not be confused with

the focal vision of the eyes) are the ones that receive adequate attention to be subsequently processed by the driver. Once the input is accepted in the focus of attention, it is ready for processing. However, this is no guarantee that it will be processed. That which is processed depends upon the channel capacity of the visual system and the degree of noise (distortion) associated with the transmission."

The authors further recommend that the vehicle, driver, and roadway be treated as a closed-loop control system with feedback, and that adequate experiments should be conducted to statistically validate the various elements of the driving task.

One concept of identifying the areas in which subject drivers have difficulty during the initial phases of the study was the measurement of some type of psychophysiological response. The logical question was which measure would reveal, with the greatest degree of reliability, the state of stress of the driver. Eight physiological indices were examined:

(1) Brain potential and electroencephalography

(2) Heart potential and electrocardiography

(3) Muscle action potential and electromyography

(4) Respiration

(5) Temperature

(6) Blood pressure

(7) Ocular potentials

(8) Galvanic skin response

Each of these indices was examined in light of its potential for evaluating individual features of the roadway and its environment. Several types of problems were identified which preclude the use of physiological parameters to measure the driver's response to individual roadway or traffic situations. Among these are (a) baseline drift, (b) weak signal amplification, (c) interpretation of the data, (d) latency, and (e) degree of interference of the measurement equipment with the driving task. It was concluded that several of the physiological indices appear to have immediate potential for measuring the general level of driver arousal associated with relatively long segments of roadway. None, however, offered substantial potential for evaluating driver reaction to specific situations.

The physiological indices which appear immediately applicable include heart potential, relative blood pressure, body temperature, and respiration rate. Brain potentials and galvanic skin response have, in the long run, the greatest potential; however, some minor problems associated with their use still exist. These problems can be solved within the present state-of-the-art, but, to the authors' knowledge, they have not been resolved to date (July 1970). Muscle potentials and eye movements as pure physiological responses do not at this time appear useful.

Future studies of physiological parameters should be directed toward the definition of the comfort arousal baseline and the normal arousal band which can serve as standards for general roadway evaluation.

DRIVER EXPECTANCY CONCEPT

The importance of expectancy in effective communication with the driver, coupled with the fact that roadway geometry is the primary information source, led the research staff to recommend to the Project Policy Committee further research in the realm of driver expectancy. The committee, after due consideration of the alternatives, approved further research in this area. The objectives of this research effort were to: (1) define driver expectancy operationally; (2) delineate factors which influence driver expectancy; (3) propose a design philosophy accompanied by an analytical technique for developing driver expectancy criteria; and (4) identify additional areas for driver expectancy studies.

A Definition of Driver Expectancy - A definition of driver expectancy must be in terms of the conditions which it causes, rather than conditions that cause it. From this perspective, the factors that influence expectancy are primarily the same factors which the highway engineer uses in roadway design. A review of previous studies in this area revealed nine propositions from the behavioral sciences which have application in driver expectancy. These, briefly stated, are as follows:

1. Expectancy serves to prepare the individual to perform a response.
2. Expectancy also serves to develop anticipation for the appearance of the stimulus.

3. The response will be the one which the individual has been prepared by expectancy to make unless some unusual circumstance intervenes.
4. Expectancy performs a selective function for the individual. From a host of behaviors which could potentially occur in any one situation, expectancy serves to select one.
5. The time required to react to an unexpected stimulus is much greater than the corresponding time for expected ones.
6. There is an optimum time interval between the point when expectancy initiates a behavior process and that point when the stimulus appears to consummate the behavior. The time interval can be too short, and the individual will not be adequately prepared, or too long, and the anticipation has waned with a corresponding loss of the preparatory advantages.
7. Expectancy involves learning which is a result of both formal instruction and informal training gained through driving experience. The degree of learning is different for each individual, and the identical stimulus can have different meanings to each individual, thus causing different behaviors.

8. Expectancy involves learning and is, therefore, subject to the problems of retention and recall.
9. An expectancy is developed for the environmental context associated with the task in which the driver has been involved, is currently involved, or will be involved.

These nine propositions were integrated into two more general concepts: (1) expectancy provides a readiness to respond in a particular manner; and (2) a persistence to carry through with the behavior. These concepts coupled with the requirement for an operational definition, resulted in the following definition:

> Driver expectancy is an observable, measurable change in the driving environment which increases a driver's readiness to perform a driving task in a particular manner and, in addition, causes him to persist in this until it is completed or interrupted by other environmental circumstances or changes.

Two things should be pointed out prior to leaving the above statement. One is that this definition does not attempt to account for variation in driver behavior in expectancy situations caused by such internal factors as motivation and personality, nor drugs and alcohol. The author recognizes the influences of such factors and better identifies some of them in subsequent sections of this report; however, it seems that these are direct responsibilities of the driver and only an indirect responsibility, if any, of the highway engineer.

Secondly, the definition represents an attempt to define driver expectancy in terms of the conditions which cause it, rather than the conditions it causes. The former is a practitioner's approach and is decidedly different from the latter which represents the conventional handling of expectancy by the behavioral scientist. This departure will, in the long run, provide the most benefits. It is the practitioner's vantagepoint which will inherently lead to the development of roadway design criteria of value to the highway engineer.

Factors Affecting Driver Expectancy - A great many factors influence driver expectancy and include the items listed below:

Perceptual Factors

(1) Sensory quality and dimension (see color and differentiate between hue, brightness and saturation)

(2) Configuration (ability to perceive shape outline and groupings)

(3) Consistency (recognition and identification of objects)

(4) Subjective frame-of-reference (capacity to make valid and reliable judgments regarding physical features of the environment)

(5) Concrete object character (perception of the whole rather than the individual parts)

(6) Prevailing set (what one sees is influenced by previous exposure to the situation, the individual's attitude, personality, current needs and future goals.

