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

Robert Dewar, Ph.D.
University of Calgary, Alberta

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.

The advantages of laboratory approaches are mainly economical (unless one is using a sophisticated simulator), and many subjects can often be tested simultaneously, using film or slides. Although it may seem essential in a laboratory procedure to duplicate the divided attention demands of the driving task by using secondary or loading tasks, evidence suggests that this may not be necessary. In a series of reaction time experiments by Dewar and Ells (1984) involving the same set of 16 signs (half symbolic and half verbal) a variety of laboratory reaction time procedures were used. The simplest was the presentation of only a slide of the traffic sign to be responded to as quickly as possible. Other variations included secondary tasks that involved processing of digits, maintaining a speedometer at a specific speed, and presenting the stimuli against a visual background which was very similar to the visual scene observed by the driver (a motion picture of a roadway scene taken from a moving vehicle). Other loading tasks involved the processing of digits at the same time the traffic sign was presented, as task requiring varying degrees of mental effort - detection, identification, and memory (Testin & Dewar, 1981). The overall results of this series of experiments indicated that the correlations between reaction time to these signs and a roadway measure of legibility distance was independent of the use of secondary loading tasks. The simple procedure of presenting only the slide of the traffic sign seems adequate to measure this particular aspect of traffic sign comprehension (speed with which the sign could be identified).

There are various ways of asking the subject what a traffic sign means. One of the most effective techniques has already been described by Martin Pietrucha. This involves simply asking subjects what the sign means (in the case of symbols) and recording the answer (or having the subject write it down).

Following up the response by determining why the subject thought the symbol meant what it did can give valuable additional information about why a symbol is or is not effective. Other techniques involve clarity ratings, where subjects are asked to indicate (for example on a five-point scale) how well a symbol conveys a particular message. Another procedure which provides some information about the "meaningfulness" of a symbol, even when the subject does not know its actual meaning, is the semantic differential, a measure found to be correlated with comprehension as measured by more traditional techniques (Dewar & Ells, 1977). Occasionally preference measures are used to determine how well subjects like specific versions of traffic sign symbols. This subjective technique might give some helpful information where other procedures do not differentiate versions of a traffic sign message, however, in general they should not be relied upon as being particularly helpful in gauging comprehension.

In evaluating motorist understanding of traffic control devices it is important initially to determine the criteria by which a sign will be judged. Understanding the meaning of a sign, and what response is appropriate to a sign, is obviously of prime importance. Other considerations which are relevant include the speed with which subjects can understand messages (reaction time) and the distance at which messages can be understood. In some instances ability to comprehend the traffic control device when it is seen for only a fraction of a second (glance legibility) may also be important. Therefore, in evaluating effectiveness of traffic control devices one must combine several techniques in order to get the broad picture of how adequate a particular device is. Examples of the use of this combined approach can be found in work by Roberts, Lareau and Welch (1977), as well as Mackett-Stout and Dewar (1981). In these two studies

the results of the different techniques were combined to form a single index of the effectiveness of symbols.

References

Dewar, R. E. & Ells, J.G. (1977). The semantic differential as an index of traffic sign perception and comprehension. Human Factors, 19, 183-189.

Dewar, R. E. & Ells, J.G. (1984). Methods of evaluation of traffic signs. In R. Easterby & H. Zwaga (Eds) Information Design: The Design and Evaluation of Signs and Printed Material. Chichester: John Wiley, 77-90.

Mackett-Stout, J. & Dewar, R.E. (1981). Evaluation of symbolic public information signs. Human Factors, 23, 139-151.

Roberts, K., Lareau, E.W. & Welch, D. (1977). Perceptual factors and meanings of symbolic information elements. Vol.: II, Technical Report, Washington, D. C., FHWA, Report No. FHWA-RD-77-65.

Testin, F. J. & Dewar, R.E. (1981). Divided attention in a reaction time index of traffic sign perception. Ergonomics, 24, 111-124.