- o SINGULAR TESTING. Many devices are used jointly in concert with others, rather than singularly by themselves. Testing in that case must be done jointly in context with the other dependent devices as a total package. Otherwise misleading, invalid results will occur.

- o REALISTIC DISPLAY. Too often, presentation of TCD's under test does not include normal distractions that drivers regularly experience such as other moving vehicles in the traffic stream, pedestrians, parking maneuvers or an excessively long viewing interval.

- o RESTRICTIVE VISIBILITY MODE. Testing is commonly conducted under clear visibility conditions, while many (or most) traffic control devices are most critically needed under less than clear visibility conditions. Test conditions should recognize the need to replicate those critical viewing conditions.

- o NON-VERBAL RESPONSE. Many test procedures depend on a verbal response, including written or multiple-choice answer, which inject the additional requirement of fluency in the testing language. Such language fluency is not necessarily required to understand and respond correctly to the device under test. More accurate, reliable indications can be obtained from test procedures that require non-verbal responses.

CONCLUSION

Laboratory testing of driver response to TCD's using a variety of simulation techniques offers the prospect of a quantum improvement in accuracy and validity of test results. Agreement on standardized testing procedures followed by refinement and validation out on the roadway appear to be the next steps toward improving the effectiveness of uniform traffic control devices. Such standardized testing procedures would include the following requirements:

- o Nighttime illumination as well as daytime.
- o Both wet and dry pavement scenes.
- o Realistic scenes containing many TCD's in context.
- o Non-verbal response measurements.
- o Consideration of "Novelty Effects."

TESTING TCD COMPREHENSION

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Signs used to regulate, warn, and guide traffic have long been one of the standard means of communicating to the driver. Recently, however, there has been evidence that the system of regulatory, warning, and symbol signs currently in use is not well understood by the motoring public. The purpose of this project was to identify, from existing research on warning, regulatory, and symbol signs, where deficiencies in motorists' understanding may pose safety or operational problems, and to define acceptable levels of motorist comprehension.

The study developed alternative designs to remedy the identified deficiencies. These proposed alternatives were laboratory tested, and final sign designs were tested in a simulated highway environment. The results of the simulator testing were verified in closed field tests.

Since there are many test techniques used to evaluate traffic signs that contain the word "comprehension," it is clear that comprehension means different things to people. In fact, many of the tests measure similar characteristics of the sign or human performance response to sign stimuli, but they go under different names. Many arguments have been advanced as to the validity and importance of each of these techniques. They are all valid to a degree, but their relative importance to the initial design process varies. It can be argued that only two measures are of real importance in the initial design process: conspicuity and understandability. Conspicuity is a measure of how well the sign "stands out" from its background or how often it is noticed. Clearly, in order to be able to read and understand a sign, one must realize that there is a sign in the first place, or how can a person read a sign he cannot see?

Understandability is a measure of how well the meaning or intent of the sign is communicated. It is good that a motorist can notice a sign along the road, but if he pulls over, stops, and looks at the sign and cannot even guess the message that the sign is trying to convey, then the situation is no better than if he did not detect the sign in the first place. It can be argued further that conspicuity can be improved by varying the contrast between the sign legend and the sign background or the sign background and visual environment, but meaning and the understanding of a concept are areas where variance of strict physical parameters are not likely to improve performance. Therefore, comprehension as defined in this study was cognitive understanding of a concept represented by a sign.

This study used a comprehensive review of the research literature, as well as other information sources to explore the magnitude of the motorist sign comprehension problem. Knowledgeable transportation professionals were contacted to obtain any information they might have regarding this problem, and a review of tort liability cases involving highway signing was conducted to see if any incidence of problem signing showed up in the court records. The purpose of these activities was to establish an information base which was used to identify signing with comprehension deficiencies.

Once the final group of problem signs was identified, work began on generating redesigned signs. The designs addressed the specific problems associated with each sign, whether it be aiding the motorist in establishing directional references, as with the DIVIDED HIGHWAY sign (W6-2) which is confused with the END DIVIDED HIGHWAY sign (W6-1), or firmly establishing a concept which may be totally foreign to the driver, such as flagging as a traffic control (ADVANCE FLAGGER sign, W20-7a).

Once new sign alternatives were developed, laboratory, simulator, and field procedures were used to test the various sign redesigns. The simulator was used to test for potential problems in viewing the new designs in an active or moving environment. Closed field testing was used to verify the simulator results. The bulk of the test work, however, involved the laboratory experiments. It was felt that in these experiments the greatest amount of new knowledge regarding motorist comprehension was gained.

The purpose of the laboratory evaluations was to select the most promising sign redesign alternatives for simulator testing and field verification. Because of the large number of candidates, two separate laboratory procedures were conducted to select the most promising sign designs for simulator testing. The two laboratory studies involved a screening procedure and a selection procedure. The screening procedure eliminated those sign redesigns that were the least effective. The selection procedure identified the sign design that was the most promising. After each of the most promising design candidates was compared to its existing counterpart, final recommended changes to the MUTCD were made.

