Human Information Processing and License Plate Design

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In many aspects of transportation, such as vehicle design and traffic control devices, "human factors" are given careful consideration. An understanding of how individuals function in their environment in response to certain stimuli usually leads to a better design. The vehicle license or registration plate has a role to play in law enforcement, data collection, traffic safety, and even the image of the state that issues it. In this paper is evaluated the extent to which states are applying basic principles of human factors, ergonomics, or human information processing in the design of their license plates. By drawing from the extensive literature in these fields, the degree to which the plate is effective in communicating its visual message can be determined. Several specific recommendations are given regarding the size, shape, color, and format of the characters used on vehicle license plates.

The license plate displayed on a motor vehicle serves several functions. First, it is an indication that the vehicle was properly registered at the time the plate was issued. To law enforcement agencies and witnesses to incidents involving motor vehicles, it is the most specific means of identifying a particular vehicle. This specificity of vehicle identification is also important to researchers interested in tracking vehicles entering and leaving study areas. To officials concerned with nighttime traffic safety, a reflectorized plate is an important item. To those interested in promoting a distinctive feature of the home state, the license plate is an opportunity to display a slogan on thousands and thousands of vehicles, wherever they may travel.

For these and other purposes the license plate may serve, it acts as a visual display. Visual displays are devices, no matter how simple or complicated, that are used to send information to a human receiver. The page of a book, a computer terminal, or a license plate is a visual display. For a display to be effective, its message must be visible, distinguishable, and easily interpreted (*1*).

As a visual display, the license plate can be assigned several characteristics that will help in the application of certain fundamental principles of ergonomics to its design. The license plate is a static display. Unlike a television or a clock, its message is fixed. Its primary message usually consists of a code—alphanumeric symbols (letters and numbers in nonword format)—rather than pictorial symbols or natural language words. A license plate is usually confined to a 6- × 12-in. two-dimensional rectangular space on an object that may be observed while stationary or while passing by at 60 mph or more. The conditions under which an attempt to read the plate may take place vary from bright sunlight to fog, or the dark of night. The license plate is an externally illuminated sign that is reflectorized in most states, but it gives off no illumination of its own.

These characteristics of a license plate as a visual display serve as a guide to the ergonomics literature. Much in the effective design of license plates is consistent with common sense. The topics in today's ergonomics literature are much more specialized than the fundamental design principles applicable to license plates. But, in systematically identifying the design principles and their treatment in the literature, it can be shown that (a) they are not always properly applied to license plates and (b) some issues still need to be researched, or at least rediscovered in the vast literature of ergonomics, human factors, and information processing. This paper is an attempt to (a) identify these principles, (b) draw inferences from research published on these principles as they may pertain to this particular application, and (c) translate these inferences into more specific guidelines for license plate design.

In the next two sections of this paper, the design principles for a license plate as a visual display will be discussed. Subsections will deal with specific components of the design problem and the evidence available in the literature.

CAN THE LICENSE PLATE BE SEEN?

Visual acuity refers to "the ability of the visual system to resolve patterned stimulation" (*2, 3*). Except for a possible state symbol, the patterns on license plates are alphanumeric characters—letters and numbers. In this section, three topics that help determine how well license plate patterns can be seen and recognized are considered.

Size and Form of Characters

Among the many articles on legibility, the work of Smith (*4*) is the most useful for the purposes of this paper. He summarizes an extended study of display legibility as a function of character size and viewing distance. The 2,007 observations in the study include a variety of display types (isolated letters, words, random number sequences) and viewing conditions (dim, normal, and bright illumination). Each combination of character size and viewing condition can be resolved into a standard measure of visual acuity, the subtended visual angle. Bartley (*5*) established 1 min of arc as the minimum standard acuity condition for normal eyes under normal conditions to distinguish fine detail. Thus a letter E would have to subtend a minimum vertical angle of 5 min (its three horizontal strokes and the two spaces between them) to allow the standard viewer to recognize and distinguish it from, say, the letter F (Figure 1).

