attributes of drivers. Positive Guidance is designed to provide spot and short-segment information system improvements to ameliorate safety and operational problems at relatively low cost. It is based on the premise that a driver can be given sufficient information to avoid accidents and/or drive efficiently at hazardous locations and locations with operational problems.

Once it has been established that the appropriate complement of devices has been utilized, it still remains to determine whether, how, and to what extent each device has been tested. From the perspective of the Federal Highway Administration, it is most important that uniformity and appropriateness of traffic control devices be maintained through standardization of devices and device applications. However, even with standard devices applied in accordance with the Manual on Uniform Traffic Control Devices, there is no certainty that there has been appropriate empirical evaluation of the device. As a matter of fact, until recently, there was little knowledge of what signs, signals, or markings have been tested.

An on-going study by Comsis, Inc. was commissioned by the Federal Highway Administration to assess all standard devices. One of the study's primary objectives was to trace each device from its inception and/or introduction into the current Manual (the first Manual was introduced in the 1920's). Some devices have always been in the Manual, others were gradually incorporated, and some were included through a mechanism of request for change and approval by an advisory committee. Over the years, a procedure evolved that included the need to experiment, but many devices were never tested, particularly those that were introduced early. It was found, when the evolutionary and literature history of each device was traced, that approximately 60 percent of all devices were empirically evaluated. Thus, only 6 out of 10 devices was tested. Furthermore, there is still information lacking on those devices which were tested as to the efficacy of the testing. Hence there is no assurance that the testing which was done was proper and conclusive.

In conclusion, while the state-of-the-art of testing of traffic control devices has gone forward, there is still much to be accomplished. Devices are still used that were never evaluated, and no single criterion exists for proper testing of devices in accordance with sound human factors principles. Much work still remains to develop such criteria and test devices on a priority basis.

INFORMATION PROCESSING AND PERCEPTION

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Speaking positively, our traffic control devices, in general, are performing successfully, as evidenced by steadily declining accident rates and comparative reports of driving experiences in foreign countries. As always, we are striving for improvements in traffic control devices by identifying and developing techniques for their evaluation before they go out for actual trial and error utilization on public streets and highways. Some laboratory research has been done on many devices currently in the Manual On Uniform Traffic Control Devices, but nearly half have not been formally tested.

Driving requires the continuous reception and processing of information as a prerequisite to the decision-making process before actions can be taken. Most of the information is received visually, but the human computer only operates on one channel at a time, considering one problem before accepting another. The brain can time-sample by accepting information sequentially, provided the interval between samples is sufficient for the brain to respond. But if the input samples are received too infrequently, the brain's short-term memory may fail to retain the previous sample and operate independently on the following input only. The significance of this phenomenon is that warning signs, for instance, can be mistakenly installed either too close or too far in advance of the hazard.

Basic human factors and driver capabilities need to be considered in developing a standardized testing procedure. The following points are offered to illustrate the complexities involved.

- STOPPING DRIVERS DOWNSTREAM. Comparative testing of candidates devices sequentially by posting in the field and stopping drivers several hundred yards downstream from the device to question their recognition and response is one method that has been used. Unfortunately, the brain's short-term memory erases quickly in order to go on to the next problem, so that the fact that people do not remember having seen the device does not necessarily mean they failed to take into account before discarding the input. This testing method fails for reasons of validity.

- PRESENTATION OUT OF CONTEXT. If a picture, sketch or other display of a device under test is displayed out of context, as on a driver's license examination for instance, it is not likely that much useful information will be obtained from the viewer. The question remains as to how far we must go to present the test device in a roadway driving context? Movies and video displays have been used, but a mechanical driving simulator can only test one person (or perhaps a very small group) at a time, making the procedure very expensive and time consuming to obtain a large, dispersed and representative sample.

- NOVELTY EFFECT. If drivers are shown a symbol they have never seen before, their response will likely be overly positive. Yet if the symbol is adopted and put in the field in competition with the other aspects of the highway scene, as the novelty wears off there may be no improvement in response. Examples are "Dear Xing" signs or "Speed Limit 28 mph."

- NIGHTTIME DEGRADATION OF VISUAL ACUITY. Testing only under daytime lighting conditions fails for validity as many persons suffer from night myopia (the pupil opens wider as the light dims, resulting in a severe loss of focus). A normal 20/20 eyesight in the daytime may degrade significantly to 20/40 or 20/70 at night.

- VISUAL DEGRADATION UNDER SPECULAR CONDITIONS. Specular glare from mirrored surfaces, such as wet pavement, sign faces, or roadway delineators under certain circumstances can suddenly and completely eliminate the message being conveyed.

- 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.

- 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.

- 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.

- 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:

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