

Further, the extent to which a driver is distracted when they encounter a level crossing may interact with the saliency of certain level crossing controls. Given that the saliency of flashing lights was one of the reasons commonly given for the preference of flashing lights over traffic lights, it is important that future studies look at the effect of driver distraction on level crossing control saliency to determine whether crossing controls deemed salient and effective at low levels of distraction remain effective at high levels of distraction. Also relating to the issue of distraction, future studies could examine the potential benefits of in-vehicle train warnings at level crossings

In conclusion, although the present study was limited in that it only assessed driver compliance to level crossing controls situated in a rural environment and under very specific circumstances where an immediate decision was required to brake and stop safely or to proceed through the crossing, the finding that drivers made more violations of Traffic light-controlled level crossings than Flashing light-controlled level crossings suggests that the use of traffic lights in this capacity in real-world situations may not result in any additional safety benefits over and above those provided by flashing lights.

The subjective data provides further support for this notion. However, the reader is cautioned that more research on the issue is necessary before reliable conclusions can be made and on which related policy decisions should be based. Finally, the large number of violations seen with the stop sign condition underscores the importance of continuing to upgrade current passive level crossings to active status.

Acknowledgements

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References

1. J Edquist, K Stephan, E Wigglesworth, M Lenné, 'A literature review of human factors safety issues at Australian level crossings', MUARC report, Monash University Accident Research Centre (MUARC), 2009.
2. Australian Transport Safety Bureau Transport Safety, 'Level crossing accidents: fatal crashes at level crossings', 7th International Symposium on Railroad-Highway Grade Crossing Research and Safety, Melbourne, Victoria, Australia, Monash University, 2002.
3. M Green, 'Railroad crossing accidents', *Occupational Health and Safety* 2002 71(6) 30-36.
4. M Henderson, 'Improving safety at railway level crossings: some perceptions of the problem', *Improving Safety at Railway Level Crossings Conference*, Adelaide, South Australia, Australian Road Research Board, 2002.
5. DB Fambro, KW Heathington, SH Richards, 'Evaluation of Two Active Traffic Control Devices for Use at Railroad-Highway Grade Crossings', *Transportation Research Record*, 1989 1244 52-62.
6. VicRoads, *Traffic Engineering Manual*, Volume 1: Traffic Management, 2006.

An analysis of road signage and advertising from a pragmatic visual communication perspective: Case study of the M1 Motorway between the Gold Coast and Brisbane

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Abstract

This paper analyses examples of road signage and billboard advertising along the M1 Motorway between the Gold Coast and Brisbane from a pragmatic visual communication perspective. Such a perspective requires that two studies be conducted simultaneously. One study examines how people use designs while the other examines how features of designs meet people's needs.

For this research, the first study consisted of a literature review aimed at determining how people use road signage and advertising. Results indicate that drivers attend to signs differently depending upon personal variables such as driving

experience, environmental variables such as traffic density, and sign variables such as the message and visual design.

The second part of the research involved comparing all types of signs along the M1 to best practice in the visual design of roadway information. In this paper, designs that follow best practice were considered to be those that follow principles of positive guidance. As part of this research, the author took photographs of signs in August and September 2008.

Results indicate that research could be conducted on a few types of sign designs. For road signage, it would be useful to study the effectiveness of educational messages placed on variable message signs and whether M1 drivers would find it

helpful to have graphics placed on these signs. It would also be useful to study the use of more mixed-case text and the Clearview font on signs, and the effectiveness of tourist signs. Further, it may be useful to develop a more detailed taxonomy of driver types on which to test signs. For advertisements, it would be helpful to provide additional guidance to billboard designers on making messages more effective and appealing, and to test what creates distracting content. This paper should be useful to traffic engineers, and teachers and students of roadway information design who would like to increase their knowledge of signage design and design research.

Introduction

Signage and billboard advertising along motorways can impart important information to drivers. Signage can provide directional guidance, reassure drivers about their location, indicate sites of local services, state the speed limit, and warn of upcoming changes or hazards. Given the value of such information, it is important that signs be designed and placed so that drivers can locate, read and comprehend them within a timeframe appropriate for changing their plans and behaviour.

Billboard advertising also serves a useful role. According to the Queensland Government Department of Main Roads [1], this advertising is useful both for 'business, as suppliers of goods and services, and for the public, as consumers' (p.1-2). The Department states that billboard advertising is a legitimate form because it takes at most 2-3 seconds to read one advertisement and local businesses depend upon it to direct customers their way. Therefore, billboard designs need to be attractive to be effective. However, although the Department allows billboard advertising, it is important that these signs do not impact upon driver safety. Traffic authorities around the world have long been concerned about whether distraction by billboards can lead to accidents (for example, see Green [2]). An important question, then, is how to make effective billboards that are not overly distracting.

Given the importance of signage and advertising to drivers as discussed above, this paper takes a pragmatic visual communication approach to understanding how the design of such information might be improved and suggesting areas for further research. Cases of signs for discussion are taken from the M1 Motorway between Queensland's Gold Coast and Brisbane. In this paper, signage and advertising are considered together to provide a more complete picture of the information environment.