The method used to measure legibility is simple. Attach a

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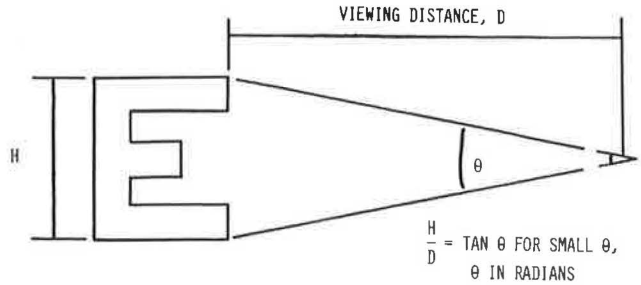

FIGURE 1 Subtended visual angle, θ.

display sample to a vertical surface. Position a viewer at a distance far enough away so that the display cannot be read. Then ask the viewer to approach slowly and record the farthest distance at which he can read the display. Letter height is then divided by viewing distance to determine the visual angle in radians (*4*). The results of Smith's study are summarized in Figures 2 and 3. The cumulative distribution in Figure 3 is especially useful as a visual display design tool, although

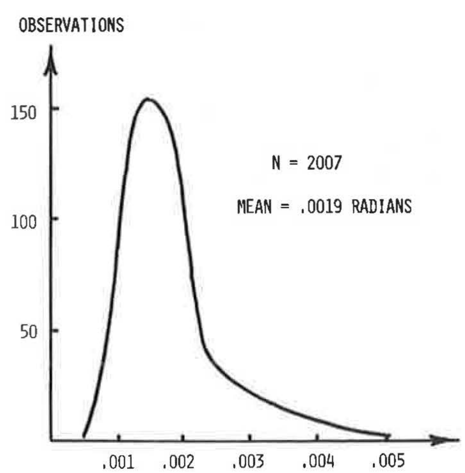

FIGURE 2 Distribution of visual angle at limit of legibility (*4*).

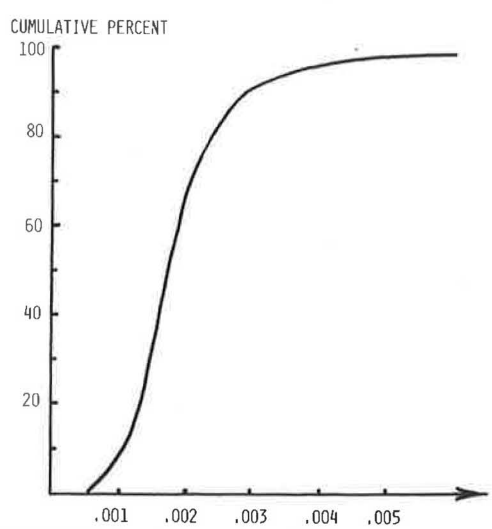

FIGURE 3 Cumulative distribution of visual angle at limit of legibility (*4*).

Smith himself misinterprets it: "at a letter height subtending 0.0015 rad, 38 percent of displayed letters can be read" (*4*,p.667).

Given the context of this statement and the variety of subjects in the study, a more correct statement would be: at a letter height subtending 0.0015 radians, 38 percent of a representative sample of observers would be able to read the display.

Smith is careful to cite other factors that influence the data collected for the study:

1. Display context can influence legibility. Word labels are more easily distinguished than are isolated letters or random numbers. Whereas the total study has a mean θ-value of 0.0019 radians, nonword displays require a mean θ-value of 0.0024 radians to be identified.
2. The visual angle required for legibility is, to some extent, dependent on viewing distance. Although no consistent relationship could be developed, mean θ for viewing distances between 10 and 22 m (the longest distances in the study) was 0.0018 radians.
3. Letter shapes, viewing conditions, and age of subject may have detectable impacts on θ. For most applications, bold vertical and black alphanumerical characters with height-to-width-to-strokewidth (H:W:T) ratios between 30:18:5 and 6:6:1 are effective in reflected displays (*1*). An example is the uppercase NAMEL style. An alternate view is offered, however, by another study (*6*), which claims that "the upper case form for any given letter will not necessarily be the most legible for use in codes" such as vehicle license plates.
4. There is often a trade-off between character size large enough for legibility and character size small enough to fit all information required for a display in a limited space. When this happens, it may not be possible to include a "factor of safety" to put character size above the 90 percent size in Figure 3; character size will instead be closer to the minimum legibility criteria. In these cases, special care should be taken to minimize the use of characters that can be easily confused. The obvious examples are O (oh) and 0 (zero), I and 1, O and Q, and G and C. The extent to which pairs of letters in a given set of letter forms may be confused can be tested by appropriate experiments (*7–9*) and evaluated using a "confusion matrix" (*9, 10*). In Table 1, for example, it is indicated that 28 percent of the time the letter Q was perceived as the letter O by subjects tested under the conditions established for the experiment (*9*).