Traffic System Factors

I. <u>Environmental Factors</u>

A. Natural
   1. Terrain
   2. Weather
   3. Gravity

B. Man-Made Factors
   1. Setting/Landscaping
   2. Roadway Design
   3. Roadway Condition
   4. Traffic
   5. Legal

II. <u>Driver Factors</u>

A. Personality

B. Abilities

C. Physical Condition

D. Training

E. Past Experience

F. Trip Objective

III. <u>Vehicle Factors</u>

A. Driver/Vehicle Interface

B. Vehicle/Roadway Interface

C. Condition of Vehicle System

D. Number/Type of Passengers

IV. Driving Task Factors

A. Direction Changes

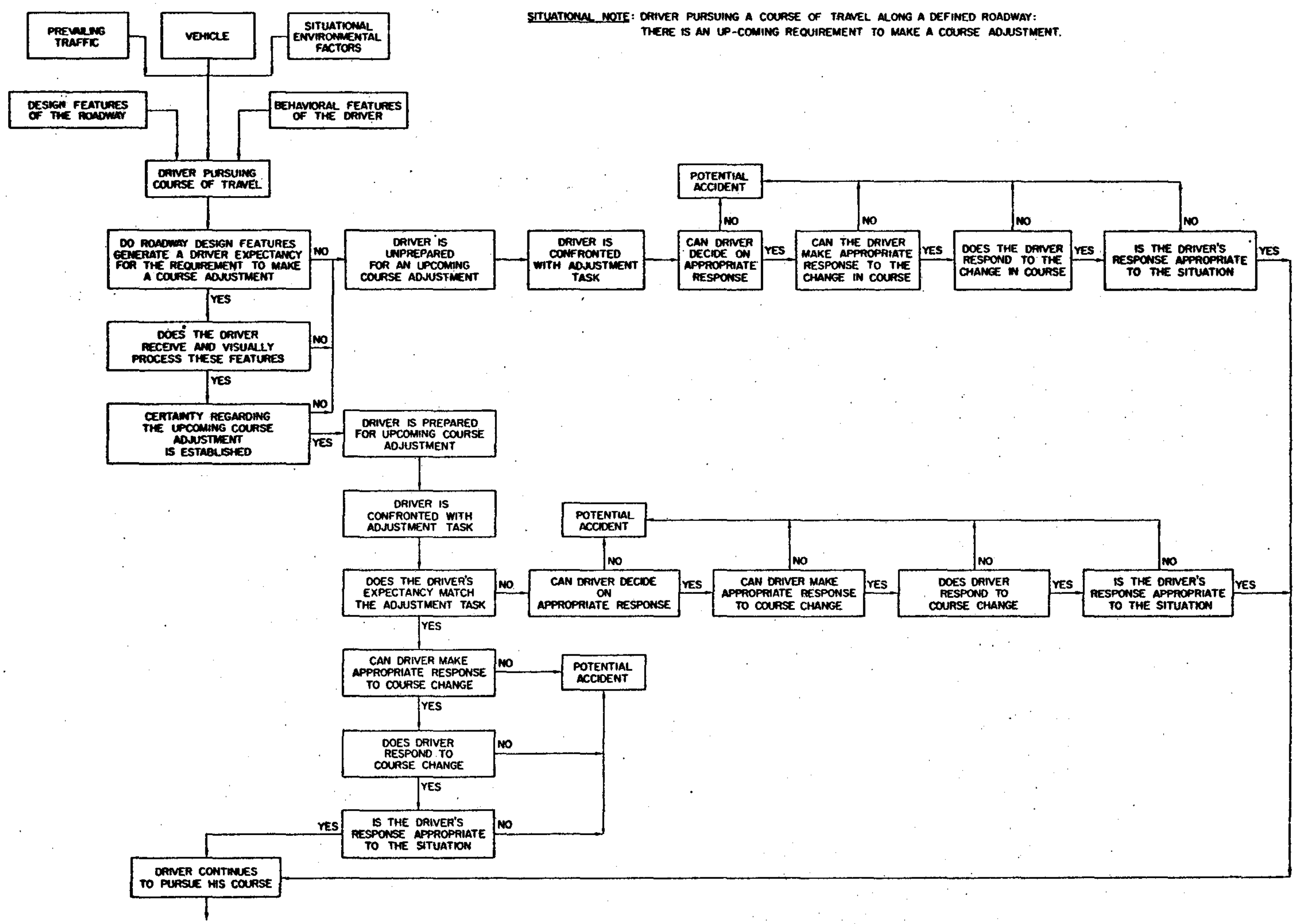
B. Speed Changes

The framework to consider driver expectancy in the design and operation of highway facilities must take into account all of these factors and their most important interactions.

Driver Expectancy Criteria - The concept of driver expectancy as a comprehensive design philosophy is relatively new. It is apparent from the foregoing list of factors which affect it that driver expectancy is indeed already a part of most highway design criteria. The important factor appears to be the development of a method to integrate driver expectancy into the design, operation, and maintenance processes.

The idea of designing the roadway to facilitate driver expectancy is fairly novel; however, many of the basic concepts are embodied in the design principles currently in use in highway design. Thus, what is needed is a new way to organize and use existing design data in the design process. This, in turn, requires a detailed analysis of the driving task in order to insure compatibility of the design and the driver's expectancy of the design.

Driving Task Analysis - The technique proposed for analyzing a driving task is shown in Figure 2. This technique combines in a simplified manner some of the better features of functional flow



FLOW ANALYSIS OF DRIVING TASK

Figure 2

diagrams, information-decision-action analyses, and operational sequence diagrams. If utilized properly, it will provide the highway engineer with a capability to consider driver expectancy in his design.

Figure 2 is a flow diagram describing in block form a driver pursuing a course of travel along a defined roadway. The situation has been defined in this case as having an upcoming task requirement for the driver to make a major course adjustment. The diagram identifies a sequential series of questions the driver must resolve during the impending course of events, with assistance from roadway design provided by the highway engineer. Alternative flows of activity are shown based upon the decision of the driver at critical points. This figure provides insight into how an immediate sequence of events, in addition to the general factors of the traffic system, relates to driver expectancy and to the driver's subsequent behavior.

As implied, roadway design provides information to the driver prior to and at decision points, ensuring hopefully that the behavior is suitable to the driving task. This is accomplished by structuring and controlling driver expectancy. This is easy to understand now, because, to paraphrase the earlier discussion, changes in the driving environment that "get" a driver ready to do something and "keep" him ready until he does it, have been operationally defined as driver expectancies. The major task now is to delineate factors affecting driver expectancy which would serve as inputs for consideration in the flow analysis.

Driver Expectancy Checklist - A technique proposed both for developing driver expectancy criteria and ensuring its implementation in the design process is the design checklist. The checklist approach is proposed because it is a technique suited to engineers who have the ability to use their own intuition to resolve design problems. It works best when the engineer is an experienced designer familiar both with the existing criteria for and the user of his product. Under these conditions, a checklist becomes a tool for conceptualizing the design question, jogging the designer's memory, directing his thought, and making sure that all facets of design are considered in the development process. Finally, it can be used as a quality control device by either the designer himself or by a professional counterpart to evaluate the final design. This latter feature is particularly important when there are requirements to demonstrate design validity.

Admittedly, the checklist loses some of its value when the designer is either unwilling or unable to place himself objectively in the position of the user. Another disadvantage is that the checklist does not actually produce design data, and sometimes it fails to require the designer to approach a design task systematically. Concerning design data, it is certainly true that these are not provided by checklists; however, the checklist can force the designer, as mentioned previously, to consider all design facets. Then he, through experience, can to go known sources from which detailed data can be obtained. Regarding a checklist's failure to require a systematic attack of design problems, this is not an inherent weakness, but merely a shortcoming of the person who has constructed it. Proper development alleviates this problem.

Checklist Development - A checklist was developed by the research staff and submitted for review to the participating States. Each State was asked to distribute the draft checklist to design engineers, traffic engineers, and maintenance engineers. Each individual was requested to indicate for each item whether or not it should be included in the checklist and to perform an overall evaluation of the checklist concept as an aid to their daily duties. Table 1 is a summary of the responses to the checklist evaluation. It is apparent from the table that a vast majority of those reviewing the checklist favored the concept. In addition, all items included in the final checklist received approval by at least fifty percent of the reviewers. The final version of the checklist is included in Research Report 606-5, "Driver Expectancy: Definition for Design." This checklist was developed with the many possible shortcomings in mind and in general the authors feel that these disadvantages mentioned have been overcome. For example, it is proposed primarily for the experienced highway designer, and it should be used in conjunction with the systematic flow analysis previously described.

The final draft of the checklist was submitted to the AASHO Committee on Geometric Design for possible publication by this group. This would insure nationwide distribution of the checklist. The AASHO Committee recommended the checklist for publication, and it will be published in the near future.

TABLE 1
SUMMARY OF
DRIVER EXPECTANCY CHECKLIST EVALUATION

Number of Review Copies Distributed	216
Number of Copies Returned	124
Number of Evaluations	120
Number of Design Engineers Included	51
Number of Traffic Engineers Included	48
Number of Maintenance Engineers Included	21
Number of States Included	12

	Total	Design	Traffic	Maintenance
Number Favoring Checklist Concept	96 (80%)	41 (80%)	37 (77%)	18 (86%)
Number Not Favoring Checklist Concept	10 (8%)	5 (10%)	4 (8%)	1 (5%)
Other Responses	2 (2%)	2 (4%)	0 (0)	0 (0)
No Response on Question	12 (10%)	3 (6%)	7 (15%)	2 (9%)
	120	51	48	21
Percentage of Those Indicating a Preference Who Favored the Checklist Concept	90.6%	89.1%	90.2%	94.7%

HIGHWAY ENGINEERING TIPS

Recognition of the fact that highway design engineers do not read research reports called for a different method of reporting the findings of this research and offering suggestions regarding possible solutions to this problem. The criteria which the reporting technique should meet were as follows:

(1) Brief and easy to read;

(2) No more than concept;

(3) Idea or ideas for solving the problem;

(4) References where more detailed information can be located;

(5) Coded for rapid review of a particular topic area.

