HIGHWAY SIGNING FOR DRIVERS' NEEDS

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ABSTRACT

Traffic signing and pavement marking practitioners rely on a number of very useful manuals to assist them in selecting appropriate highway signs and corresponding field installation locations. These tools include the TAC Manual of Uniform Traffic Control Devices (MUTCD) for Canada and the provincial traffic signing manuals, in the case of the Province of Ontario, the Ontario Traffic Manual (OTM). While the manuals generally do an excellent job in providing advice for the selection and placement of individual signs in standard situations, there is very little direction for installing traffic signs or pavement markings in more complex situations, particularly where one or more signs are required at the same location.

This paper describes a course developed for the Ontario Ministry of Transportation that addresses more complex traffic signing and pavement marking problems through the application of human factors principles to the analysis of a series of case studies. The case studies were based on videotaped road sections from across Ontario that were analyzed using a positive guidance approach. This paper provides an overview of the course content, case studies and analysis approach.

1 Introduction

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This paper describes a course developed for the Ontario Ministry of Transportation, that addresses more complex traffic signing and pavement marking problems through the application of human factors principles to the analysis of a series of case studies. The case studies were based on videotaped road sections from across Ontario that were analyzed using a positive guidance approach. This paper provides an overview of the course content, case studies and analysis approach.

1.1 Sign and Marking Challenges

Road design plays a major role in determining the difficulty of the signing and the marking task. Most roadways can be signed based on traffic manual standards. However, roadways with geometric challenges will present signing and marking challenges, which the manuals may not cover, and for which engineering judgment must be used.

Examples of such challenges include:

- Signing and marking of unusually sharp curves
- Signing and marking of road sections with abrupt transitions between high speed freeways or multi-lane highways and the first signalized intersection
- Signing and marking of passing lanes in which vehicles may be stopped to make left turns
- Placement of guide signs at closely spaced interchanges

These situations may come to light because of high crash rates, observations of municipal or police road patrols and/or public complaints. Often it will be the case that standard signing and marking techniques have been used, but do not appear to be sufficient. To enhance traffic operations and safety for a challenging road design, an understanding of driver needs and limitations in vision, visual search and information processing is needed. This knowledge will help traffic professionals to optimize the selection, design and placement of signs and markings in these situations.

1.2 A Course for Practitioners on a Drivers' Needs Approach to Signing

The Ministry of Transportation of Ontario (MTO) recognized that there was a gap between information available to signing and marking practitioners in the manuals, and the "real world" requirements of getting the message to the driver in the most efficient manner. To address this problem, the MTO funded development of a two-day traffic highway-signing course to go beyond the manuals, in order to assist practitioners in making more informed decisions about highway sign selection and placement in complex or problem locations.

The course development involved visiting the MTO Regional Traffic Offices to determine their needs for the proposed course, videotaping locations where traffic operational issues were being experienced, and creating a course which began with a review of the human factors issues affecting driver behaviour, and then used the videotaped locations as case studies to illustrate the application of human factors principles. The course attendees gained a new perspective on how to deal with difficult signing and marking issues.

In this paper we provide an overview of the course material that was presented.

2 Existing Highway Signing Tools

The single most important highway signing tool available to the Canadian traffic signing and pavement marking practitioner is the TAC MUTCD. In addition, the provinces of Québec, Ontario, Alberta and British Columbia have their own provincial MUTCDs or traffic manuals, which have been developed with each province's specific signing and marking needs in mind. In those provinces where a provincial manual exists, that manual is the first reference tool used in making signing and marking decisions. When the provincial manual does not cover the particular signing or marking problem, the next reference source is the TAC MUTCD. Other manuals, such as the MUTCD for the United States can also be referenced if necessary.