Smith rightly concludes his study by noting that a visual display may be composed of legible alphanumerics but be

TABLE 1 EXCERPT FROM CONFUSION MATRIX (*9*)

Stimulus	Response	Percentage
Q	O	28
B	R	18
F	T	18
T	I	16
H	N	15
J	I	15

otherwise so clumsily designed or installed as to be confusing or unseen. "Legibility, then, is only the necessary first goal in the design of effective display" (*4*,p.669).

Comments on Current Practice

In this subsection some of the ideas just presented are applied to the characters currently used on license plates. Table 2 gives a sample of the variety of license plate formats recently or currently in use. Standard J686 of the Society of Automotive Engineers specifies a 6- × 12-in. overall size for motor vehicle license plates and designates the locations of the bolt holes. As for the size of the main alphanumeric symbols on the plate, most states appear to have adopted an H:W:T ratio of 69:30:7 (measured in millimeters). Examples of noteworthy exceptions are West Virginia (62:32:7) and Wisconsin (76:36:9.5). In addition, the letter in the standard Indiana passenger car format is 49:20:4. If $\theta = 0.003$ radians is adopted so that the 90 percent level in Figure 3 is exceeded, and it is then applied to the prevalent license plate letter height (h) of 69 mm, the maximum legible viewing distance (d) can be calculated as

TABLE 2 LICENSE PLATE FORMATS FROM SELECTED JURISDICTIONS

Jurisdiction	Format
California	**1 LVB232**
Florida	**TCF 087**
Illinois	**FGC 371**
	CM 6679
Indiana	**79F1046**
Louisiana	**376A892**
Minnesota	**EOL 166**
Ohio	**DDQ*394**
Pennsylvania	**GKL*347**
Tennessee	**1•6AOM71**
Texas	**487*CGE**
Washington	**CAB 143**
Wisconsin	**L68•341**
Federal Republic of Germany	**AIC–UN 938**

Note: *indicates location of state outline or symbol.

$$d = (h/\theta) = (69 \text{ mm}/0.003) = 23 \text{ m } (75.44 \text{ ft})$$

Using the rule of thumb that vehicles should not be closer than 2 sec apart, the maximum speed (r) at which a 69-mm-high license plate character will be legible under normal conditions can be calculated with at least 90 percent probability:

$$r = (d/t) = (75.44 \text{ ft}/2 \text{ sec}) = 37.72 \text{ fps} = 25.7 \text{ mph}$$

For an observer to identify 69-mm characters from a 2-sec interval distance at 55 mph (161.3 ft), he or she would have visual acuity of $\theta = 0.0014$ radians, which is at the 28 percent level. This is probably reasonable for a trained observer with good vision, such as a police officer. But the 49-mm letter on the Indiana automobile plate would not be legible to this 28 percent (72nd percentile) observer at 55 mph until the vehicle interval was reduced to 1.42 sec, which is in violation of the 2-sec minimum car-following rule.

To assess the difference between the 69-mm "standard" height and Wisconsin's 76-mm height, let us consider an average observer with a θ threshold of 0.0019 radians. Using $d = h/\theta$ with $h = 69$ mm, $d = 36.3$ m = 119.1 ft. With $h = 76$ mm, $d = 40.0$ m = 131.2 ft. Seven extra millimeters of character height provide 12 extra feet of viewing distance. More important, fixing d at 119.1 ft and using $h = 76$ mm in $\theta = h/d$ produces a θ-value of 0.0021, which includes about 72 percent of the subjects in Figure 3. Thus, 7 extra millimeters of character height add another 22 percent of the population to those who can recognize the alphanumeric symbols 119.1 ft away.