The concept which most nearly met these criteria is the design tip concept developed by the aerospace industry. It serves as a means of introducing inexperienced personnel to the concepts involved and, therefore, is an educational tool. Also, it serves as a rapid review of specific areas in which the designer must undertake infrequent design problems.

The title, Highway Engineering TIP, was selected by the Project Policy Committee, and a general format for the TIPS was approved. The format which was generally followed in the development of the Highway Engineering TIPS is as follows:

Heading - Introduces reader to concept. Letter size generally reflects relative seriousness attached to concept by research agency and/or drivers in diagnostic field studies.

Introductory Paragraph(s) - Need or problem is stated in fairly concise terms.

Explanatory Text and/or Illustration(s) - Central portion of TIP either (1) elaborates need or problem, (2) explains some potentially successful approaches to satisfying the design situation, or (3) accomplishes both 1 and 2 to some degree.

TIP - Complements heading by reviewing essense of overall TIP presentation, with special emphasis on a suggested course of action.

References - A selected list of readings is included on the back of the sheet. It should be realized that each of the references pertains to the concept(s) involved in the overall TIP, but it is not necessarily in full agreement with the course of action suggested in the TIP.

Each TIP was submitted to a subcommittee of the Project Policy Committee for review and modification prior to distribution to the entire committee for vote. Those TIPS receiving ten or more positive votes were published in most instances. The contract manager reserved the right to approve each tip and required that a disclaimer be placed on the front of each tip. Examples to illustrate this concept are included in the subsequent pages for the reader's information.

HIGHWAY ENGINEERING

- ✓ TRAFFIC OPERATIONS AND SAFETY
- ENVIRONMENTAL FACTORS
- ELEMENTS OF DESIGN
- ✓ DRIVER EXPECTANCY

A Recommendation of the MULTI-STATE POLICY COMMITTEE Based on the Findings of PROJECT HPR-2(108) "Diagnostic Studies of Highway Visual Communication Systems" sponsored by Eighteen Participating State Highway Departments in cooperation with The U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads and Conducted by Texas Transportation Institute, Texas A&M University, College Station, Texas 77843.

STREET NAME SIGN LOCATION SHOULD SATISFY DRIVER EXPECTANCY

Traditionally most signing has been placed at the right roadside, and this is where the driver expects to find street name signs. Failing to locate the sign of interest on the right, the motorist successively scans the median area and then the left side of the intersection - if he has not yet passed through.

<u>SUGGESTED LOCATIONS FOR STREET NAME SIGNS ARE SHOWN BELOW:</u>

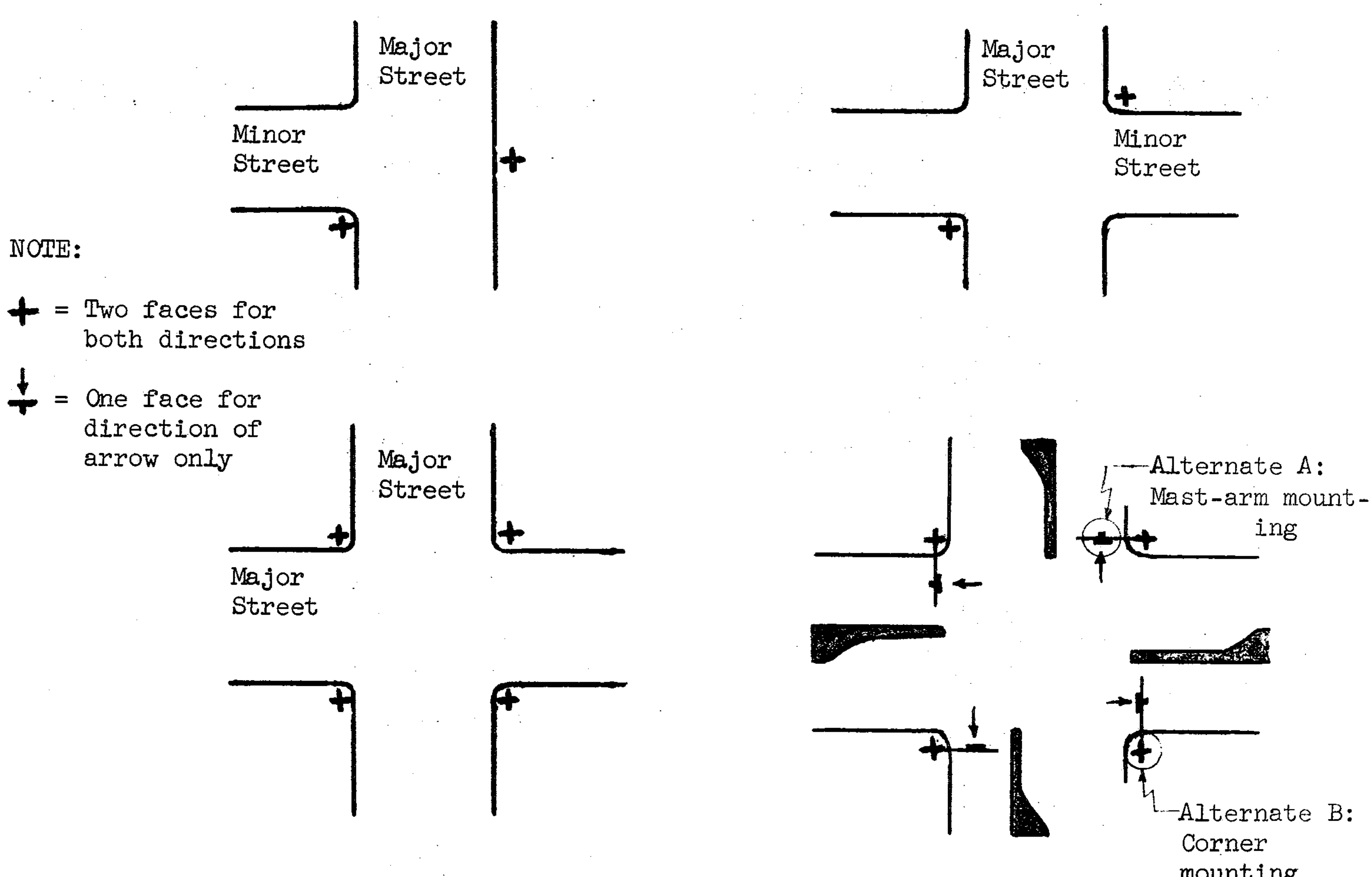
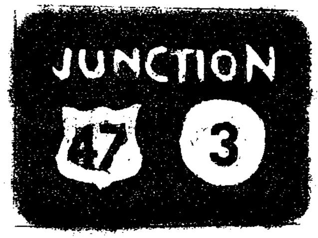


Figure 3

A Recommendation of the MULTI-STATE POLICY COMMITTEE Based on the Findings of PROJECT HPR-2(108) "Diagnostic Studies of Highway Visual Communication Systems" sponsored by Eighteen Participating State Highway Departments in cooperation with The U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads and Conducted by Texas Transportation Institute, Texas A&M University, College Station, Texas 77843.

INTERSECTIONS ON RURAL HIGHWAYS ARE CRITICAL AREAS AND ADVANCE SIGNING IS NECESSARY.

Black and white



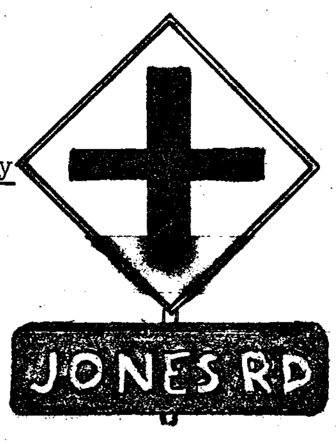
Black and white

<u>Standard Junction Assemblies</u>

Junction signing of the type above has had fairly regular use for some time. When properly designed, it provides the driver sufficient time to read the message, decide on a course of action, and safely maneuver according to his desires.