These tools are excellent reference and guidance documents, which can assist all practitioners, regardless of experience, in making decisions regarding sign selection and placement. However, there are many complicated scenarios facing the practitioner that are not detailed in the tools mentioned above. In the past, practitioners have relied on experience and engineering judgment to make decisions in these cases. The manuals refer to "using engineering judgment" when laying out more complicated signing or marking plans. In many instances, the only way that a practitioner knows if the final signing or marking solution is effective is to monitor the collision history and complaint data. It would be preferable if there were a more solid basis for making decisions in these cases than "engineering judgment". The approach taken by this course was to educate the practitioner about what a driver needs to know, when they need to know it, and what the driver's limitations in visual search and information processing are, and how to select signs and markings that address these limitations. The analysis method involves putting the practitioner "in the driver's seat", determining

whether key sign characteristics have been considered and applying positive guidance principles to develop improved signing and marking.

3 Human Factors and Drivers' Needs Course Content

Drivers obtain information about the driving task from a variety of sources. The principal source is the road design itself. When the road design changes, signs and markings play a critical role in informing the driver so that he or she is prepared to respond appropriately to changes in the driving task.

The first half day of the course provided:

- An overview of the driver characteristics and limitations in visual search and information processing that underlie effective sign design
- A discussion of six attributes that must be considered to make signs effective: conspicuity, legibility, comprehension, information load, sign placement and driver response

A summary of the content of this part of the course, with the exception of driver response considerations, is given below.

The remainder of the course involved the presentation of case studies of problem road sites, and application of a human factors analysis to the selection and placement of signs and markings.

3.1 Overview

The first section of the course deals with the basics of driver limitations and abilities with respect to visual search, information processing and mental workload. An understanding of these reveals the importance of:

- Standard colours and shapes, sufficient letter height and proper placement to ensure signs are detected, identified, read and responded to rapidly
- Short, unambiguous messages for drivers who must time-share between vehicle control and time reading

3.1.1 Driver Visual Search

For several decades, studies have been carried out using eye movement cameras to record drivers' visual search patterns. Mourant and his colleagues did much of the early work on driver search and eye movements and published their findings in 1969. Among these findings are that most eye movements in driving are less than six degrees travel. About 90% of fixations fall in a narrow region within 4 degrees of the focus of expansion – the point in the moving visual field straight ahead of the driver where objects appear stationary. Hence, visual scanning is fairly restricted, which may account for drivers missing signs that are placed too far to the side of the road or too high (1).

The driving task, to a large extent, determines the search pattern. As compared to driving on an open road, the search pattern is much more concentrated during close car following. If patterns were to be recorded as drivers approached a signalized intersection, intending to turn left, the pattern would be different again, with more fixations to the left and fewer to the right. The point is that driving is visually demanding and drivers' fixations will be, for the most part, determined by their particular driving task. Signs should be placed where drivers are already looking, and where they expect to see them. Drivers expect signs to be placed on the right and close to the travelled way. Therefore placements that violate these expectations will result in signs not being detected or being detected late.

3.1.2 Driver Information Processing

The human capacity to process information is limited. It has been estimated that out of over 1 billion bits per second of information directed at our sensory system, people are consciously aware of only 16 bits per second. Driving at fast speeds, in effect, increases the amount of information in the environment, thereby taxing our information processing capacity. Limitations of drivers' information processing capabilities require that changes in the highway environment occur gradually, and that the amount of information on highway signs and the number of signs be severely limited.

Despite our limited capacity to process information, drivers function quite effectively. The average driver has only one accident every 20 years after all. The main reason for our effectiveness is that people are expert "pattern-recognizers" and depend very much on previous experience to respond quickly and accurately in most driving situations. This works well if the environment corresponds to our expectations.

3.1.3 Driver Mental Workload and Performance

Driver mental workload depends on the demand of the driving task. Task demand is dependent on the driving task (e.g., making a left turn vs. driving through an intersection), on road geometry (e.g., straight vs. curved roads), on traffic density and mix (e.g., trucks, bicyclists), on environmental conditions, on driver familiarity and experience, and on vehicle characteristics (e.g., width and length, braking distance, standard vs. automatic transmission, acceleration capabilities).