The author had an unexpected opportunity to conduct a crude experiment on this question. While driving on an Interstate highway in Indiana, Smith's test procedure was modified slightly to fit the environment of high-speed traffic. The observer's car would close gradually on cars with Indiana plates at 60 mph until he was certain of the numbers on the target plate. At that "moment of certainty" he started a stop watch while noting the location of the target car's rear bumper. When the observer reached that location, the timer was stopped. For several such trials, the times were between 1.10 and 1.31 sec. In one case, a black-on-yellow plate was approached from behind. The "moment of certainty" occurred at a "distance" of 1.50 sec. The target was a Wisconsin license plate. Because Indiana numbers are 69 mm high, Wisconsin characters are 76 mm high, and a vehicle travels 26.83 m/sec at 60 mph, the author's θs for the plates of the two states can be calculated:

$$\theta \text{ (Indiana)} = 0.069 \text{ m}/[(26.83 \text{ m/sec})(1.20 \text{ sec})] = 0.00214$$

$$\theta \text{ (Wisconsin)} = 0.076 \text{ m}/[(26.83 \text{ m/sec})(1.50 \text{ sec})] = 0.00188$$

Admittedly, this was not a precise experiment, but if a carefully conducted study yielded similar results, the θs would be interesting. These values are for the same observer under the same conditions, yet even after character size is accounted for, the Wisconsin plate is more legible (produces a lower θ) than Indiana's.

Color and Contrast

The overwhelming majority of the ergonomics literature is, surprisingly, less concerned with how use of colors might improve the legibility of a display than with a subject's ability to identify color or with the chromatic nature of the light used in an experiment (*11*, *12*). Just as surprisingly, the few references to color and acuity simply state that black characters on a white background provide superior results (*1*, *11–15*). What appears to be a fundamental question with respect to daily experiences is, according to Jung (*13*), "complex" and "difficult to understand." Hassenstein (*16*), as cited by Jung (*13*), has proposed a model to explain how information about color is processed and the International Commission on Illumination (CIE) standard chromaticity diagram permits specification of any color mixture (*1*, *11*), but none of this has been successfully applied to the question of which color combinations should be considered (or avoided) in alphanumeric visual displays. In addition to the larger character sizes used on Wisconsin plates, that state also has employed the particularly effective black-on-yellow combination in recent years. Nevertheless, in 1987, Wisconsin will begin issuing red-and-white plates.

As mentenioned at the start of this paper, most license plates are reflectorized. Although no studies specific to the luminance and legibility of plates at night were found in the ergonomics literature, related work on highway signs has appeared there (*17*, *18*).

One Plate or Two?

A license plate may be well designed for legibility, but will it be seen? Approximately 18 states issue only one license plate per registered vehicle. Typically, the reason given for a single plate is economic (*19*)—production and mailing costs can be reduced and, because license plate fees are usually not reduced accordingly, additional revenues accrue to the state.

Opposition to the single plate system, based primarily on a survey of interested parties, has come from law enforcement officials (*19*, *20*). A more systematic appraisal begins with considering the relative value of front and rear plates for law enforcement purposes. If a moving vehicle must be identified by its license plate and the observer is driving in pursuit, a rear license plate meeting the legibility criteria set forth earlier in this paper will suffice. If, however, the observer is a bystander who is to the front of the vehicle in question, the absence of a front plate causes a difficult visual recognition problem. Indeed, the problem is manifold. The author's personal experiences as a runner and as a roadside collector of vehicle data support the reasonable hypothesis that it is easier to read the front plate of an approaching vehicle than the rear plate of a vehicle that has already passed.

It is precisely because the observer must wait for the vehicle to have passed his or her location that there are multiple problems:

1. Reduced exposure time of the target (license plate). In calculating the maximum viewing distance, $d = h/\theta$, earlier, it was assumed that one vehicle followed another at similar speeds and, therefore, that there existed a prolonged exposure duration. A vehicle passing an "average" ($\theta = 0.0019$ rad) observer at 40 mph is out of range ($d > 119.1$ ft) in 2.03 sec.

