

SECTION 4.

HUMAN FACTORS ISSUES

As shown by the diversity of the published literature in this field, concerns about the potential impact of DBBs on road safety are based on a number of human factors concepts and principles. Much of the discussion about human factors issues is captured in the reviews of research and the development of, and recommendations for, guidelines and regulations of DBBs that appear in other Sections of this report. This section presents a brief overview of these key human factors issues.

- *Conspicuity* is often defined as the ability of a stimulus to stand out from its background. Traffic engineers want to ensure that official traffic control devices (signs, signals, and markings) are sufficiently conspicuous, day and night and in all weather conditions, that they communicate their message to the driver unambiguously, reliably, and in a timely manner. But the large size of roadside billboards (typically 14 ft by 48 ft), the placement of some such billboards close to, or directly within, the driver's line of sight, frequently changing messages and images that can appear to be flashing, and extremely high levels of illumination, tend to make such billboards highly conspicuous, particularly at night. As a result, the conspicuity of official traffic control devices and of other visual signals required for safe movement (e.g. vehicle reflectors, brake lights and turn signals as well as the vehicles themselves) may be reduced, with a consequential reduction of safety.
- *Distraction and inattention.* It is important to distinguish between these two terms, which are often confused. Inattention involves the failure of a driver to concentrate on the driving task for any reason, or for no known reason at all. It is distinguished from distraction in that it may have no known cause, and possibly no remediation. Conversely, distraction is a failure of concentration on the driving task that is a direct result of some activity or stimulus that triggers this failure to concentrate. Distraction may be due factors internal to the driver, such as fatigue, medication, illness, alcohol, or a focus on unrelated issues. It may be external to the driver but internal to the vehicle, such as mobile telephone use, adjusting the vehicle's controls or non-safety-related equipment (e.g. radio, navigation system, heating or air conditioning), conversations with passengers, or other non-driving related behaviors such as reading, grooming, or singing. Finally, distraction may be due to factors that are external to the vehicle, including vehicular, pedestrian or bicycle traffic, buildings, scenic vistas, roadside businesses, or advertising signs, including billboards. Whereas it may be impossible to control for the inattention that affects all drivers from time to time, many of the causes of distraction can be controlled.

- *Information processing.* One reason why official traffic control devices are designed as they are is to ensure that they meet certain basic human factors requirements. These requirements are described in the MUTCD, in Section 1A.02, as:

- A. Fulfill a need;
- B. Command attention;
- C. Convey a clear, simple meaning;
- D. Command respect from road users; and
- E. Give adequate time for proper response.

The MUTCD implicitly recognizes that information contained on official signs will be ineffective, and thus, possibly ignored, if the message demands too much time or effort by the road user to read, understand, and act. To this end, the Manual specifies the language for standardized word messages on signs, prohibits the display of Internet addresses and recommends, for example, the avoidance of phone numbers with more than four characters. The only exceptions to this Standard and its associated guidance are for signs that are intended for viewing only by pedestrians, bicyclists, occupants of parked vehicles, and “drivers of vehicles on low-speed roadways where engineering judgment indicates that drivers can reasonably stop out of the traffic flow to read the message” (p. 2A-2). The requirements and guidance in this section of the Manual also apply specifically to Changeable Message Signs and to logo panels on specific service signs. The demands on a driver’s information processing capabilities are addressed in the MUTCD, not only for the content of individual signs, but for the placement and spacing of signs as well. For example, the manual recommends that signs should be located only on the right side of the roadway (with certain exceptions) “where they are easily recognized and understood by road users” (p. 2A-8), and, because of increases in traffic volumes, a priority for sign installation locations should be established. Such a priority suggests that regulatory and warning signs whose location is critical, should be displayed in preference to guide signs where conflicts may occur. Less critical information, such as that on guide signs, should be moved to less critical locations or omitted, because “overloading road users with too much information is not desirable” (p. 2A-11). The Manual also requires that signs requiring different decisions by road users “be spaced sufficiently far apart for the required decisions to be made reasonably safely” (p. 2A-8), and recommends that, with specific exceptions, signs should be individually located on separate posts or mountings. Yet billboards are often placed on the left side of the road, frequently are placed in close proximity to one another, often on the same mounting, and do not generally adhere to good human factors practice that suggests restrictions to the amount of information conveyed on the sign.

- *The Zeigarnik Effect.* In 1927, Russian psychologist Bluma Zeigarnik demonstrated that tasks that have been initiated by humans but, for whatever

reason, interrupted before they could be completed, lead to feelings of anxiety and a desire to complete the task. In the years since the original demonstration of what we now call the Zeigarnik Effect, it has been shown that the discomfort related to task interruption has broad implications. For example, it is thought that it is this phenomenon that causes drivers to continue looking at the changing messages on DBBs to learn what comes next; and it is the basis of the technique used in advertising in which a complete message is “sequenced” across several different signs or multiple message changes of a single sign.

- *Brightness and glare.* Brightness is the subjective impression of the luminance of a sign, and glare is a physiological response. The majority of public complaints about DBBs concern their excessive brightness, particularly at night, to the extent that they become the most conspicuous item in the visual field, and draw the eye away from other objects that need to be seen. The photograph shown in Figure 5 was taken by the author of a DBB from a distance of six miles. The photograph was taken at 7:52 AM, and has not been altered in any way.