On rural intersections marked only with standard crossroad warning signs, the level of information presented by a junction assembly is unavailable to the motorist. A combination of signs as exemplified below would effectively fulfill directional needs in such situations.

<u>Warning-Directional Assembly</u>



Black on yellow

Minimum 6" letter height

White legend on green background or black legend on yellow background.

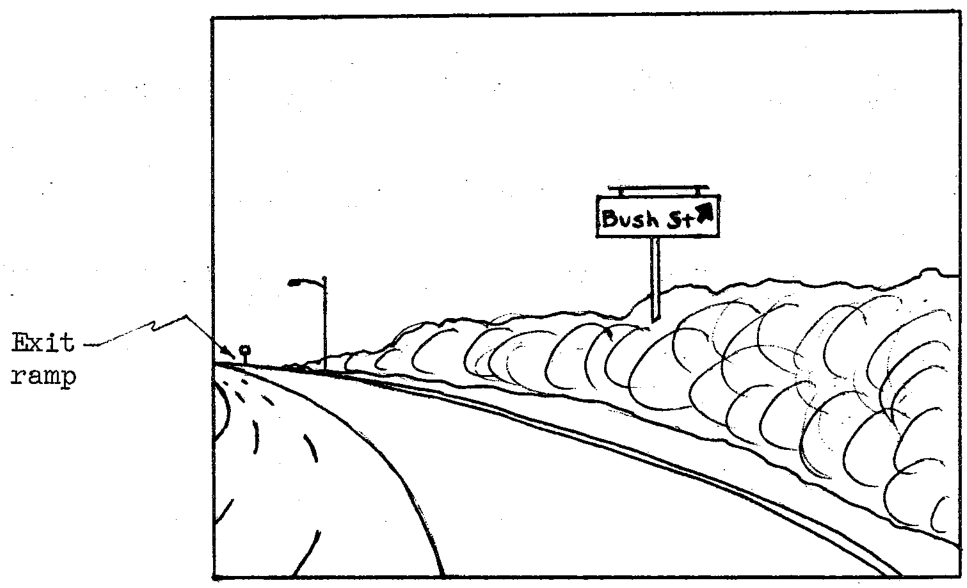
TIP: <u>THE ADDITION OF AN ADVANCE NAME PLATE TO THE INTERSECTION WARNING SIGN IS HIGHLY RECOMMENDED</u>.

Figure 4

A Recommendation of the MULTI-STATE POLICY COMMITTEE Based on the Findings of PROJECT HPR-2(108) "Diagnostic Studies of Highway Visual Communication Systems" sponsored by Eighteen Participating State Highway Departments in cooperation with The U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads and Conducted by Texas Transportation Institute, Texas A&M University, College Station, Texas 77843.

Drivers object to the use of directional arrows on most advance exit signs.

SUCH USAGE OCCASIONALLY CONFUSES THE DRIVER. PREMATURE POSTING OF ARROWS, THAT DOES NOT READILY RELATE TO ROADWAY GEOMETRY, INDUCES A SENSE OF URGENCY OR TEMPTATION TO EXIT BEFORE REACHING THE RAMP. THERE IS A POTENTIAL FOR UNSAFE, ERRATIC MOVEMENT BY DRIVERS WHOSE ALERTNESS MAY BE SLACK. ALL MOTORISTS WILL BE LESS AT EASE AND HENCE WILL PERFORM BELOW THE OPTIMUM LEVEL.



The directional arrow on the advance sign directs traffic into the roadside growth.

Tip: THE CASE FOR THE USE OF DIRECTIONAL ARROWS SHOULD BE CONSIDERED THOROUGHLY, NOTING SUCH ALTERNATIVES AS "NEXT RIGHT" OR "THIS EXIT."

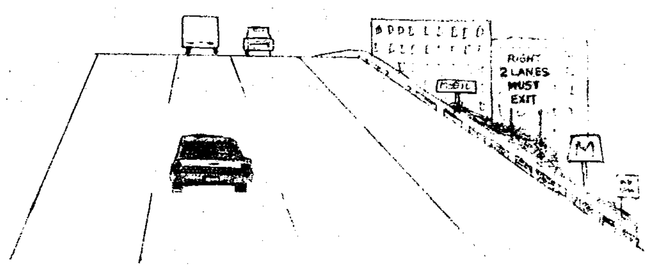
Figure 5

A Recommendation of the MULTI-STATE POLICY COMMITTEE Based on the Findings of PROJECT HPR-2(108) "Diagnostic Studies of Highway Visual Communication Systems" sponsored by Eighteen Participating State Highway Departments in cooperation with The U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads and Conducted by Texas Transportation Institute, Texas A&M University, College Station, Texas 77843.

BLACK-&-WHITE, ROADSIDE REGULATORY SIGNING ON FREEWAYS IS SOMETIMES INEFFECTIVE.

The vast majority of signs on freeways presents a large green background with white legend. The visibility of this choice of colors has proven rather effective in conveying directional guidance to motorists - which is the information of paramount interest to them. But while improvements in directional signing have accompanied developments in freeway operation, regulatory signs - whose importance on freeways may be even greater than on facilities with lower speeds or lower volumes - are still installed in relatively small, black-and-white roadside configurations. The resultant inversion of control device priority yields unnecessarily hazardous operation. One subject driver replied:

"Those little black-and-white signs tell you anything: 'DON'T THROW LITTER ON THE HIGHWAY,' 'DON'T PARK ON THE SHOULDER,' almost anything. The thing that is important to me is which lane to be in, in order to get where I want to go."



The "target value" of black-and white roadside regulatory signs is often inadequate, especially in an urban environment and in competition with commercial signing. The inadequacy of such installations quite often contributes to erratic movements when the intended message deals with a lane drop or EXIT ONLY situation.

Tip: DRIVERS TEND TO IGNORE STANDARD BLACK-AND-WHITE, ROADSIDE REGULATORY SIGNS ON FREEWAYS.

Figure 6

A Recommendation of the MULTI-STATE POLICY COMMITTEE Based on the Findings of PROJECT HPR-2(108) "Diagnostic Studies of Highway Visual Communication Systems" sponsored by Eighteen Participating State Highway Departments in cooperation with The U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads and Conducted by Texas Transportation Institute, Texas A&M University, College Station, Texas 77843.

MANY ARTERIAL STREET NAME SIGNS DO NOT FULLY SATISFY DRIVER NEEDS

Street-name signing practice has not kept pace with improvements in geometric design standards and operating speeds. Unfamiliar drivers can not operate in a smooth and natural manner when street name signs fail to provide adequate visibility ("target value") and legibility; hazardous maneuvers and inconvenience are the usual consequences.

There are two basic approaches to the problem of adequately posting names of intersecting roadways:

(1) PLACE LARGE SIGNS AT THE INTERSECTION.
(2) USE ADVANCE STREET NAME SIGNS TO COMPLEMENT THE SMALLER SIGNS AT THE INTERSECTION PROPER.

Suggested Type of Advance Name Sign

TIP: The following design standards should be assumed for street name signing:

1) White letters on green background (the most visible combination)
2) Street names composed of at least 6" letters, supplementary legends 2" smaller
3) Advance sign placement on both left and right roadside (or overhead) on divided facilities with more than two lanes in each direction
4) Overhead span-wire mounting of advance signs on undivided arterials having three or more lanes in each direction and/or extensive roadside interference
5) Inclusion of both street name and route number (if both exist)
6) Addition of supplementary legend to an advance sign to fully inform drivers concerning the intersection to which the sign applies or one-way operation on the intersecting street

Figure 7

A Recommendation of the MULTI-STATE POLICY COMMITTEE Based on the Findings of PROJECT HPR-2(108) "Diagnostic Studies of Highway Visual Communication Systems" sponsored by Eighteen Participating State Highway Departments in cooperation with The U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads and Conducted by Texas Transportation Institute, Texas A&M University, College Station, Texas 77843.