Drivers do best at a moderate level of demand. In contrast, performance is poor and errors more likely when drivers are either overloaded or underloaded. Overload situations can occur due to such combinations as high traffic densities, with demanding road geometrics, varying traffic speeds or signs loaded with information. Underload will occur on unvarying roadways with few exits or entrances, and little traffic. In underload situations, stimulation is reduced. In response the brain shuts down and is less responsive to stimuli that should be detected. Some roadway sections do induce driver boredom and even sleepiness.

The length of time that a driver will look at a highway sign is related to driver workload. Bhise and Rockwell measured how long drivers spent reading guide signs when following an unfamiliar route, as a function of traffic density (2). In low-density traffic, in the 8 – 10 seconds that a guide sign was legible, drivers spent a total of 2.6 seconds on average looking at the each guide sign that they needed to use to follow a route. In high-density traffic, drivers reduced total glance duration considerably, to an average of 0.9 seconds per sign.

Eye movement studies indicate that during highway driving, drivers make frequent brief glances – on the order of 3 glances per second, within a narrowly constrained area, suggesting that driving is a visually demanding task. Signs are generally glanced at more than once. Long fixations are avoided because drivers are reluctant to go for more than two seconds without checking the road.

3.2 Effective Sign Attributes

Effective signs do the following:

1. They attract the driver's attention, even in a cluttered background (Conspicuity).
2. They maximize legibility through use of optimum letter fonts and line spacing, and optimum background colour and luminance contrast (Legibility).
3. They use word messages and symbols which have been tested for comprehension and have been shown to be understood by the majority of road users (Comprehension).
4. They limit the amount of information so that, for a given letter and symbol height, drivers will have sufficient time to read the entire message, and extract the necessary information (Information Processing).
5. They use letter and symbol heights of sufficient size, and are placed at an appropriate distance from the turning point, so that drivers have not only the time to extract information from the sign but also the time to carry out any manoeuvre, such as a lane change, that must be completed before a turning point is reached (Sign Placement).
6. They produce the desired driver behaviour.

Each of these attributes is discussed below.

3.2.1 Conspicuity

Conspicuity refers to the attention-attracting quality of a sign, and depends on the sign characteristics, on the interaction of the sign with the background in which it is seen, and on whether and where the driver expects to see it. The more conspicuous a sign is, the easier it will be for a driver to detect it quickly.

Drivers actively search for signs and as long as they are placed where expected, drivers will find them. Eye movement studies suggest that drivers look at virtually every traffic sign (3). Warning signs were looked at twice on average, with average glance duration of ½ second. Shorter glances may also be made. A glance as short as 1/10 second is enough to identify sign shape and colour, which in the majority of cases tells the driver what type of information is on the sign and whether further attention is required.

At night, retroreflectivity is critical for increasing the distance at which a sign is detected. Sign materials are designed to reflect light back along the angle of incidence. The closer the driver's eye height is to the headlight height, the more light will be received at the eye. This sign design makes efficient use of headlights.

High intensity sheeting improves conspicuity. Over a period of years retroreflectivity deteriorates and it is important that there be a program of night inspection and/or regular replacement of signs to ensure retroreflectivity in maintained. Only recently has there been an extensive human factors effort to determine how much reflectivity is necessary. Although much progress has been made in identifying the required retroreflectivity level below which signs must be replaced, this requires the use of a retroreflectometer as well as considerable effort. Ontario does not currently have a policy on minimum levels of retroreflectivity.