Figure 5. Unaltered photograph of a DBB from a distance of six miles

- *Legibility and readability.* Signs, to efficiently communicate a message, must be legible and readable. Specific design characteristics of official traffic signs such as font, letter size, color and contrast between figure and background, etc., have been specifically selected and mandated after years of empirical

testing to be optimized for legibility and readability under all conditions so that they can communicate their messages quickly and unambiguously. As one example among many, the MUTCD suggests that “word messages should be as brief as possible and the lettering should be large enough to provide the necessary legibility distance. A minimum specific ratio, such as 25 mm (1 in) of letter height per 12 m (40 ft) of legibility distance, should be used” (p. 2A-7). Conversely, billboards may display no such properties. Instead, they tend to exploit the same human factors characteristics discussed above to ensure that the signs take more time to read, demand multiple glances to communicate the intended message, etc. Indeed, billboards often mix multiple font designs and sizes, multiple colors of figure as well as background, even text written sideways or upside down on the sign, to achieve an impact that is quite the opposite of that for which official signs strive.

- *Novelty*. In human factors, it is known that a novel stimulus, one that a driver has not encountered previously, is likely to capture attention and lead to a response merely because of its novelty. Hence, when new safety treatments are applied to the roadside environment, the research that is performed to test the effectiveness of such treatments is typically postponed until the “novelty effect” has passed. When traditional, static billboards display the same message to drivers for weeks or months at a time, it is widely believed that drivers begin to ignore the signs. However, DBBs present a new and different image every few seconds, and because such images can be immediately downloaded to such signs from remote locations, the signs have the capability of presenting a unique, novel image and message to a driver every time the sign is approached.
- *Sign Design, Coding, Redundancy*. As discussed above, the key design features of official traffic control devices include size, shape, color, composition, lighting (or retroreflection), contrast, legibility, and simplicity and reasonableness of message. These features are intended to be used, in varying combinations, to draw attention to the devices, to produce a clear meaning, to permit adequate time for response, and to command respect from the road user. TCDs are designed to be uniform, unmistakable, placed and operated uniformly and consistently, and removed if they are unnecessary. “Uniformity of devices simplifies the task of the road user because it aids in recognition and understanding, thereby reducing perception/reaction time” (p. 1A-2). DBBs, on the other hand, follow none of these principles of uniformity or consistency.
- *Visual attention*. Our attention may be drawn to, or captured by, an object such as a billboard either because we make a conscious effort to attend to it (“top down”) or because some characteristic of the object (e.g. size, placement, brightness, etc.) captures our attention without volitional intent (“bottom up”). The first type of visual attention is also referred to as “search conspicuity,” whereas the second is known as “attention conspicuity.” Road

and traffic safety experts take advantage of bottom up visual attention capture by: employing unique colors for traffic control devices when challenging conditions are present (e.g. the use of orange for construction and work zones), outfitting emergency response vehicles with flashing lights and sirens, and by using flashing beacons and/or flashing messages on road signs when urgent safety warnings must be communicated. DBBs, more than any previous technology used for roadside advertising, are capable of commanding drivers' attention by employing extremely high luminance levels, bright, rich colors, and a pattern of message display that may appear to flash.¹²

- *Positive Guidance.* Positive Guidance is an analytical tool developed by FHWA in the early 1970s based upon the pioneering work of Alexander and Lunenfeld (1972). The tool is based on the premise that drivers can be given sufficient information about road hazards when and where they need it, and in a form that they can use to enable them to avoid error that might result in a crash. The tool integrates knowledge from both human factors and highway engineering to produce an information system that is matched both to the characteristics of specific roadway locations and the capabilities of drivers. Alexander and Lunenfeld developed operational definitions of the driving task and driver "expectancy," the primacy of needed information and the manner in which that information should be presented, the concept of decision sight distance, and the consequences of system failure. The Positive Guidance tool has been used, nation-wide and internationally, for more than 30 years.
- *The Moth Effect.* Green (2006) reviewed research that suggests that there is a "moth effect" that may cause drivers to not only look in the direction of a bright light source on the side of the road, but inadvertently steer in that direction as well. Perhaps more appropriately seen as a variant of the physiological mechanisms of phototropism or phototaxis, in which the eye is drawn to the brightest objects in the field of view, the moth effect has been described by some as causing crashes as a result of a driver's loss of lane maintenance due to a combination of reduced optic flow and an "intense attentional fixation on a roadside target" (p. 18).

¹² For more than 25 years, a debate has raged between the outdoor advertising industry and the road and traffic safety community over the issue of whether changeable message billboards present "flashing" messages. Most regulatory documents, throughout the U.S. and abroad, specifically prohibit signs that use flashing lights or messages. And the billboard industry has routinely defended DBB technology by stating that such signs do not flash. The MUTCD defines "flashing" as "an operation in which a signal indication is turned on and off repetitively" (p. 1A-11). The U.S. Coast Guard publishes a "Light List" (USCG, 2006) in which it describes different "characteristics of lights" used in lighthouses and lighted buoys. Two of these light characteristics could be used to define the operation of most DBBs. An "alternating" light is one which shows different colors alternately; an "occulting" light is one "in which the total duration of light in a period is longer than the total duration of darkness and the intervals of darkness (eclipses) are usually of equal duration." Note that the duration of a displayed image and the duration of any dark or blank display between successive images, is not considered in any of these three definitions. Accordingly, if one were to apply any of these technical definitions rather than a more common dictionary definition DBBs would likely be classified as flashing signs.