Drivers expect sequential information signing to have consistency in color and message.

Driver expectancy is occasionally ignored in the design of advance and exit signing on freeways. The two main characteristics that are inadequately coordinated between paired signs are color combination and form of directional designation.

I. Color Considerations

Freeway directional signing is expected by drivers to be green with a white legend. When an advance sign follows this convention but the associated exit sign "happens to be" a black and white combination, motorists tend to overlook the second sign or act erratically due to confusion.

HESITATION OR CONFUSION, PARTICULARLY ON HIGH-SPEED HIGHWAYS, CAN CREATE CHAOS AND CONTRIBUTE TO TRAFFIC ACCIDENTS.

II. Composition of Legend

Two major points must be kept in mind to insure reasonably uniform treatment throughout an entire interchange:

A. Local names and localized jargon often confuse unfamiliar drivers and should be avoided or relegated to a level of impact much lower than that of any numerical route designation (and cardinal direction) that might apply.
B. References to interchanging highways or streets should have the same form on all signs: an exit should not be designated by destination on one sign, local name of the roadway on another, and route number and general direction of the crossroad on yet another.

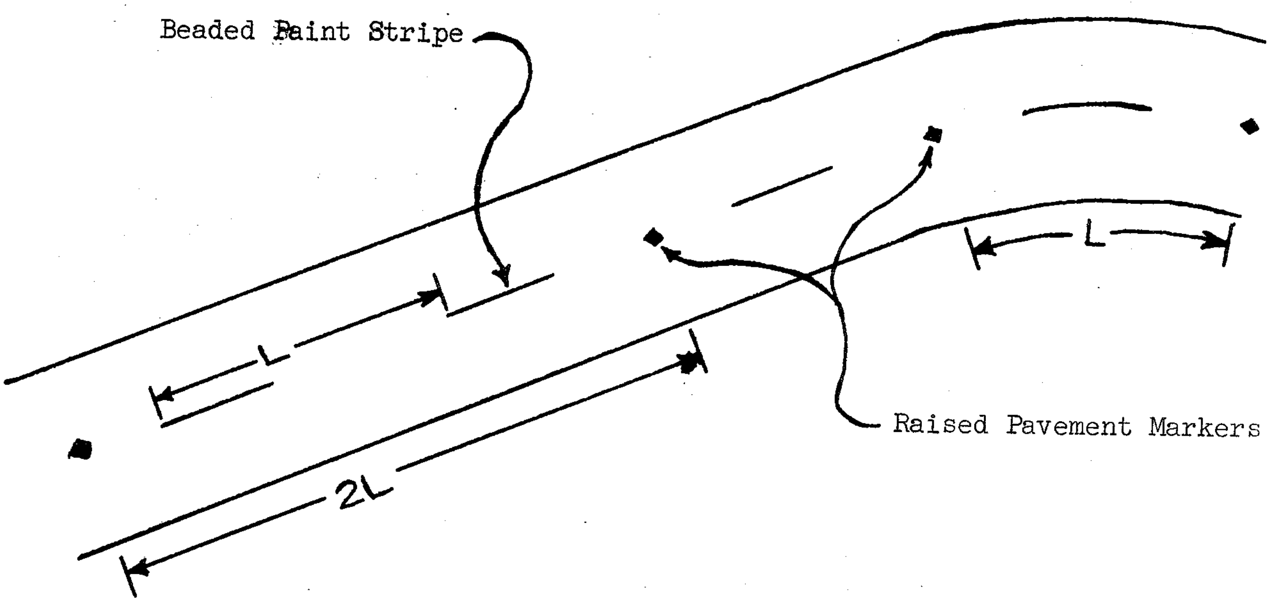
tip: COLOR AND MESSAGE UNIFORMITY IN AN INTERCHANGE SIGN SERIES DECREASES ERRATIC VEHICLE MOVEMENTS.

Figure 8

A Recommendation of the MULTI-STATE POLICY COMMITTEE Based on the Findings of PROJECT HPR-2(108) "Diagnostic Studies of Highway Visual Communication Systems" sponsored by Eighteen Participating State Highway Departments in cooperation with The U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads and Conducted by Texas Transportation Institute, Texas A&M University, College Station, Texas 77843.

PAVEMENT MARKINGS ARE A PRIMARY SOURCE OF INFORMATION TO THE DRIVER. THEY SHOULD BE EFFECTIVE UNDER ALL ENVIRONMENTAL CONDITIONS. INVESTMENT IN DURABLE MARKINGS AND MARKERS SHOULD BE BALANCED TO PROVIDE DAY AND NIGHT, DRY AND WET-WEATHER VISIBILITY.

On roadways where any snow removal is accomplished with steel plows slightly raised, with rubber plows, and/or chemically, the optimum combination of centerline or lane delineators for moderate traffic volumes appears to be the following:



TIP: CONSIDERATION SHOULD BE GIVEN TO THE USE OF RAISED REFLECTIVE MARKERS FOR ALL INSTALLATIONS WHERE SNOW REMOVAL METHODS WILL PERMIT OR WHERE SNOW IS NOT A PROBLEM.

Figure 9

A Recommendation of the MULTI-STATE POLICY COMMITTEE Based on the Findings of PROJECT HPR-2(108) "Diagnostic Studies of Highway Visual Communication Systems" sponsored by Eighteen Participating State Highway Departments in cooperation with The U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads and Conducted by Texas Transportation Institute, Texas A&M University, College Station, Texas 77843.

Edgelines Are Recommended For All Roadways

Edge striping is deemed essential not only on two-lane highways with unpaved shoulders, but also in critical places such as horizontal curves and near roadside hazards on all roadways, and at critical times such as during darkness and inclement weather conditions. Indeed, motorists favor edgelines even when there is normally high contrast between shoulder and through-lane, when the highway is lighted, or when a parking lane exists.

PRINCIPAL BENEFITS OF EDGE STRIPING

1. INFORMATION IS PROVIDED DRIVERS WITH WHICH TO GUIDE THEIR VEHICLES UNDER UNUSUAL GEOMETRIC AND WEATHER CONDITIONS. An improved level of visual communications aids drivers at all times.

2. DRIVERS ENJOY A GREATER SENSE OF SECURITY IN THE LATERAL PLACEMENT OF THEIR VEHICLES. The probability of straying into another traffic stream or onto the shoulder is lessened.

3. THERE IS MORE LATERAL CLEARANCE BETWEEN MULTILANE TRAFFIC STREAMS WHEN MEDIAN EDGELINES ARE USED. Motorists in the inside lane are encouraged to drive closer to the median, and drivers in non-median lanes laterally disperse by operating closer to their left lane lines. Safer and more efficient traffic flow clearly results.

4. THE STRUCTURAL INTEGRITY OF THE PAVEMENT EDGE AND SHOULDER ARE PROTECTED. The economic life is extended and hazardous raveling and granular erosion are reduced.

TIP CONTINUOUS EDGE STRIPING SHOULD BE SERIOUSLY CONSIDERED FOR USE ON VIRTUALLY ALL FACILITIES.