Taking a pragmatic visual communication perspective requires that the researcher conduct two studies simultaneously. One study examines how individuals use a particular design and the other looks at how features of the design meet individuals' needs. For this research, the author first conducted a literature review of how drivers attend to roadway signs and advertising, and then compared messages on and visual features of different types of signage and advertising along the M1 to best practice

in the design of such information. This type of research is useful for establishing what types of drivers are using particular types of signs under what conditions and for what reasons, and how the visual features of signs meet those drivers' needs. It also provides the opportunity to compare signage and advertising along a relatively recent stretch of roadway in Australia to current ideas on signage design.

Research method

The first research step involved reviewing literature on how drivers use different types of roadway signs and advertising. For this study, the focus was on drivers' *attention to these signs*. The second step involved collecting examples of all types of signs and all billboard advertising along the M1 motorway between Brisbane (Exit 2) and the Queensland-NSW border at Tugun. This stretch of roadway was selected partly for convenience, but also because it is a good example of a modern Australian motorway that should follow signage regulations set by the Queensland Department of Main Roads, as well as use relatively current signage research and technology.

Examples of the types of signs collected were permanently-mounted variable messages signs (VMS), and guide, tourist, service, truck-driver message, transit lane and warning signs. Particular cases were selected for discussion based upon how their messages and visual features met the *principle of positive guidance*, which Russell [3] defined as 'the concept that a driver can be given sufficient information where he/she needs it and in a form he/she can best use ... to safely avoid a hazard'. (p.155)

A more detailed description of this principle is provided later. Visual features examined in the signs included the amount of information contained on a sign, information arrangement, use and design of symbols, font, colours, relative sizes of typefaces, and redundancy of information. The visual features were then compared to literature on best practice in signage design. To gather examples, an assistant drove while the author took photographs. Photographs were taken with a Sony A100 ten megapixel digital camera on 16 and 18 August and 14 September 2008.

The author also examined messages and visual features in the advertising billboards. This information was compared to guidelines provided by the South African National Roads Agency Limited (SANRAL) [in 4] and research by Van Meurs and Aristoff [5] on how to create effective and appealing advertisements. Conclusions were drawn regarding how messages and visual features of the signage and billboards met guidelines for best practice, and where additional research might be conducted.

A model of driver attention to signs

Although Luoma's [6] eye movement research suggested that drivers look at almost every traffic sign, other research has indicated that drivers attend to signs differently depending

upon personal variables such as driving experience and route familiarity; environmental variables such as traffic density, and day or night-time driving; and sign variables such as the message, visual design and placement. In this paper, attending to a sign means reading and processing it. Figure 1 presents a summary of variables that affect drivers' attention to signs.

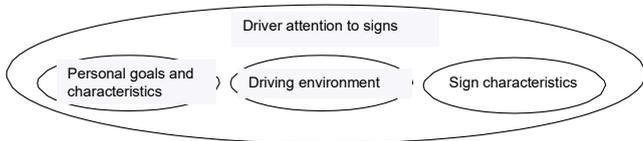


Figure 1. Variables affecting attention to road signs

Although signs are important, research indicates that it is the road itself that provides most of the information that drivers need [7]. That is, drivers navigate by reading the path of the marked bitumen within the landscape, and noting objects along the road, and the presence and speed of other vehicles. Therefore, traffic authorities can help drivers most by designing, building and maintaining safe roads. That said, however, signage needs to be designed so that it helps drivers when and where they need it. Drivers do not attend to every sign and it is probably not cognitively manageable or safe for them to do so. However, when a driver does need a sign, it should be available and in a useful form to help the particular driver. Therefore, all signs need to be well designed for all types of drivers under a variety of driving conditions.

Attention based on personal goals and characteristics

This section reviews theory and literature on how drivers' attention to signs varies with their driving goals, driving expertise and physical characteristics.

Attention based on drivers' goals

Neisser's [8] theory of attention, which says that attention varies according to people's interests, provides one useful tool for explaining research results on road sign attention. Consider first the difference in attention to signs by younger and older drivers. Milosevic and Gajic [9] found that younger drivers (aged 25 or less) were more likely to attend to signs than older ones (aged between 26 and 55). Using Neisser's theory of attention to explain this difference, novices may better attend to signs because they are just learning to drive and therefore find all signs to be important. At the same time, more experienced drivers have learned which signs are most useful to them and filter out the rest.

Milosevic and Gajic [9] provided other evidence that attention to signs varies according to interests. Their research found that those who drive more than 10,000 km per year, professional drivers and those who are driving on official business are more likely than other drivers to attend to warning signs. The long distance, professional, or official driver appears to have a stronger interest in maintaining a license than other drivers, and

therefore cannot afford to ignore warnings (e.g., speed limit signs) that could lead to loss of license and job.

Other researchers provide further evidence that drivers' attention to signs varies according to their goals or interests. Consider the research of Johansson and Rumar [10] and Johansson and Backlund [11], who found that drivers in general are more likely to recall more personally threatening warning signs than other warning signs. These researchers found that drivers in general are more likely to remember signs that indicate a change in speed limit or a police control area than signs that indicate a general, non-specific warning or a crosswalk. Applying Neisser's theory to the results, drivers remember these particular signs because of their personal interest in avoiding speeding fines and police interaction.

Further, research shows that different types of drivers attend differently to a particular type of sign, the variable message sign (VMS). According to Chatterjee and McDonald [12], who studied VMS in European cities, these signs are typically used to display messages about 'hazards, traffic conditions, parking, public transport or the environment' (p.560) with the intent of decreasing driver stress and improving road use efficiency by encouraging drivers onto other roads. The study reported that as few as one-third of drivers notice these signs.