To summarize, important principles of conspicuity are:

- Driver search pattern depends on the driving task
- In general, drivers expect signs on the right
- Drivers look at virtually every sign
- Signs placed where drivers expect to find them will be detected by most drivers
- Retroreflectivity is critical for increasing the distance at which a sign is detected

3.2.2 Legibility

Legibility refers to the distance at which a sign can be read. At the speeds that we drive, drivers move towards signs quickly – at 10 to 30 metres per second – and reading takes time. Long messages must be legible at a distance that allows the driver to read the entire message. If drivers must carry out a manoeuvre before reaching a sign, then the legibility distance must allow the driver to read the sign and make a comfortable and safe manoeuvre or else advance signing must be used. To date, sign legibility requirements have mainly been determined based on engineering judgment, and not on any measures of how far away the unfamiliar driver needed to see a sign in order to extract the information and if necessary carry out a manoeuvre before reaching the sign. Despite this, experience as drivers suggests that most regulatory, warning and guide signs do have adequate legibility, although there are notable exceptions. These exceptions are mainly signs for which drivers must complete a manoeuvre before reaching the sign (e.g., road name signs, left turn restriction signs), or extended

messages, such as are found on advance notification construction signs and changeable message signs.

Only 73% of the population has 20/20 corrected vision and we do license drivers with up to 20/40 vision. An extensive U.S. Federal Highway Administration (FHWA) study of legibility concluded that to provide the letter size needed to accommodate 75 – 85% of older drivers and 95% or more of younger drivers, under both day and nighttime conditions, a legibility of 3.6 m/cm should be assumed for series C and D letters that are used on warning and regulatory signs, and 4.8 m/cm for series E modified letters that are used on highway guide signs (4). In other words, a 20 cm letter height in E modified font can be read by the majority of drivers by the time they are 96 m (4.8 m/cm x 20 cm) away.

Strictly speaking, warning and regulatory signs are less legible than guide signs because the fonts used, C and D, have narrower stroke widths for a given letter height than is the case for the E modified font used on guide signs. However, warning and regulatory signs are much more familiar to drivers, and drivers can generally predict, based on colour, shape, and sign placement, what the sign will say. Familiarity can as much as double legibility distance.

Symbols can convey in a single image the same message that may require several words of text. Therefore the symbol size is generally considerably larger than individual letters, making the sign legible at greater distances as compared to the equivalent word message. Due to the significant legibility benefits of symbol signs, their use is encouraged wherever practical, as long as the symbol is well understood.

In order for a sign to be effective, it must be legible at a distance that allows a driver to read it and safely carry out any required actions within the appropriate time window of opportunity. When the message is lengthy (e.g. several destination names, or complex construction information), drivers will need more time to read the entire message than for a sign with a single symbol or a few words. If a lane change manoeuvre is required, it may have to be started or fully completed between the point at which the sign is first legible and the gore.

To summarize, important principles of legibility are:

- Drivers are moving at 10 – 30 m/second and signs must be legible at a distance that allows drivers to read the entire message
- To accommodate the majority of drivers, under both day and nighttime conditions, a legibility of 3.6 m/cm should be assumed for series C and D letters used on warning and regulatory signs, and 4.8 m/cm for series E modified letters used on highway guide signs
- Familiarity can as much as double legibility distance
- When drivers must carry out a manoeuvre, such as changing lanes, before reaching the sign, even greater legibility is required to allow for this. Alternately, advance signs must be used.

3.2.3 Comprehension

Comprehension refers to driver understanding of the meaning of the message, and any symbols or abbreviations used.

Traffic professionals often assume that if a symbol has been in use for many years, or is an international standard, drivers will understand it. Unfortunately, testing shows that this is not always the case. Word messages can be just as difficult. What is obvious to local drivers, for example, “advanced green when flashing”, may be a mystery to the tourist. Because drivers have little time to read them, sign messages are, of necessity, short and can be ambiguous. For example, a changeable message that says “congestion 1 km” could be interpreted as congestion lasting 1 km or starting in 1 km. Abbreviations that are clear to an engineer, e.g., NB for northbound, may be uninterpretable to many drivers.

When signs use arrows, placement is critical to drivers’ understanding about which lane to be in or which road to take. Drivers can be confused about which lane to take in situations where the highway curves and an overhead guide sign with down arrows is used. These signs are generally lined up so that the arrows are directly overhead the appropriate lanes. Since drivers are unlikely to be looking at the sign in the last second, this may not actually be the best alignment, however there are no studies comparing different ways of doing this and testing driver comprehension. Drivers can also be confused about the exit to which a sign with an arrow applies, when there are closely spaced exits. The use of an advance arrow when a straight arrow should be used can also confuse drivers.