Test booklets containing the sign design options placed in contextual highway scenes were prepared. Each page included a picture of the sign and the question "What do you think this sign means?" Some of the responses from the screening procedure indicated that some subjects were "reading" too much or too little into the highway context scenes. They appeared to be too generic. In an attempt to correct this, the generic scenes were tailored more to the sign which was to be placed in the scene.

Since many of the written responses from the screening procedure had meanings which could have been interpreted many ways (e.g., "schoolbus - stops ahead", or "school busstops ahead"), it was decided that after the subjects filled out the test booklets they would be debriefed about their replies. The debriefing had two approaches: one used non-directive questions to clarify vague responses or elicit additional information, and the other asked direct questions about parts of the symbol or why a certain reply had been made. Those conducting the debriefing attempted to gather as much additional information as possible with the non-direct approach before beginning any direct questioning.

Information gathered from the debriefings was used to clarify subjects' written responses. This allowed the experimenters to assign specific replies to "gist" responses with a greater degree of confidence than in the analysis of the screening procedure results. The debriefing also provided insight into problems dealing with communication by sign and into the effectiveness of that communication which heretofore had not been identified. Upon probing subjects about some answers which were considered "incorrect" in the screening procedure analysis, it was found that these subjects did have a functionally correct interpretation of the sign but failed to express it in writing. Therefore, many of the answers previously considered incorrect were counted as correct answers.

A discussion of the individual results for two of the signs follows.

<u>W1-2 Curve Sign (Test Signs 1-4)</u>. The best performer in this group was Sign #3 (92 percent correct). The existing sign did quite well also (84 percent correct). One problem did surface during the debriefing with this sign. It means that there is a personal conceptual stereotype for a section of road which is not a tangent section. What this means is that everyone has his or her own way of describing a section of curved roadway. For one person, if the road is not straight it is curved. The degree of curvature is sometimes indicated by an adjective such as "right angle" or "little," or sometimes degree of curvature is not noted at all. For someone else, any type of curve is a turn (e.g., sharp turn, an easy turn). When shown the Curve Sign and asked to tell what the sign means, a subject would reply, "It's a turn." If the subject was shown both signs side by side and asked if he noted a difference between the two signs, he

would say, "Well they're both turns, but this one (pointing to the Curve Sign) is a longer turn." Asked to elaborate on what a longer turn was, he would reply, "It's not as hard as the other one (the Turn Sign)." One begins to sense that the actual difference between these signs may be noted by different drivers, but with replies such as this it is difficult to say if one sign communicates the idea better than another one.

S1-1 School Advance Sign (Test Signs 17-21). Sign #21 was the sign most often correctly identified (83 percent correct). During the probing procedures, replies to certain questions caused some concern over whether the "advance" and "crossing" concepts are understood at all. An example of this would be when a subject was shown Signs #18-#21 he might give a written reply, "school crossing." If the subject was asked what he thought the arrow on the sign meant, he would reply, "Ahead." But of course it means ahead, all these signs (in the test booklet) mean ahead. Don't they? You wouldn't be warning me about something behind me, would you? When shown School Crossing Sign this same subject would give the written reply, "School Crossing." Since there is no arrow on the crossing signs (Test Signs #22 and #23), there is no way to prompt the subject on the inferred concept of ahead. If one of the test advance signs (Test Signs (#18-#21) was shown side by side with either of the crossing signs, and the subjects were asked to note any difference between the two, the concept of having two signs to warn about the same thing is so foreign to them that they would invent new interpretations for the advance sign (e.g., "School children along this road"). This was done despite the fact that they had already interpreted the sign differently. Again, it seems that part of the message does get through, but it is difficult to see if it is the exact desired message.

As part of this project many different tests were performed to determine which signs had good cognitive value. During the laboratory, simulator, and field phases it was learned which of the tests were the most effective. With this new knowledge, more effective sign design and evaluation procedures can be developed.

TESTING MOTORIST UNDERSTANDING OF TRAFFIC CONTROL DEVICES

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The two major approaches to evaluation of traffic control devices are laboratory and field testing. Each approach has its advantages and disadvantages. Field tests provide the "real world" environment of the driver and are therefore more representative of the actual driving situation. However, some methods, such as studies on eye movements while driving, involve equipment which is very intrusive and creates a situation which is not all that realistic. In field methods which incorporate observation of driver behavior (e.g., using video cameras, recording by observers) the drivers' behavior is known, but the reasons for it may not be. For example, if a vehicle turns left when there is a "no left turn" sign, is it because the sign was not seen, was not understood or was deliberately disobeyed? Unless we can determine the reason for the violation, the adequacy of the traffic control device remains unknown. Field testing involving in-vehicle measurements (e.g., instrumented vehicles) are excellent techniques, but are also very time consuming and expensive.