A study by Peeta and Ramos [13] offers insight into who attends to VMS and why. These researchers found that males, younger drivers, those who drive regularly in an area and well-educated people are more likely to attend to VMS to take alternative routes. The researchers hypothesized that each of these driver types wants to save travel time. Another explanation, however, may be that they simply do not like to wait. The researchers believe that males and younger drivers will divert because they are more willing to take a chance on an alternative route, and educated people divert because they value their time more highly. Those who travel regularly in an area will divert because they have a good understanding of alternative paths.

Attention to signs also varies depending upon whether drivers are familiar with a route. Mourant, Rockwell and Rackoff [14] found that drivers on unfamiliar routes are likely to spend a larger percentage of their time, 7.5 per cent, viewing signs than those on familiar routes who spend 5.4 per cent of their time. It is reasonable to assume that these drivers are interested in signs because they need help with way-finding and learning the road.

Attention based on expertise

Borowky, Shinar and Parmet [15] found that experienced drivers have expectations about where particular signs should be placed. The researchers shifted the positions of *no right turn* and *no left turn* signs to unexpected locations and found that experienced drivers were less likely to notice them than inexperienced drivers. However, when the signs were placed as expected, the experienced drivers were more likely to notice them. The results of this study indicate that drivers develop *schemas* or cognitive patterns regarding where signs should be placed and that authorities should therefore design for these schemas.

Anderson's [16] cognitive learning theory, which describes three stages of learning, provides a useful tool for explaining how such schemas develop. When first learning something, Anderson says that we are in the *cognitive stage*, which is when we develop 'explicit knowledge which we can report and of which we are consciously aware' (p.234). In Queensland, drivers are in this stage while studying for the multiple choice test required for a learner's permit.

Anderson's second stage of learning, known as the *associative stage*, describes what happens when learners begin performing and gradually becoming more competent at a skill. During this stage, 'errors in the initial understanding are gradually detected and eliminated... and the connections among the various elements required for successful performance are strengthened' (p.274). Regarding the use of road signs, novice drivers in this stage begin attending to signs and adjusting their behaviours according to messages received.

Finally, during Anderson's third stage of learning, known as the *autonomous stage*, 'the procedures become more and more automated and rapid' (p.275). When in this stage, drivers know how to scan the environment for relevant signs. They have a well-developed schema of where different types of signs are placed and what the signs look like so that they can respond automatically.

Attention based on physical characteristics

One physical characteristic that appears to affect attention to signs is a person's age. Milosevic and Gajic [9] found that drivers aged 56 and over are less likely to attend to signs than other drivers. This finding may indicate that these drivers may have reduced vision, which prevents them from easily reading the signs, or reduced reaction time, which causes them to place more attention on the road and surrounding traffic than on signs. Either cause indicates that design efforts should be aimed at helping older drivers.

Conclusions regarding attention to signs based on personal goals and characteristics

The above research provides some clues on how to design signage to meet drivers' needs based upon their personal goals and characteristics. First, signs should be placed where experienced drivers expect them to be so that they will not miss them. Second, sign content should be short and visually clear so that it can be seen and read quickly by a variety of driver types including novices who need to keep their eyes on the road and traffic, drivers on unfamiliar routes, and older people with reduced vision and reaction time. Lastly, it may be worthwhile to develop a more detailed taxonomy of drivers so as to better understand their particular needs. As Green and Low [17] wrote:

In most areas of design, it is possible to create usable artifacts ... that serve large groups well. However, there is much work spent in identifying typical users, defining their mental models, doing task analysis, defining goals and testing proposed designs. (p.35)

Attention based on the driving environment

Research by Shinar and Drory [18] shows how drivers' attention to signs is correlated with both their personal goals and the driving environment. The researchers found that drivers attend to signs better at night because their reduced vision means that they can access less information from the road itself than during the day. Therefore, drivers' interest in signage increases as darkness falls and they need alternative information for navigating. The section of this paper devoted to sign characteristics will discuss research on how to better design signage for night-time drivers.

Changes in traffic density can also affect attention to signs. Bhise and Rockwell [19] found that drivers who were travelling in low-density traffic and following an unfamiliar route spent an average of 2.6 seconds viewing signs that were useful to their way-finding. In contrast, drivers who were travelling in high-density traffic and following an unfamiliar route spent an average of 0.9 seconds. These results indicate that signs need to be designed so that they can be easily read by drivers who need to devote a greater portion of their attention to the surrounding traffic.

Sign characteristics that affect attention

Attention to signs can also be affected by manipulating features of signs themselves. As discussed in the research method section, a useful principle to follow in sign design is that of positive guidance. Ideas covered thus far on meeting drivers' signage needs all fall under the umbrella of positive guidance.

Positive guidance emphasises the principles of *primacy, spreading, coding, and redundancy*. When following the principle of primacy, signs are placed only where needed and in the order needed. When following the principle of spreading, the amount of information is kept within cognitive information processing limits. For example, if drivers need more information at a particular time than they can effectively read and comprehend from a single sign, then the information should be spread across multiple signs. According to Smiley and colleagues [7], a sign is made 'comprehensible through word messages and symbols that have been tested... and shown to be understood by the majority of road users' (p.5). Keeping a sign within cognitive information processing limits also involves ensuring that a sign is *conspicuous*, which means it should 'attract the driver's attention, even in a cluttered background' (p.5).