2. But when did the vehicle come "into range"? This raises the matter of the time it takes an observer to focus on the "target" once it has come into view. As the target vehicle passes the observer, the rear plate is about to come into view. But these are extremely poor conditions under which to perform a recognition task [i.e., reading symbols (*11*)]. The target is moving with a lateral component in the observer's field of view and the target's eccentricity (departure from straight-ahead view) further complicates the task; all the while the target is increasing its distance from the observer at a rate of 40 mph. Again, from the author's experience, this task of recognition can be accomplished, but (a) unless the need to perform the task is anticipated, it will not be done accurately and (b) a front plate makes the task considerably easier. There are hundreds of papers in the literature on detection tasks (did a given event happen?) involving exposure duration (*11*), eccentricity (*21*), and moving targets (*22*, *23*), but nothing was found to provide a quantitative experimental basis for addressing this topic. This is perhaps the most fascinating and practical of the experiments proposed in this paper.

WILL THE SYMBOLS BE REMEMBERED?

If there is a need to read the symbols on a license plate, there is usually a need to perform some subsequent task based on the observation. Unless this task is simply reading the information directly onto audio tape, the immediate next requirement is to remember the information until it can be recorded or used. The ability to recall information involves processes known as sensory memory and short-term memory.

Perceptual analyses, such as recognition, are performed on stimuli residing in sensory memory (SM). Incoming information enters "temporary storage" and resides briefly in SM as an "icon." These stimuli persist for a time and are available for processing when the external input has ceased. Although information in SM rapidly decays, part of it is selected and transferred into short-term memory (STM). The third part of the memory model is, of course, long-term memory (LTM), but it would be a mistake to think of these three parts as separate, sequential memory systems. The perception of a word or letter, for instance, involves LTM to identify and name the word or letter. Similarly, STM is better described as the active, conscious part of LTM than as a separate "box" (*24*, *25*). In this section, the results of experiments that most closely fit the problem of recalling the message on license plates are presented.

Length of Message

One limitation on the number of characters in a license plate would be related to the ability of an observer to provide a "whole report" of a display seen during brief exposure. A whole report is the reciting or listing of as many characters seen and recalled as possible. Among the work of the many researchers interested in the relationship between whole report quality and exposure duration, that of Sperling (*26*) and Mackworth (*27*) stand out. A. H. C. van der Heijden (*28*) summarizes their work and builds on it to produce the relationship shown in Figure 4. Beyond $t = 5$ (1 sec), the mean number of elements reported by the individuals in the study leveled off at about six. This is in close agreement with Miller (*29*) in his classic article, wherein he concluded that STM can process about 7 ± 2 items, and with Cardozo and Leopold (*30*). It also ties in with the discussion earlier in this paper about the stationary observer waiting for a glimpse of the rear plate. One second is about the maximum time available for observation of the rear plate.

In the case in which the target vehicle can be followed, the observer has the opportunity to "rehearse" the eventual recall

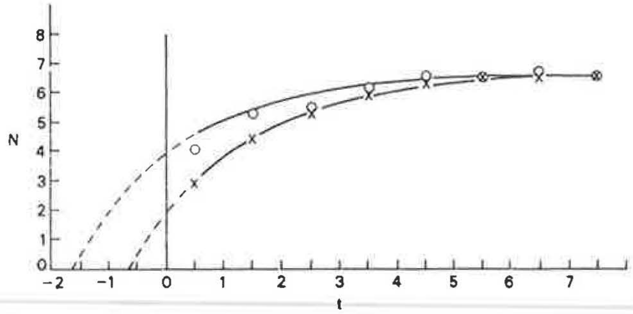

FIGURE 4 Mean number of elements reported (N) per exposure duration (t, in units of 200 msec) and kind of postexposure field. The open circles represent a nondistracting postexposure field and the crosses a "noisy" postexposure environment. Fitted functions are $N = 6.6689 [1 - e^{-0.5430(t+1.6398)}]$ for the open circles and $N = 6.7046 [1 - e^{-0.5150(t+0.6278)}]$ for the crossed points (*28*).

of the information. Consequently, more items can be stored for recall, but even here certain factors affect the amount of information available. One is not knowing the length of the sequence of characters about to be viewed (*31*). If the character string is longer than expected, or the exposure time is too short to allow adequate rehearsal, it is likely that some items cannot be recalled. Typically, the elements most often missed are those in the middle of the sequence (*32, 33*).