Where comprehension is poor, and redesign is required, it is often the case that only small changes need be made. For example, the comprehension of the standard SLIPPERY WHEN WET sign, which has been found to be very low (44% in the Dewar et al. study) (5), was greatly improved – to 91% – by merely adding drops symbolizing falling rain, and a line symbolizing the surface of the road (6).

To summarize, important principles of comprehension are:

- Just because a sign has been in use for many years does not mean that drivers comprehend the message
- Unfamiliar drivers may not understand a message that is well understood by local drivers
- Alignment of signs using arrow designations is critical and if poorly aligned can lead drivers to misunderstand directions
- Sometimes only small changes are necessary to greatly improve comprehension

3.2.4 Information Processing

Drivers have a very limited time window in which to read signs. This is particularly critical at highway speeds, when drivers are traveling very quickly. For example, assume a sign has 35.6 cm (14 inch) letters that correlate with a legibility index of 4.8 m/cm. A driver travelling at 100 km/h (or 28 m/sec) on a freeway can first read the letters at a distance of 171 m. This means that the driver has only 6 seconds of reading time. To accommodate the 85th percentile driver, reading an unfamiliar message, such as might be found on a changeable message sign giving alternate route directions, or on a construction advance notification sign, it has to be assumed that the driver can only read approximately 6 major words or symbols.

Drivers must time share sign reading with manoeuvring in traffic, and cannot spend the total available time reading signs. As noted earlier, eye movement studies of drivers reading highway guide signs as they followed an unfamiliar route showed that typically drivers glance 2 or 3 times at each sign and in total, in low density traffic, spend an average of 2.6 seconds total time fixating on each sign, and, when closely following another car, only 0.9 seconds, with maximum total glance duration for some signs at 4 seconds. For warning signs, young drivers approaching at 73 km/h looked twice on average at each warning sign, with each glance lasting approximately ½ second (7).

Based on eye movement research, Mace & Gabel describe a model to predict minimum required visibility distance (MRVD) for static signs that considers driver information processing time (8). With respect to reading time for standard regulatory, warning and guide signs, they use an estimate of approximately ½ second per word, and a minimum of 1-second reading time for a symbol. Mace and Gabel estimate that the maximum glance time that a driver might use to read a sign, with lower volumes of traffic and wide lane widths, would be 4 or 5 seconds. If the message length exceeds what can be read in this time period, then an away (from the sign) time is considered, during which the driver glances at the road.

To summarize, important principles of information load are:

- Reading times while driving should be considered to be on the order of ½ second per major word for static signs with simple and/or familiar messages
- Where messages are unfamiliar or complex, a longer time, on the order of 1 second per major word, is a more appropriate estimate.

3.2.5 Sign Placement

In order for a sign to be effective, it must be legible at a distance that allows a driver to read it and safely carry out any required actions (e.g., a lane change) before reaching the decision point. A key placement issue for directional and guidance signs is to ensure enough time is available for the driver to check for a gap and change lanes comfortably before reaching a gore or turnoff. In low volume conditions, to encompass the majority of drivers, a distance equivalent to 8 seconds at the assumed operating speed is

required, and in high volume conditions, this time should be increased to 9.8 seconds. If advance signs are used, this increases the distance between where the information becomes available to the driver and the gore.

To summarize, an important principle for sign placement is:

- Signs must be legible at a distance that allows a driver to read them and safely carry out any required actions (e.g., a lane change) before reaching the decision point.