The principle of coding is that standard information can become more recognizable if it is visually coded in a standard way, for example with the same shape and colour. Effective coding also considers that signs are made *legible* through the 'use of optimum letter fonts and line spacing, and optimum background colour and luminance contrast' (p.5) [7]. Finally, the principle of redundancy is that drivers will be more likely to understand a sign if it provides the same information in more than one way, for example as with both words and an image, as discussed earlier. To these principles, it is also helpful to add another design principle promoted by Smiley and colleagues [7], which is that signs should 'produce the desired driver behavior' (p.5).

Designing for the principle of primacy

Along the M1 section under study, this research noted that the principle of primacy is sometimes violated for one type of sign, which is the VMS. Messages on these signs often contain public service or educational rather than traffic guidance information. Sometimes the signs are blank, but little traffic-related information is given because there is little need for it. Examples of VMS educational messages are 'Every k over is a killer', 'Keep left unless overtaking', 'Report traffic incidents call 13 19 40', 'Slow down stick to the left', and 'Police now targeting defective vehs'. Figure 2 presents an example of one of these signs along the M1.



Figure 2. Example of a VMS along the M1

Regarding VMS messages, Dudek and Ullman's [20] VMS design manual for the Texas Department of Transportation states the following:

Messages will be most effective when they encourage some type of response from the motorist, such as to:

- Reduce speed
- Move out of a blocked or closed lane, and/or
- Take an alternative route (p.3-3).

The M1 educational messages are meant to encourage a long-term behavioural change rather than just an immediate response. On the M1, more research is needed to determine how drivers use these messages. As discussed earlier, since younger drivers attend to more signs than experienced drivers, it is possible that educational messages targeted towards younger drivers may be helpful. However, there is some danger that drivers may ignore these signs altogether if the drivers do not perceive the messages as credible. According to Dudek and Ullman [20], VMS credibility will be reduced if messages are inaccurate, not current (e.g., they remain the same each day), irrelevant, obvious or trivial.

The visual design of M1 VMS messages is discussed under the section titled 'Designing for the principle of coding'.

Designing for the principle of spreading

Figure 3 shows a typical example of a guide sign along the M1, which follows the principle of spreading in that it stays within cognitive information processing limits by presenting a reasonable amount of information in a clear and easy-to-read format.



Figure 3. Example of a guide sign along the M1

Some tourist signs along the M1, however, appear to contain a great deal of information and in a smaller size of text, which would make them difficult to read in the short amount of time available. Figure 4 presents an example. This sign may be particularly difficult for older drivers to read.



Figure 4. Tourist sign

Designing for the principle of coding

Signs along the M1 also follow the *principle of coding*, which is that standard information can become more recognizable if it is visually coded in a standard way – for example, with the same shape and colour. This principle also includes the concept that signs should be legible and conspicuous. Returning to Figure 3, guide signs along the M1 all follow a standard format. As shown in the example, each type of information has a unique design created by its position within the sign, choice of upper or mixed-case font, and colouring of the text and background. The font used throughout the sign, which is highly legible, is from the series AS 1744-Standard Alphabets for Road Signs.

The mixed case for the suburb names works well since people can recognise familiar words faster when printed in mixed than upper case [21]. One explanation why people recognise words faster

when they appear in mixed case is that the words have a more unique shape. Another explanation is that people are simply used to reading in mixed case and are therefore faster at it.

In recognition and legibility tasks, Garvey, Pietrucha and Meeker [22] compared the distance from which drivers could read signs containing place names that were printed in uppercase and mixed-case text. In the recognition task, drivers were told what word they were looking for and were asked to indicate the moment when they recognised the word on a sign. In the legibility test, drivers were asked simply to read a word as soon as they were able. In the legibility test, there was no significant difference in reading time between mixed case and uppercase for text of the same size. In the recognition task, however, the 'same-sized mixed-case fonts performed significantly better than the all-uppercase' (p.10).

Although the experiment [22] showed no difference in legibility for place names that were presented in uppercase or mixed-case text, there may be a difference for longer phrases composed of more familiar words. Therefore, it may be valuable to test whether a sign such as that in Figure 5 would be read faster if presented in mixed case.



Figure 5. Sign printed in all uppercase letters

For the purpose of reducing irradiation or halation of text on road signs, Garvey and colleagues [22] have designed a font specifically for roadway usage called Clearview, an example of which is shown in Figure 6. Irradiation describes

the blurring of text lines against 'high-brightness reflective signage materials' (p.7) (see Figure 7). The Clearview font helps to reduce irradiation by having 'more open interior spaces' so that when irradiation does occur, there are still open areas within letters. The font also uses tighter tracking (the space between letters) so that word shapes are more distinctive. According to the researchers [22],

Under daytime conditions, the [US] Series E(M) and both of the Clearview fonts had essentially equal readability distances. At night, however, with headlamps and bright signing materials, the Clearview font that took up the same amount of sign space as the Series E(M) resulted in significant improvements in readability distance... This was true in both the legibility task and the recognition task. (p.11)

The researchers reported a 16% increase in recognition distance for night driving. As stated earlier, since drivers generally use signs more at night than during the day and since older drivers may have reduced vision, it would probably be worth testing the Clearview font on road signage under Australian conditions. More than twenty US states have adopted Clearview [23].