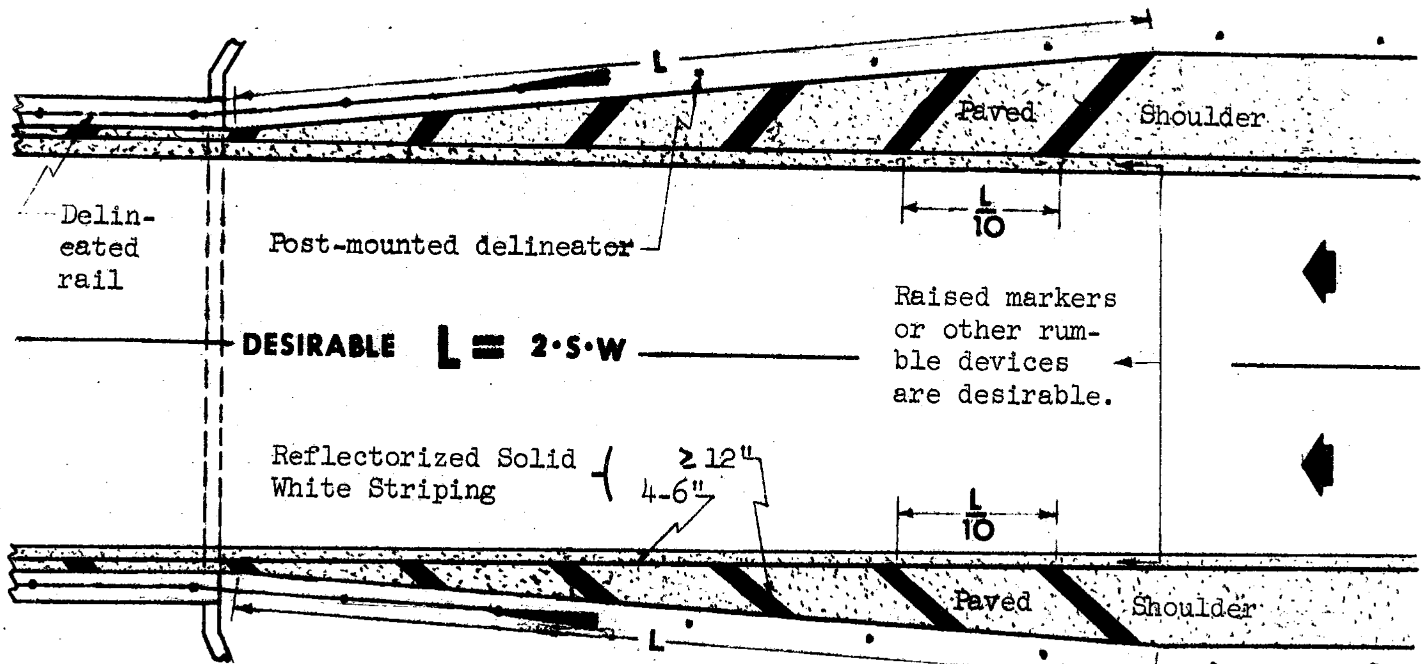
Figure 10

A Recommendation of the MULTI-STATE POLICY COMMITTEE Based on the Findings of PROJECT HPR-2(108) "Diagnostic Studies of Highway Visual Communication Systems" sponsored by Eighteen Participating State Highway Departments in cooperation with The U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads and Conducted by Texas Transportation Institute, Texas A&M University, College Station, Texas 77843.

Drivers need to be guided onto narrow bridges and past hazards.

MOTORISTS ARE SOMETIMES CONFUSED WHEN APPROACHING AN OBSTRUCTION MARKED ONLY BY ONE DELINEATOR OR HAZARD BOARD. THEY MUST NOT ONLY BECOME AWARE THAT A HAZARD EXISTS, BUT THE EXPECTED PATH SHOULD BE INDICATED WITH EFFECTIVE DELINEATION.

View and feel of the roadway itself are critical, so pavement edge markings and markers are a primary source of guidance. A suggested approach to effective delineation is shown below:



L = length of taper in feet
S = 85th (offpeak) percentile speed or design speed in mph
W = offset in feet

Note: A particular guardrail placement is not being recommended. Considerations other than delineation are involved.

TIP: USE EXTRAORDINARY EDGELINES TO GUIDE THE DRIVER PAST HAZARDS.

Figure 11

A Recommendation of the MULTI-STATE POLICY COMMITTEE Based on the Findings of PROJECT HPR-2(108) "Diagnostic Studies of Highway Visual Communication Systems" sponsored by Eighteen Participating State Highway Departments in cooperation with The U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads and Conducted by Texas Transportation Institute, Texas A&M University, College Station, Texas 77843.

ALL GUARDRAIL AND BRIDGE RAIL ON UNLIGHTED FACILITIES SHOULD BE PROPERLY DELINEATED

Positive delineation of hazards immediately adjacent to the roadway shoulder is considered necessary by many drivers, particularly on unlighted facilities. Probably the most common such hazard is the guardrail installation. If a guardrail is delineated only at its ends, an approaching driver may have some doubt as to what maneuver is required to avoid the hazard. While operating on the roadway at night opposite a long stretch of undelineated guardrail, a driver forced to leave the travel lane might be startled (and act erratically) due to the sudden appearance of a restriction to his maneuverability on the shoulder. The emergency situation is especially critical where there is less than a full-width shoulder.

Some of the ways to provide continuous delineation of guardrail and bridge rail are as follows:

1. Provide post-mounted delineators behind the rail.
2. Paint the rail with reflective paint.
3. Add a strip of reflective sheeting or a reflective button to selected posts.
4. Attach prismatic, reflective wedges at intervals along the rail.
5. Provide overhead roadway lighting.

Of primary importance is the need for delineation, not the particular type used.

REFLECTORIZATION OR OVERHEAD LIGHTING OF GUARDRAIL AND BRIDGE RAIL NOT ONLY INFORMS THE DRIVER OF PROMINENT OBSTACLES AT THE ROADSIDE, BUT IT ALSO SERVES TO DELINEATE THE ROADWAY ALIGNMENT.

TIP GUARDRAIL AND BRIDGE RAIL SHOULD HAVE CONTINUOUS OR REGULARLY-SPACED DELINEATION, REGARDLESS OF THE TREATMENT EMPLOYED ON THE REMAINDER OF THE ROADSIDE.

Figure 12

A Recommendation of the MULTI-STATE POLICY COMMITTEE Based on the Findings of PROJECT HPR-2(108) "Diagnostic Studies of Highway Visual Communication Systems" sponsored by Eighteen Participating State Highway Departments in cooperation with The U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads and Conducted by Texas Transportation Institute, Texas A&M University, College Station, Texas 77843.

All Guardrail and Bridge Rail on Unlighted Facilities Should Be Properly Delineated

Positive delineation of hazards immediately adjacent to the roadway shoulder is considered necessary by many drivers, particularly on unlighted facilities. Probably the most common such hazard is the guardrail installation. If a guardrail is delineated only at its ends, an approaching driver may have some doubt as to what maneuver is required to avoid the hazard. While operating on the roadway at night opposite a long stretch of undelineated guardrail, a driver forced to leave the travel lane might be startled (and act erratically) due to the sudden appearance of a restriction to his maneuverability on the shoulder. The emergency situation is especially critical where there is less than a full-width shoulder.

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Of primary importance is the need for delineation, not the particular type used.

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Figure 12

DIAGNOSTIC STUDIES

Diagnostic Team Composition - The multi-discipline diagnostic team approach was the principal method of research used for this project. The diagnostic teams, representing the various disciplines related to the field of visual highway communications, reflected a broad spectrum of drivers that could be expected to use the roadway. Each team member drove one route and observed a fellow driver on another route. In so doing, the subject drivers were willing to participate and freely expressed their opinions of specific aspects of the driving run. The diagnostic teams for the study were composed of the following:

Traffic Operations Engineer - Individual in a traffic engineering capacity at state or district level.

Law Enforcement Officer - Individual with experience in traffic law enforcement and currently serving in an administrative capacity.

Highway Administrator - Individual who has influence in state policy-making, such as Assistant State Highway Engineer, major highway division head, etc.

Professional Driver - Individual with considerable driving experience, but limited familiarity with the study site, such as a cross-country truck driver, taxi driver, or delivery service driver.

Lay Drivers - Individuals who do not use the study site route frequently and who occasionally drive in other states. Sources of subjects include various civic clubs, state vehicle registration offices, chambers of commerce, local parent-teacher associations, church groups, etc.

Team members were asked to drive vehicles other than their own. Therefore, a short period of time was required for adjustment to the vehicle.