Pattern of Characters

The sequence in which characters (especially letters) show up in a display has a significant impact on the quality of recall. Two concepts are at work here: chunking and meaningfulness. Miller (*29*) developed the idea that an individual can substantially increase retention of a character string by mentally subdividing the string into groups or chunks of from three to five items. The success of such chunking is due in part to the elements in each chunk. For instance, letter pairs that seldom occur in words—such as pairs drawn from the letters B, P, J, W, F, G, C, and M—are more difficult to recall (*34, 35*). Conversely, pronounceable chunks—even if they are nonwords like LIS or NYD—make the recall task much easier (*24*). If C stands for a consonant and V for a vowel, verbal units such as CCC are clearly more difficult to process than CVC or VCV. Hull (*35*) has determined that there is little difference in the ability to recall a six-letter (LLLLLL) string or a six-number (NNNNNN) string. Many states appear to have recognized the advantages of three-character chunks. (Note the LLL NNN format or variations thereon in Table 2.) However, Canadian postal codes such as H9X 3B7 and K1S 4V4 appear to defy easy learning.

Another way to aid recall is to add meaning to the characters. In Indiana, the 92 counties are assigned numbers according to their alphabetical order. Thus the car with the plate 79F1046 in Table 2 is registered in the 79th county, Tippecanoe. Washington and Tennessee order their counties by population, and the rank of the county of registration is the prefix on those states' plates. The "C" in CAB 143 for Washington's plate in Table 2 stands for Spokane County, the third largest by population. Not only is this an aid to roadside data collectors interested in counties of origin, but it can have the effect of concentrating the observer's attention on the "random" part of the display that, without the familiar meaningful prefix, is correspondingly shorter to process through the SM and STM. The West German system uses letter prefixes to identify the issuing license branch. With a few historical exceptions, the largest areas have one-letter prefixes and the smallest have three letters. Thus "M" is found on a plate from Munich, "CO" on a plate from Coburg, and "NES" on a plate from Bad Neustadt. The familiarity of these letter patterns in an expected position on the plate greatly facilitates the task of recognition (*33*). The German method is probably the easiest to master, because an observer does not have to memorize the counties in a state in alphabetical order or learn the population ranks of the counties, which are subject to change at each census anyway. Also, the larger jurisdictions have shorter prefixes, leaving more space for the digits necessary to give each vehicle a unique number sequence.

Another phenomenon that assists license plate recall is the vanity plate that spells out distinctive words or their approximations. Even though they are almost always nonstandard in format, they are among the most memorable because they often spell out words, names, or clever expressions.

Role of Stress

This topic can be approached from opposite viewpoints, and both may have validity. On one hand, there is the notion that the ability to store and retrieve the plate's information is negated by other sensory stimuli or emotional reactions. If this is a common occurrence, a much more conservative license plate design is needed to compensate for it.

On the other hand, there is the concept of attention (*36*). A special event calling for recognition of the characters on a license plate may cause the observer to filter out distractions and increase accuracy of recall (*37*). Although there has been some use of incentives and "threats" to experimentally explore this point with human subjects (*37*), there is much more to be learned here.

RECOMMENDATIONS

The body of knowledge uncovered in the ergonomics literature, as analyzed and applied to the design of license plates, leads to certain recommendations:

1. Issue two license plates. If one of the major functions of a plate is to clearly identify a vehicle for law enforcement purposes, the money saved by issuing only a rear plate may be a false economy.
2. Increase character size, subject to space available on the plate and need for other information to be displayed there. A number of states have been experimenting with new slogans on their license plates, presumably to boost their image to tourists. This has led to "Wander" on Indiana plates and "You've Got a Friend in" for Pennsylvania. It is not clear that this is any more of a selling point than an attractive design, such as the stalk of

wheat on the Kansas plate that is currently being phased out.