Figure 6. Comparison of Australian standard road sign font with Clearview font



Figure 7. Example of irradiation [24]

It is also useful here to discuss the coding of VMS. Along the M1, VMS messages are presented in simple text, which Chatterjee and McDonald [12] have found to cause 'few problems with ... legibility and comprehensibility' (p.570). Further, M1 VMS messages are amber-coloured, which in another study [23] was found to be preferred over red or green. In addition, M1 VMS consist of no more than two frames, have no more than two lines of text per frame, and for single frame messages, do not flash. This design follows that set by the US Department of Transportation [25]. Regarding flashing, a study of drivers in a simulator by Dudek, Shrock, Ullman and Chrysler [26] found the following:

Most subjects (60%) preferred the one-phase static messages to the flashing message (40%)... The most common reason for preferring the flashing message was that it gets the attention of drivers. The most common reasons for those who preferred a static message was that it gives the driver more time to read the message and that it is easier to read. (p.126)

Thus, the non-flashing, single-frame VMS used on the M1 should be the design that is most preferred by drivers.

Designing for the principle of redundancy

The principle of redundancy states that drivers will be more likely to understand a sign if it provides the same information in more than one way – for example, as with both words and an image, as discussed earlier. A study by MacDonald and Hoffman [27] found that placing a symbol in a sign makes it more memorable for many drivers. These researchers studied drivers' attention to signs by asking them to make in-vehicle

oral recordings of everything in the driving environment of which they were aware at particular points along a route. The researchers measured attention using a 'ratio of reports mentioning correct sign information to the total number of reports for that site' (p.592), which they named *the level of reported sign information (RSI)*. They found that signs containing a symbol were 'associated with a small but significant increase' in the RSI (p.600).

In another study, Jacobs, Johnston and Cole [28] ran experiments aimed at comparing recognition distance between signs encoded with a pictorial symbol and those with text. They found that that well-designed and easily-encoded symbolic signs are read from greater distances than textually-encoded signs. It is noteworthy that many M1 signs contain symbols (e.g., emergency phone signs, railway station signs).

Wang, Hesari and Collyer [23] studied the effectiveness of using graphics on VMS. They found that graphics helped both native and non-native English-speaking drivers with sign comprehension and response, but helped the non-native speakers more. In this light, it may be useful to study the effectiveness of placing graphics on M1 VMS.

The M1 'Transit Lane' sign in Figure 8 shows excellent usage of symbols. This sign uses a combination of symbols and words to attract drivers' attention to the specific information that describes their situation. The vehicles are presented in their best view, which is side on, and the symbols face towards the text, thus creating pointers towards it. The symbols also provide redundancy in message delivery.



Figure 8. Multi-symbol sign on the M1



Figure 9. Sign designed to attract additional attention with fluorescent-orange border

Redundancy also occurs when the same message is provided on more than one sign. It is noteworthy that along the M1, merge, speed limit reduction and guide signs are presented in duplicate to assist drivers. For example, Figure 9 presents an example of an M1 speed limit reduction sign that is placed and visually designed to maximise attention. Copies of this sign are placed on both the left and right sides of the southbound M1 lanes, and following them are the speed limit signs. The sign also works to attract attention by using larger than usual text and a wide fluorescent-orange border.

Roadside advertising

To give a more complete description of roadway information, it is useful to look at the design of roadside advertising and its place in causing driver distraction. Wallace [2] reviewed literature on distraction from billboard advertising and found that accident rates seem to be correlated with billboards placed at intersections or junctions. He theorised that at such places, if drivers are searching for information, any advertisements might slow reaction time. Wallace found no evidence, however, that billboards in and of themselves cause accidents.

Ady [29] studied changes in accident rates before and after the placement of three billboards. He found that two of the billboards showed no effect, but the third did at the .05 level of significance. This last billboard was placed on a sharp bend. Wallace [2] hypothesized that it caused accidents because it was overly surprising to drivers. On the stretch of the M1 being considered, none of the billboard advertisements are placed in locations that would cause accidents as identified in the literature reviewed by Wallace.

Coetzee [4] noted that it is difficult to define what is a high-attention advertisement, or one that could lead drivers to have accidents. He said that 'it is obvious that advertisements containing human faces or the human body ... attract attention' (p.8). According to Wallace [2], problem signs could contain 'primary colours, bright lights... flashing neon, [or they could be] information-rich ... (with moving images for example), [or be] sexually or otherwise explicit...' (p.55).

A useful tool for considering what is a reasonable amount of information for a billboard is provided by the South African National Roads Agency Limited (SANRAL [in 4]). These regulations limit the message length of billboard advertisements as measured in bits of information using the criteria presented in Table 1.