Before participating in the study, team members were subjected to ocular examinations. These tests were conducted to identify any defects that drivers might have in visual acuity, depth perception, and color vision. Possession of a valid driver's license is generally sufficient indication of adequate visual acuity for purpose of diagnostic evaluation. A visual examination would only be necessary to detect those defects in subject drivers which would significantly affect the results of the study, and such cases do not occur frequently. A summary of the visual examination results is shown in Table 2.

Figure 13 compares the visual acuity of subject drivers from this study with the national norm for visual acuity. Because these curves are very similar, it can be concluded that visual examinations to determine driving capability are not economically justified.

Allocation of Study Sites - The assignment of the various study sites to geographic regions was based upon the relationship between study sites and states, shown in a matrix arrangement. In this case, the rows of the matrix designate the characteristics of the study sites, whereas the matrix columns represent regions in

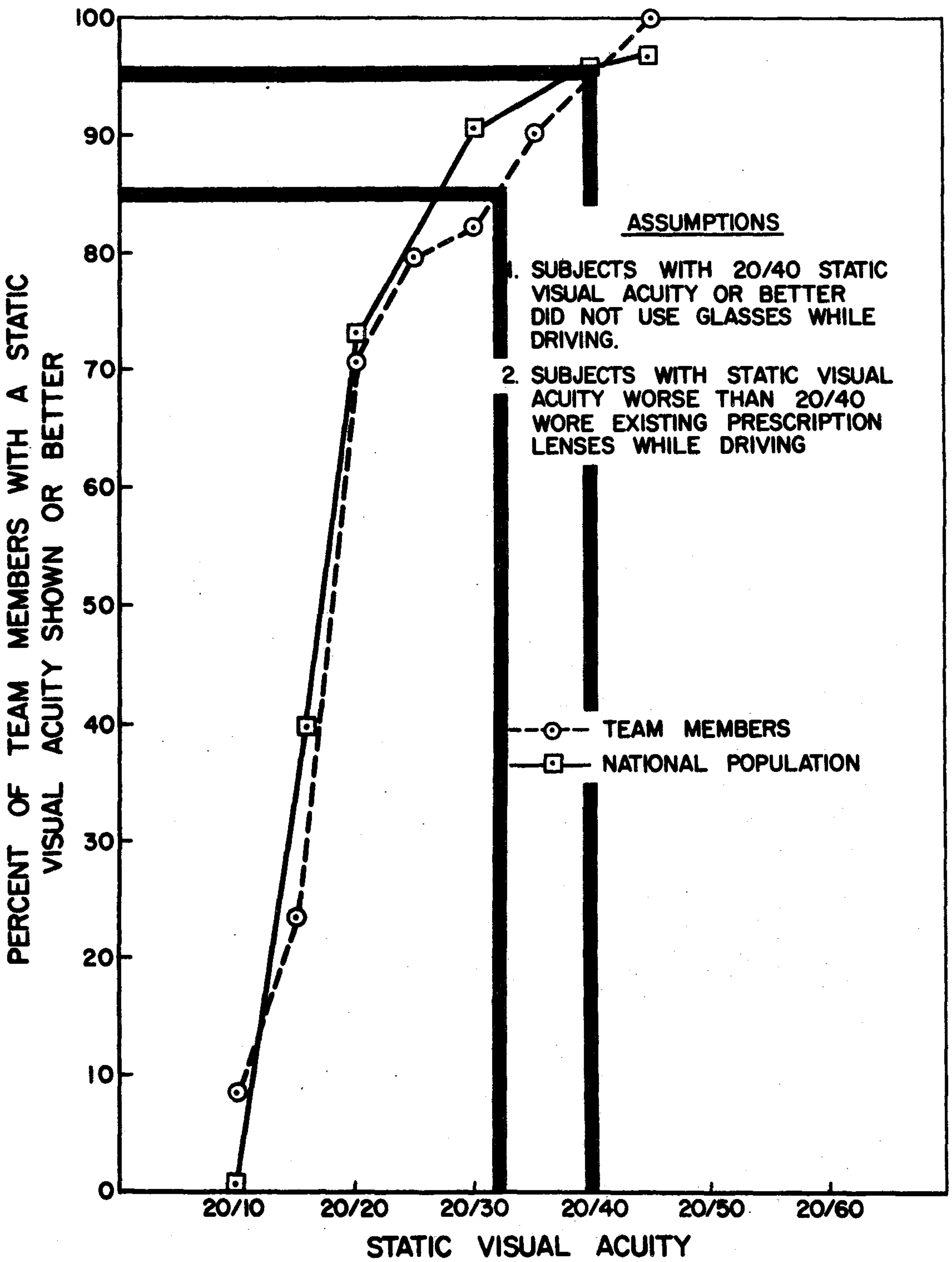

Figure 13. Comparison of Visual Acuity of Team Members with National Population

which the study sites are to be located. The site allocation matrix appears as follows:

Site Allocation Matrix

Geographic Distribution		Regions				Row
Site Characteristics		Northeast	Southern	Central	Western	Totals
Freeway	Lighted	X		X		4
	Unlighted		X		X	
Arterial	Lighted	X	X			4
	Unlighted		X		X	
Two-Lane Highway		X			X	2
Column Totals		3	3	1	3	10

This technique requires the establishment of row and column totals for the allocation matrix used in this study. These totals served to restrict the number of study sites assigned. The row totals were established by recommendation of the Project Policy Committee. Four freeway sites, four arterial street sites, and two, two-lane rural highway sites were included in this recommendation. The freeway and arterial classifications were subdivided into lighted and unlighted sites. The rows, consisting of the freeway and arterial site subdivisions and the two-lane highway classifications, each had a total of two.

The column totals were established by the number of states not included in the pilot studies in each geographic region submitting potential sites. Potential sites in the pilot states were considered only when an acceptable site in the other states of that region could not be found. This was considered desirable in order to insure the greatest possible geographic distribution.

Guidelines were established for the assignment of study sites to states:

1. Cells of the matrix, defining possible study site locations, were selected at random.
2. No cell was selected a second time.
3. Total allocation to a row or column did not exceed the predetermined marginal total (i.e., the row or column total).
4. Column totals were established by the number of states in the various regions submitting possible sites.
5. Row totals were established by the number of sites to be included in each classification.

The resulting allocation of study sites was assigned to the states within each region after due consideration of the various sites recommended by the states.

This method of allocating study sites, while appropriate for the research study is not practical for most States. A criteria based on number of complaints or accident experiences would be more appropriate.

Selection of Driving Routes - The routes to be used for the study sites were selected after a thorough investigation of interesting roadways for adequate turnaround points, or loop route capability, and review of the various types of communication elements presented on each. Each of the two driving routes used was selected to provide a total driving time of approximately twenty to thirty minutes. On rural freeway sites the routes were extended to approximately forty minutes.

The routes were selected in a manner that would allow the subject to approach the study section by several intersecting roadways. When it was possible to do so, a short loop which left the study section at one intersecting roadway and re-entered it at another point a short distance away was utilized for the runs. This insured that the driver would not have previously viewed the interchange and, thus, would be required to use the communication devices provided.

Documentation of the Study Site - Referencing of the study sites was accomplished using geographic points along the roadway as the primary reference system, supplemented by special reference markers when the distance between features was greater than desirable. For example, on arterial streets where the street name signs were legible, the intersections were used as reference points without supplemental reference markers. In the case of freeway sites, the interchange structures were used as the basic reference points, supplemented by reference markers placed at one-half mile intervals between interchanges. The reference points and reference marker numbers were recorded during the driving runs as each point was passed.

Television tapes were prepared on each route to provide both video and audio coverage. In addition, 35mm color slides were made in a continuous sequence along each route to record various roadway features.

Group sessions were held at each study site after completion of the driving runs. Team members discussed aspects of the driving routes in which possible improvements could be made. During these sessions, the opinion of the majority of the team concerning each point was recorded.