3.3 Positive Guidance Principles

Knowledge of human limitations in information processing, and human reliance on previous experience to compensate for this limitation, lead to the "positive guidance" approach to highway and traffic control device design. This approach is based on a combination of human factors and traffic engineering, which was developed in the early 1970's (9) and elaborated on in a series of documents published by the U.S. Federal Highway Administration. With respect to traffic control devices, the positive guidance approach emphasizes several issues:

- **Primacy** – determine the placements of signs according to the importance of their information, and in such a way as to avoid presenting the driver with information when and where it is not essential
- **Spreading** – where all the information required by the driver cannot be placed on one sign or on a number of signs at one location, spread it out over space so as to reduce the information load on the driver
- **Coding** – where possible, organize pieces of information into larger units, using colour and shape coding to enhance performance. Colour and shape coding of traffic signs accomplish this by representing specific information about the message based on the colour of the sign background and the shape of the sign panel.
- **Redundancy** – say the same thing in more than one way. The STOP sign in North America has a unique shape and message, both of which convey the message to stop. Redundancy can also be expressed by giving the same information with two devices (e.g., "no passing" indicated with a sign and pavement markings).

The central tenet of the positive guidance approach is that designs that meet drivers' expectations increase the likelihood of drivers responding to situations and information correctly and quickly. Conversely, when drivers are surprised because their expectations are violated, slowed responses and errors occur.

The implications of positive guidance for traffic signs is that the most important signs (e.g., stop signs) must take priority over less important signs (e.g., guide signs). Information presented to the driver should be spread out, so that the driver can deal with it in small chunks. When a driver is busy following a curve and observing chevron

signs, other non-essential warnings (e.g., moose crossing) should not be presented if this information can be located just as easily on a tangent section. Where there are a number of traffic signs that drivers must look at, advertising signs which might unnecessarily occupy the limited time available to read signs, should be prohibited.

4 Case Studies Course Content

The course was designed to provide the underlying human factors concepts and principles to the course attendees first and then to reinforce these concepts through examples in the form of case studies. The topics for the case studies were based on a number of criteria. Early in the process of developing the course, iTRANS visited all but one of the Provincial Regional Traffic Offices to discuss examples of challenging areas that might be covered in the course. With these specific locations in mind, we then visited each site and collected video, still photographs and field notes. In travelling to these locations, we also identified other sites that we felt would assist in illustrating the course concepts.

The topics selected for case studies were:

- Curves
- Passing lanes
- Highway transition areas
- Interchanges and lane designations
- Intersections
- Speed management and pedestrians

The locations, situations and signs/markings selected for each case study were treated as hypothetical examples. It was recognized that the design of the locations is affected by issues not readily apparent in the short section videotaped. As we were unable to undertake extensive data collection or analysis, nor were we able to consider costs, we did not offer solutions or recommendations within the case studies. We did, however, offer potential treatments for consideration and discussion.

Each case study followed the same general structure. We covered a set of objectives to be discussed and then provided a very cursory overview of the related OTM material. Next, we presented a series of video, still photos and slides to illustrate the various Drivers' Needs principles followed by a summary of the case study content. Where appropriate, we listed potential treatments for consideration, based on prior extensive analyses of similar road sections.

5 The Drivers' Needs Signing Approach

The signing and marking approach presented in the course was developed from the principle that drivers' needs are critical to understanding the reasons for site-specific operational problems. A complete investigation of the site must include field

measurements, an inventory of the signing layout, a review of complaint history, a thorough analysis of the collision history, a review of subsequent reconstruction and signing/marking changes since the initial construction, a review of the appropriate sign manuals, and a review of the site from the perspective of driver needs. The key to implementing this approach is for practitioners to look at the signing problem from the perspective of the unfamiliar driver.

The proposed technique can be used for new construction, but it is most useful in addressing existing conditions where no roadway construction or geometric changes are anticipated, or where minor adjustments or changes in geometrics (e.g., the introduction of a new intersection or geometric feature) are proposed.

When addressing more difficult signing and marking problems, it is important to remember that practitioners cannot always correct roadway design anomalies. Roadways cannot always be designed according to the optimum design rules and standards. Existing road operations, local terrain, environmental conditions and local political considerations all contribute to the necessity of non-conformance to design standards. It is an unfortunate assumption of many in the design fraternity that design anomalies can be fully addressed with traffic signing and marking solutions, and the sad truth is that this is just not so.