Content	Bits
Words up to 8 letters	1
Words > 8 letters	2
Numbers to 4 digits	0.5 bits
Numbers 5 - 8 digits	1
Symbol/ Abbreviation	0.5
Logo/graphics	2 bit

Table 1. Bit values of information on signs (SANRAL Regulation 1 in [4])

The bit limits were established based upon reading time, which SANRAL wanted to keep low so that drivers would have time to react to events ahead of them. SANRAL uses the following formula to determine road sign reading time:

$$T = (0.32N - 0.21) \times D [1]$$

T = Reading time

N = Bits on signs

D = Distraction Factor

D = 1.00 straight roads, less than 5000 vpd (vehicles per day)

D = 1.25 straight roads with 5000 – 30,000 vpd

D = 1.50 freeways, roads in urban areas, more than 30,000 vpd

Other SANRAL regulations useful here for a discussion on billboard content are that they ‘may not distract [the] attention of [a] driver in a manner likely to lead to unsafe driving conditions’; ‘may not affect conspicuousness by virtue of potential visual clutter’; ‘The color, or combination of colors in advert may not correspond with colors of road traffic signs’; messages should be amenable and decent; messages should be concise; ‘No advertisement displaying a single message may exceed 6 bits on freeways and 10 bits on other roads’; ‘Combination signs, or any other advert displaying more than one message may contain more than 6 bits per enterprise, service or message’; ‘Numbers longer than 8 digits [are] not allowed’; and ‘No message [can be] spread across more than one advert’ [in 4].

While measuring the bits of information on a sign as outlined in these regulations may not be a perfect system, it is useful for considering what amount of information drivers can read safely in the amount of time in which the billboard is legible to them. Coetzee [4] measured this time by making assumptions about the size of text on a billboard. If, for example, text is 1 metre high, then drivers should be able to read it from 500 metres away. The text will remain readable until the billboard is outside the driver’s 15 degree cone of vision, as shown in Figure 10. These assumptions mean that a sign is only readable over a length of 350 metres.

If a driver is travelling at 110km/h, which is the maximum speed along the stretch of M1 considered in this paper, then a sign with 1m high text is readable for 11.5 seconds. Based upon the distance at which drivers travel behind one another, which Coetzee [4] says is anything between 10 and 30m in South Africa, there is a margin of 1.5 seconds in which it is safe for a driver to glance away from the traffic at something like a billboard and not run the risk of colliding with a vehicle in

front should traffic suddenly slow. Coetzee assumes that a full glance at a sign consists of ‘3 seconds – 1.5 seconds [for] looking away and 1.5 to assess the road ahead’ (p.9). This assumption means that about four glances or 6 seconds of reading time would be available. Substituting 6 seconds into the SANRAL reading time formula yields a maximum of 13 bits of information per 500m. This value is used as a point for comparison of M1 advertising in the following paragraphs.

Figure 11 presents an example of an M1 billboard that presents a large quantity of information. Using the SANRAL guidelines, it is questionable whether drivers would have time to safely read this sign since it contains 29 bits of information and a web address.



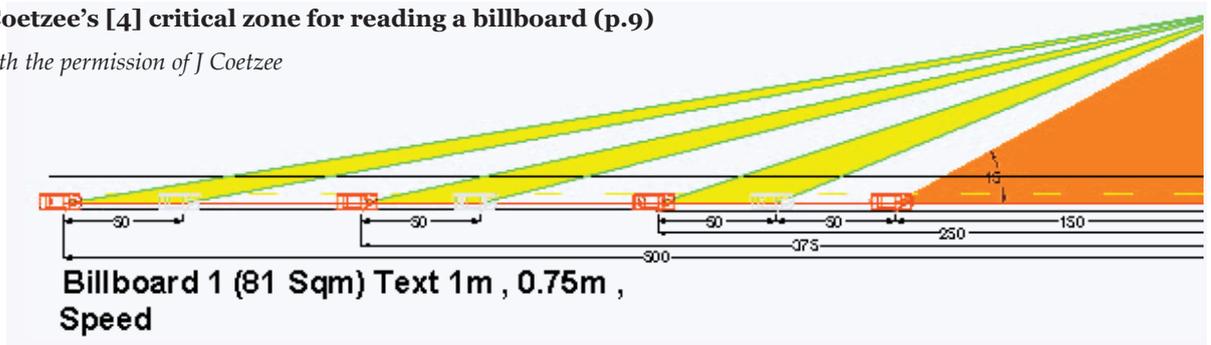
Figure 11. Billboard advertisement containing a large amount of information

The billboard in Figure 11 does, however, follow many of the guidelines for creative appeal and advertising effectiveness that are recommended by Van Meurs and Aristoff [5]. They defined effectiveness as the ‘(average) amount of time it takes a consumer to recognize the product/brand in the first fraction of a second of exposure’ (p.83), and measured creative appeal by asking subjects how much they would like to see an advertisement again. The researchers found that creative appeal was higher for advertisements with short headlines that did not mention the brand name or price, featured ‘a clear branding product shot’ (p.90), showed people against a realistic background, and were coloured predominantly in blue.

To achieve faster product recognition, results indicated that advertisements should include the product name and a product photograph (but the photograph should not be ‘in the bottom right corner’), and the photograph should not include a person,

Figure 10. Coetzee’s [4] critical zone for reading a billboard (p.9)

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especially one appearing to make eye contact with the viewer. Further, the information content should be low, and the advertisement should use fewer colours and make use of blue but avoid red as the dominant colour. The advertisements should also 'highlight new-product information' and 'use a black font and avoid a white font' (p.89).

To achieve faster brand recognition, the researchers found that advertisements should present the brand in a large font, place the logo in the upper half of the advertisement and not in the 'lower-right corner', keep the amount of information low, 'highlight new-product information', 'include a picture, but ... not of a woman or an illustration', keep the advertisement simple with a short headline in a small black font, and avoid humour (p.90).