Diagnostic Questionnaires - The subject drivers were asked to complete a questionnaire at the conclusion of the observer run for both the day and night phases of the field studies. The questionnaires were of the open-end type, and the questions were designed to stimulate the subject's thinking in a general area, rather than probing a specific point. It was felt that this technique minimized the influence on the results from the individual responsible for preparing the questionnaire. In addition, questionnaire length could be controlled.

In developing the questionnaire, the driving task was separated into four types of information needs and/or sources:

1. Position Control - That information which the driver uses in maintaining his position within the lane.
2. Directional Control - That information which the driver uses in selecting his position on the roadway, in preparation for a major maneuver.

3. Operational Control - That information which the driver uses in selecting a set of operating characteristics, including interaction with other traffic and interference from the environment.

4. Miscellaneous Information - All other elements within the view of the driver which may or may not be of interest to him.

Ten basic questionnaires were developed for use in the study:

QUESTIONNAIRE USED

Questionnaire Code	Applicable Type of Facility	Condition Assumed	External Illumination Provided
2LR	Two-Lane	Daylight	------------
2LRN	Two-Lane	Night	None
UA	Arterial Street	Daylight	------------
UANU	Arterial Street	Night	None or Safety
UANI	Arterial Street	Night	Continuous
FR	Frontage Road to Freeways	Daylight	------------
FRN	Frontage Road to Freeways	Night	None
FW	Freeway	Daylight	------------
FWNU	Freeway	Night	None or Safety
FWNI	Freeway	Night	Continuous

The diagnostic questionnaire did not prove to be very effective in providing team members' opinions of the driving runs. The primary shortcoming was that the comments given to questionnaire items were too generalized to be associated with a specific situation encountered on a particular driving run. Therefore, it was concluded that the diagnostic questionnaire is of little value and, at best, serves as a supplement to the driver interview.

Driver Interviews - The diagnostic team members were asked to drive one route and observe another driver's behavior on a second route, for both the day and night phases of the field studies. The driving and observation routes were reversed, however, for the day and night phases. The team was divided into two groups, and each group was assigned to an interviewer. The two interviewers exchanged groups for the night phase. The driving runs were conducted as shown by the following chart:

Run Number	Driver	Observer	Interviewer	Route Number
1	S_1	--	I_1	1
2	S_2	S_1	I_1	2
3	S_3	S_2	I_1	1
4	I_1	S_3	--	2

Field Studies - During the driving run, the driver was asked to comment on the features of the roadway and its environment. The interviewer asked questions only as required to stimulate productive conversation and to clarify and/or document comments previously made by the driver. Observers were permitted to comment but were asked not to interrupt the driver and to keep their comments brief.

Each occupant of the vehicle was provided with an individual microphone to insure recording of all comments. A lapel microphone was given to the driver, and all other persons used hand-held units. Reference points and brief statements to clarify and locate comments made by the driver were recorded by the interviewer.

On the day following the driving runs, the diagnostic team was assembled to discuss the various problems identified during the driver interview phase of the study and to consider possible means of resolving these specific problems. No attempt was made to reach a consensus of opinion on every point; however, the majority opinion of the team was determined for the points raised. A few comments were made by one member which were of considerable merit in the opinion of the research staff and, therefore, were included in the results of the study.

The tape of each driving run and the review session were transcribed literally by clerical personnel. This transcription was then reviewed by the interviewer, and extraneous or useless material was deleted. The remaining statements were then rewritten into proper grammatical form without altering the intended meaning. These statements became the basis for Research Report 606-4, "Summary Report - Significant Points From the Diagnostic Field Studies." This report deviates from the normal research report in the sense that a great many items were identified. Thus, a different concept of reporting was needed. The format which most nearly met this requirement was the newsprint format (i.e., a photograph, a headline and a brief text). In addition, the types of problems identified were stratified as to the type(s) of facilities to which they apply.

Conclusions From the Diagnostic Studies

1. The primary source of information utilized by the driver is provided by the geometry of the roadway. Thus, effective driver communications begin and, to a large degree, are determined by the basic geometric design.
2. The formal communications system (i.e., signs, signals and markings) serve only a supplementray function in driver communications.
3. The situation expected by the driver as a result of his perception of the situation, coupled with his previous experience, is a critical factor in effective driver communication. Unexpected situations are difficult, if not impossible, to effectively treat to meet the needs of the driver, whereas expected situations can be effectively treated with a minimum number of traffic control devices.
4. A vast majority of the driver communication needs can be satisfied using the technology currently available -- provided the information needs of the driver are considered and properly integrated into the design procedure from the inception to the completion of the highway facility.

FILM "FROM THE DRIVER'S VIEWPOINT"

The results of the diagnostic studies indicated that most of the basic information needs of the driver could be satisfied using technology currently available -- provided the various elements of the communications system, including basic geometric design, are properly integrated together. In order to effectively convey these findings and to illustrate both the problems uncovered and some possible solutions, the Project Policy Committee requested that a movie based on the findings of the research be prepared. The movie was to be semi-technical and of interest to both professionals in the highway field as well as the general public.

A script was prepared and reviewed by a subcommittee of the Project Policy Committee and the Contract Manager. In accordance with the suggestions received, a revised script was prepared and potential sites selected for filming the footage required. A team composed of a professional member of the research staff and a professional photographer visited and photographed sites in seven states to obtain the basic footage for the film. The raw footage was cut and spliced into a working print. This print with a narration done by a member of the research staff was presented to the Project Policy Committee for their review and comment. The Committee suggested a few minor changes and it was decided that the working copy in the present form should be presented to the Contract Manager and other representatives of the Federal Highway Administration. This review was accomplished and several suggestions were received on the technical content of the film. With the approval of the Project Policy Committee and the Federal Highway Administration, the film was edited, some additional footage and a professional narration were added. A working copy, including background music, was requested from the photographic laboratory.

This working copy was presented to the Contract Manager, and, through the Contract Manager, to the Chairman of the Project Policy Committee and representatives of the Federal Highway Administration. Approval for preparation of the internegative and the running of the necessary copies for the participating states was obtained. The copies were obtained and distributed to the participating states. The internegative was forwarded to the Contract Manager. The final film statistics are as follows:

Title:	FROM THE DRIVER'S VIEWPOINT
Length:	20 minutes
Type:	16mm
	COLOR
	SOUND
AUDIENCE:	General

CONCLUDING STATEMENT

This project utilized multi-disciplinary study teams to investigate the driver visual communication systems currently being utilized on the streets and highways of this country. The value of team studies cannot be overestimated. The very fact that drivers with very limited knowledge of the traffic control system were able to identify many problems and, in a great many cases, indicate why these problems occurred, is most significant. The fact that the subjects frequently interpreted devices in a manner quite different from that intended also supports the need for this type of evaluation if the communication is indeed to be effective.

It is apparent that such studies will not directly produce solutions. Far more important, they produce ideas which the engineer can nurture into a solution or series of solutions. Frequently, the engineer becomes so engrossed in the technical details that he completely overlooks the most outstanding problem. The old adage, "If you want to know what is wrong with a system, ask a user," is certainly true of the driver communication system.

The multi-state (or for that matter, multi-agency) approach to sponsoring research certainly is one of the most effective means of conducting research. The research staff was constantly surprised by the quality of leadership and the objective decisions reached by the Project Policy Committee. Free from the pressures of the individual states, each member could indeed direct the project along the course which he personally felt would be most productive.

The Project Policy Committee could and did change the direction of the project by majority vote which permits the project to pursue the course which will be the most beneficial to all concerned.

The active involvement of the sponsoring agencies provides direct inputs of many different viewpoints and the opportunity for direct implementation of the research findings. This is undoubtedly the most significant advantage to the multi-agency concept. The direct inputs by persons who will ultimately use the findings of the research tends to direct the research staff along more practical lines. This can also be considered as a significant advantage.

The objective of applied research is to produce results for direct implementation. The multi-state research concept is most effective in accomplishing this objective and should be encouraged by all levels of government.