3. Although a majority of states have adopted a three-letter, three-number (LLL NNN) format or minor variations thereof, few states appear to have considered the pronounceable nonword approach to constructing the letter sequence. The CVC and VCV sequences of consonants and vowels provide the basis for generating these units and determining whether there are sufficient combinations to issue enough unique plates. [The LLL NNN format allows more than 17 million unique combinations. Using CVC and VCV chunks, with the letter Y as both a vowel and a consonant, makes 3.4 million unique LLL NNN combinations possible. Only California has more than 10 million registered automobiles (*38*,p.17).]

4. Conduct some basic experiments to determine the best (and worst) color combinations with respect to license plate legibility. A variety of acceptable combinations would allow each state to not only maintain a helpful color contrast on its plates but also to maintain a distinctive look with respect to neighboring states.

5. Incorporate the county or locality in the number of the license plate. Several states (among them Iowa, Kentucky, Ohio, and South Dakota) include county names at the top or bottom of their plates, but these are in letters so small (approximately 16.5 mm) as to be illegible to roadside observers. Properly done, this feature not only can assist data collection but can also reduce the "random" portion of the character sequence to be processed by an observer. The number of combinations required to provide unique plates to each registered vehicle will dictate the format in a given state, but the examples of Indiana and West Germany are instructive.

The last three of these ideas would cost little or no extra money and would improve the legibility of license plates for the variety of purposes they serve.

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Laboratory Evaluation of Crash Cushion Delineation

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Alternative means of delineating crash cushions in gore areas were investigated in laboratory evaluations. A variety of passive delineation methods, including nose panels, back panels, side treatments, and combinations of these, was evaluated. The laboratory experiments used driver's-eye-view photographic slides of road scenes, only some of which contained crash cushions. A high-resolution computer graphics and digitization system was used to convert the original photographs to computerized images, so that any desired delineation could be inserted into, or removed from, the scene. Two experiments were carried out to investigate different aspects of the "conspicuity" of the markings. In one, viewers quickly searched a scene to determine if a crash cushion was present. Detection time, and the apparent distance of the crash cushion, were recorded. The other experiment provided only a brief fixed viewing time (1 sec), and the viewer was required to answer a series of questions about the scene; detecting crash cushions was a low priority, and crash cushions had no special relevance to the viewer. The results indicated differences between delineation and no delineation, as well as among alternative means of delineating, in terms of reliability of detection, speed of detection, and apparent distance of crash cushions. The findings suggest that Type 1 object markers may be less effective than other alternatives and that back panels may be an especially promising means of delineating crash cushions. There were also age-related deficits in viewers' ability to detect crash cushions.

Crash cushions (also called impact attenuators) are commonly used at freeway gores and other areas to protect motorists in run-off-the-road accidents. Typically, crash cushions guard some fixed-object hazard, such as a bridge pier or a railing end in an elevated gore area. These devices provide recognized highway safety benefits by substantially reducing the severity of accidents (*1*, *2*). However, they do not reduce the frequency of collisions and, indeed, may even result in an increase of "nuisance" collisions. This increase may result from the reduced area of the recovery zone, perceptual confusion, or simply the presence of an additional object to strike.

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Most collisions with crash cushions result in only minor injury or vehicle damage (reducing crash severity is, after all, the purpose of a crash cushion). However, these collisions still result in occasional serious injury or death as well as significant maintenance costs. Collisions with crash cushions can lead to secondary accidents and can disrupt traffic flow because elements of the barrier, or its contents (sand, water), or the impacting vehicle itself, obstruct the roadway. There is risk as well for the highway crews that must do the repair work at high-accident-risk sites with limited work space. Thus, for reasons of both safety and cost, it is important to reduce the frequency of collisions with crash cushions. One means of doing this is through effective delineation of crash cushions. Unfortunately, what constitutes "effective" crash cushion delineation, how well it works, and how cost-effective it may be are not known.

Crash cushion delineation has been recommended by the FHWA as well as by manufacturers of the devices. Marking practices differ widely. Some jurisdictions have implemented extensive programs of standardized marking practices for their crash cushions; others may only spot-treat extreme problem sites. Many varied delineation elements, which differ in size, color, shape, markings, and reflectorization and occur in numerous combinations, have been encountered.