To create both safer and more effective billboards, it seems important to limit the amount of information presented. Results of the Van Meurs and Aristoff [5] study are conflicting, however, regarding photographs of people. These photographs make an advertisement more appealing but slow down product and brand recognition. More research should be aimed at the effects on advertising appeal and driver safety of showing the human face or body in billboards.

Returning to the billboard in Figure 11, it follows guidelines recommended by Van Meurs and Aristoff [5] since it contains a product photograph, has the product and brand in the headline, has black text, and announces something new about the product. The one design element that could be improved is the logo placement, which should be in the upper half of the billboard and not in the lower right.

Figure 12 presents a billboard that could use better alignment of information to convey its message. It contains 20 bits of information, a phone number, a web page, and an additional message below the billboard. A more consistent layout would allow for easier scanning. It also contains white text in the heading.



Figure 12. Sign with poor alignment

Figure 13 presents four signs that may be overly attractive to some drivers. The Coomera Waters sign may be overly attractive because it contains materials that sparkle in the light, and the others may be overly attractive because of their subject matter and the use of women's bodies and faces.

Conclusions

In conclusion, signage along the M1 between Brisbane and the Gold Coast follows the principles of positive guidance in many ways. By comparing examples of signs and advertisements with research on how drivers attend to signs and visual communication principles for good design, a few issues have been identified for further research. For signs, studies could be conducted on how and which drivers use public service and educational VMS messages; whether more mixed-case text would improve word recognition; whether the Clearview font would improve night-time sign reading, especially for older drivers; and whether a reduction in information content and an increase in font size on some tourist signs would make them more readable.

Further, it may be worthwhile to develop a more detailed taxonomy of driver types on which to test various signs. For advertisements, the issues are in providing guidance to billboard designers on how to make messages more effective and appealing, and in testing what creates distracting content, particular in regard to the presentation of human faces.

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References

1. Queensland Government Department of Main Roads, 2002, December, Guide to the Management of Roadside Advertising. Edition 1.0 TERS Product No. 80.500.
2. Wallace, B., 2003, External-to-vehicle driver distraction. [Report]. Transport Research Series. Edinburgh: Scottish Executive Social Research. Available: <http://www.scotland.gov.uk/Publications/2003/08/17916/24495>
3. Russell, E. R., 1998, Using concepts of driver expectancy, positive guidance and consistency for improved operation and safety. 1998 Transportation Conference Proceedings.
4. Coetzee J. L., 2003, The evaluation of content on outdoor advertisements. Proceedings of the 22nd Southern African Transport Conference, 14-16 July, Pretoria, South Africa. Available https://www.up.ac.za/dspace/bitstream/2263/7113/1/Coetzee_Evaluation%282003%29.pdf
5. Van Meurs, L., & Aristoff, M., 2009, March, Split-second recognition: What makes outdoor advertising work? Journal of Advertising Research, 82-92.
6. Luoma, J., 1992, Immediate responses to road signs of alerted and unalerted drivers: An evaluation of the validity of eye movement method. Paper presented at the Transportation Research Board Annual Meeting, Washington, D. C., January 1992.
7. Smiley, A., Houghton, J., & Philp, C., 2004, Highway signing for drivers' needs. Paper presented at the Road Safety Engineering – New Developments and Initiatives Session of the 2004 Annual Conference of the Transportation Association of Canada, Quebec City, Quebec, 19-22 September. Available: <http://www.tac-atc.ca/english/pdf/conf2004/haughton.pdf>
8. Neisser, U., 1976, Cognition and Reality, San Francisco, W. H. Freeman.