5.1 Video Data Collection

Analysis is greatly assisted by means of video recordings, and the use of these to review the problem area and to consult with colleagues. Video recordings should be made from the perspective of the driver's point of view. An effective technique involves the use of a video camera, mounted on a tripod in a van with no centre console between the front seats. To ensure a steady picture, so that sign messages can be read, the tripod feet must be stabilized.

A good video recording of a roadway signing problem serves several purposes. It:

1. Provides a permanent record of the roadway conditions, whether before or after the solution has been implemented
2. Provides an inventory of existing signing and markings
3. Permits an analysis of the human factors involved with the particular problem
4. Provides a means of soliciting peer opinions
5. Permits viewing of the sign layout for the future when additional signs may need to be installed

Limitations of video recordings must be kept in mind. The driver can detect and read signs and see traffic lights and other signals at a much greater distance than is the case for a viewer of the video. Therefore the driver making the recording should report the point at which he or she can first read the sign, and read the sign message.

Lighting conditions are important. The best recording conditions are on sunny days when the sun is high. Although the newer digital cameras can compensate to some degree for low-level lighting, on overcast days signs will still record as dull images and may not be legible. A true sense of the sign's condition will not be realized. Similarly, direct sunlight on the signs (i.e. the sun is low in the sky and behind the driver) will show too much reflection and the sign's legibility is compromised. Nighttime conditions are nearly impossible for video recording as the image seen by the human eye cannot be adequately shown without specialized video equipment. Finally, recording in the rain should be avoided, as the camera's auto-focus will constantly try to focus on the windshield and not on the image outside.

5.2 Manual Review

Sign manuals should be reviewed. This exercise may be unnecessary for practitioners who are familiar with the available manuals, but is essential for newer practitioners. Knowing the available sign selections and the standard installations is critical in the initial review of the existing signage and markings. Deficiencies in terms of sign selection and location will become apparent.

5.3 Drivers' Needs Review

For each signing issue, the sign attributes, discussed earlier, should be reviewed. Questions appropriate to each attribute are given below. In every instance, the practitioner must try to put themselves in the position of unfamiliar drivers, trying at all times to view the signing and marking as though they were seeing the situation for the first time.

Sometimes, as additional signs are added to a roadway, they are installed in locations where they block existing signs or provide insufficient reading time, reducing the effectiveness of the original sign layout. When conducting a review, these problems must be identified and resolved.

5.3.1 Conspicuity Review

Are the signs and markings conspicuous? Can the unfamiliar driver readily see the signs and markings from a sufficient distance? Are the most important signs as visible as they can be? If not, the new sign layout needs to rectify this problem by introducing larger signs or perhaps improving retroreflectivity or improving sightlines (such as trimming foliage).

5.3.2 Legibility

Are the signs legible far enough away to allow the driver to easily read the entire message? Are they worn and in need of replacement? Do they follow the sign design standards outlined in the MUTCD or other manuals regarding symbol size and shape,

letter font, stroke width and letter spacing? Is the sign retroreflective so that it can be read in the dark? If not, should new signs be installed?

5.3.3 Comprehension

Are there any potentially confusing text messages or symbols used on the signs? Are there any “new” or made-up signs, and if so has there been a driver comprehension test completed on the sign to see if drivers really understand the message? Are there contradictions between signs, or signs and pavement markings? If so, how should these contradictions be addressed?

5.3.4 Information Processing/Loading

Are there too many signs for the driver to read and comprehend in the time period that the sign is legible? Do drivers have sufficient time to take the appropriate actions? This review will require some calculations to determine if the driver does have enough time. Some decisions about using distance travelled per second should be based on posted or operating speeds. If operating speeds are used, speed studies should be conducted to accurately determine the operating speed.