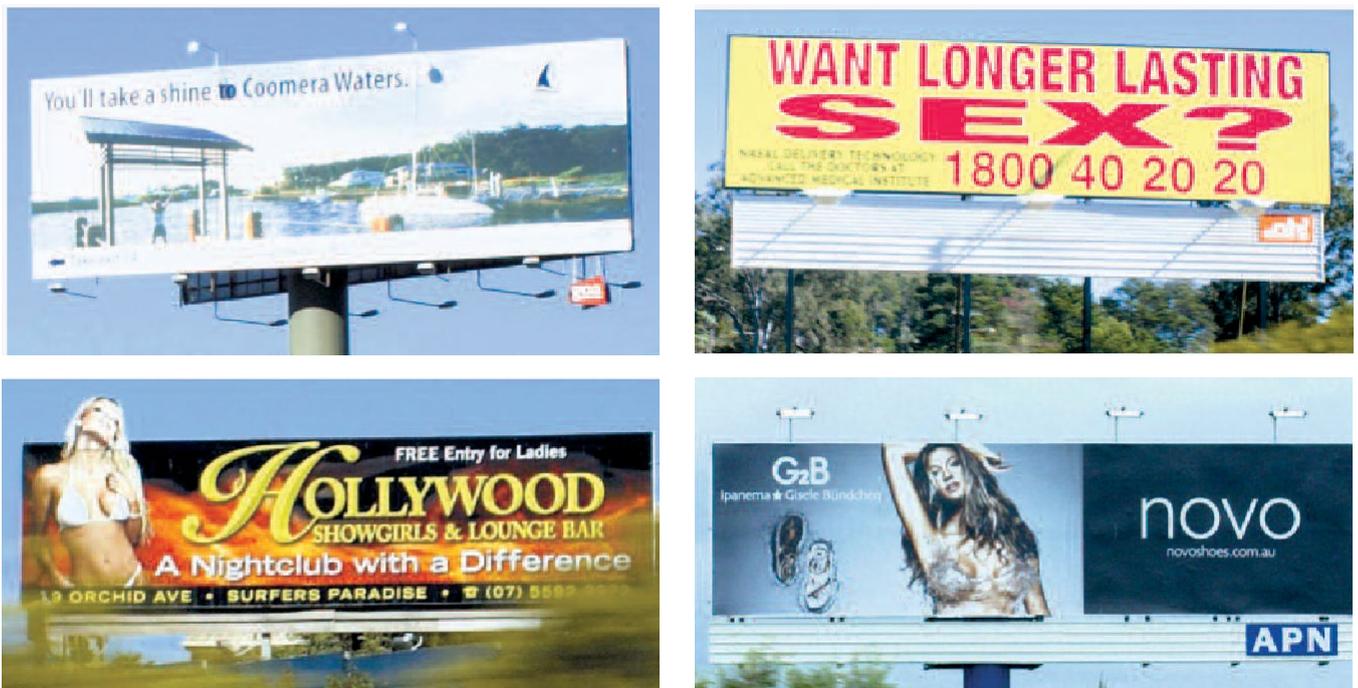


Figure 13. Potentially over-attractive signs

9. Milosevic, S., & Gajic, R., 1986, Presentation factors and driver characteristics affecting road-sign registration. *Ergonomics*, Vol.29, No.6, pp.807-815.
10. Johansson, G., & Rumar, K., 1966, Drivers and road signs: A preliminary investigation of the capacity of car drivers to get information from road signs, *Ergonomics*, Vol.9, No.1, pp.57-63.
11. Johansson, G., & Backlund, F., 1966, Drivers and road signs, *Ergonomics*, Vol.12, No.6, pp.749-759.
12. Chatterjee, K. & McDonald, M., 2004, Effectiveness of using variable message signs to disseminate dynamic traffic information: Evidence from field trials in European cities, *Transport Reviews*, Vol.24, No.5, pp.559-585.
13. Peeta, S., & Ramos, J.L., 2006, Driver response to variable message signs-based traffic information, *IEE Proceedings Intelligent Transport Systems*, Vol.153, No.1, pp.2-10.
14. Mourant, R. R., Rockwell, T.RH., & Rackoff, N. J., 1969, Drivers' eye movements and visual workload, *Highway Research Record*, Vol.292, pp.1-10.
15. Borowsky, A., Shinar, D., & Parmet, Y., 2008, The relation between driving experience and recognition of road signs relative to their locations, *Human Factors*, Vol.50, No.2, pp.173-182.
16. Anderson, J. R., 1995, *Cognitive Psychology and Its Implications*, 4th ed., New York, W. H. Freeman and Company.
17. Green, M., & Low, D., 2001, Oct/Nov, Warning! Safety signs may be ineffective!, *OH&S Canada*, Vol.17, No.7, pp.30-35.
18. Shinar, D., & Drory, A., 1983, Sign registration in daytime and nighttime driving, *Human Factors*, Vol.15, No.1, pp.117-122.
19. Bhise, V., & Rockwell, T., 1973. Toward the development of a methodology for evaluating highway signs based on driver information acquisition, *Highway Research Record*, Vol.440, pp.38-56.
20. Dudek, C. L. & Ullman, G. L., 2004, March, Dynamic message sign message design and display manual. Report FHWA/TX-04/0-4023-P1, College Station, TX, Texas Transportation Institute.
21. Forbes, T.W., Moskowitz, K. & Morgan, G., 1950, A comparison of lower case and capital letters for highway signs, *Proceedings of the Highway Research Board*, pp.355-373.
22. Garvey, P.M., Pietruka, M. T., & Meeker, D. T., 1998, July, Clearer road signs ahead, *Ergonomics in Design*, Vol.6, No.3, pp.7-11.
23. ClearviewHwy, 2004-2005, Legibility studies. Available <http://clearviewhwy.com/ResearchAndDesign/legibilityStudies.php>
24. Wang, J.-H., Hesar, S. G., & Collyer, C. E., 2007, Adding graphics to dynamic message sign messages, *Transportation Research Record: Journal of the Transportation Research Board*, No. 2018, pp.63-71.
25. *Manual on Uniform Traffic Control Devices*, 2003, FHWA, US Department of Transportation, Washington, D.C.
26. Dudek, C. L., Schrock, S. D., Ullman, G. L., & Chrysler, S. T., 2006, Flashing messages features on changeable message signs, *Transportation Research Record: Journal of the Transportation Research Board*, No. 1959, pp.122-129.
27. MacDonald, W. A. & Hoffmann, E. R., 1991, Drivers' awareness of traffic sign information, *Ergonomics*, Vol.34, No.5, pp.585-612.
28. Jacobs, R. J., Johnston, A. W., & Cole, B. L., 1975, The visibility of alphabetic and symbolic traffic signs, *Australian Road Research*, Vol 5, pp.68-96.
29. Ady, R., 1996, An investigation of the relationship between illuminated advertising signs and expressway accidents, *Traffic Safety Research Review*, Vol.3, pp.9-11.