5.3.5 Sign Placement

Are signs located far enough in advance of a gore or turn point that drivers have enough time to search for a gap and change lanes (8 to 10 seconds depending on traffic volumes) before the choice point? Are the signs located where the driver expects to see them? If not, they need to be repositioned so that drivers do not have to search for the sign message.

5.4 Assessment of Alternatives

Once inadequacies have been identified relating to conspicuity, legibility, comprehension, information load, and sign placement, the following positive guidance principles are recommended to further assess changes required to the existing signs and markings layout. These principles include primacy, spreading, coding and redundancy.

5.4.1 Primacy

The most important issue is to determine, for any given signing problem, is the information that is most important for the driver in order to negotiate the roadway ahead. In complex roadway sections such as intersections on curves and on grades, sorting the essential information into the correct order may not be simple, especially if other types of competing information, such as destination signs, are present.

The next step is to determine the placement of the prime signs in accordance with the importance of their information to the driver. The signs should be presented to the driver

so that other less important signs do not interfere with the driver's ability to obtain the primary messages.

5.4.2 Spreading

Drivers need enough time to read the messages in order to take the appropriate actions. Consequently, the next step is to review the spacing between the signs. Where the driver requires a large amount of information, it cannot be given all at one location – signs need to be spread out to allow drivers time to absorb the information on each one. When the driver is involved in a demanding driving task, such as negotiating a curve, or merging onto a freeway, he or she should not be distracted by signs unrelated to the current task.

It is generally a good idea to calculate the reading time required for the driver in the more complicated signing problems using the rules of thumb listed in the Section on "Information Processing". Together with the operating speed, reading time provides an indication of the required spacing between signs, that will allow each one to be read, These calculations may indicate a need for some of the less important signs to be relocated out of the area to reduce potential distraction. The principle of spreading out the signs applies both to ground mounted and overhead signs. Sometimes with overhead signage there is a tendency to overload the structure with signs, to avoid having to build another costly structure. In some jurisdictions the temptation to use the sign space available on overhead structures is overwhelming and inappropriate information, such as distance information signing, is sometimes located there.

5.4.3 Coding

Coding can help to simplify a driver's task when there are several signs to be read. The colour and shape of signs is essential in simplifying the message for the driver. Therefore colours associated with warning signs and traffic control signs must be restricted to those uses. When new colours are selected for information signs, they should be used consistently, so the driver can quickly locate the sign he or she is searching for.

5.4.4 Redundancy

As noted earlier, redundancy means communicating a message in more than one way. Often this is a combination of markings and signing, for example, as is used for centre left turn lanes. Other examples are lane designation signs complemented with arrow lane markings, or a right lane ends sign complemented with diagonal arrow markings which reinforce the end of the lane. Together the combination is a stronger message than either signs or markings alone. At problem sites, practitioners should ensure that the existing signing and markings complement each other. Where there are conflicting messages, steps to correct the conflict should be taken immediately.

5.4.5 Review of Potential Solutions

In the final review, there will likely be a number of improvements that might be effective in improving the roadway operations. Some of these solutions might be low-cost, such as just relocating some existing signs. Some solutions might be higher cost such as installing new signs or even overhead signage.

Often, the ultimate solution is roadway reconstruction, the most costly solution of all. Where a roadway is at a point where reconstruction is already being contemplated, the drivers' needs approach to signing is an essential technique to assisting with improving its current state. The technique can also help identify the roadway reconstruction necessary.

6 Conclusion

The drivers' needs approach to traffic signing and pavement marking is a human factors based approach to addressing operational concerns on complicated roadway sections where drivers are faced with high workloads or unexpected changes in the roadway. The technique includes a review of driver needs and limitations, as well as identification of deficiencies in sign: conspicuity, legibility, comprehension, information load, and placement. The principles of positive guidance are then applied to the signing problem under review, and alternatives to the existing signing plan are developed. This approach will assist drivers in making more accurate assessments of the roadway ahead, reduce mistakes in driver analysis of the situation ahead and improve roadway safety.

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