DISCUSSION PAPER

Digital billboards and road safety: An analysis of policy and research findings in 2013–14

Introduction

Victoria was the first Australian State to have introduced a small number of digital billboards, and this has been followed by New South Wales and Queensland. However, there is some concern that there should be clear standards surrounding the installation and use of these signs to minimise their potential impact on road safety. In 2009, the OMA drafted a discussion paper to outline national and international policies for digital billboards, and research findings in relation to digital billboards and driver distraction.

This discussion paper is an update of the OMA's 2009 discussion paper.

The aim of this paper is to provide the most current information on digital billboards and road safety to assist Australian road authorities and local councils to make appropriate decisions regarding the installation and use of digital billboards near or on the roadside.

This discussion paper is divided into the following four sections:

I. The technology: this section outlines the different definitions for digital billboards and describes how they operate.
II. The policies: this section outlines how national and international jurisdictions currently regulate the installation and use of digital billboards near or on the roadside.
III. The research: this section outlines the most current research findings in regards to the proposed relationship between digital billboards and driver distraction.
IV. Discussion and recommendations: this section discusses the implications of current policy and research and outlines the OMA's recommendations in regards to the installation and use of digital billboards.

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SECTION I: THE TECHNOLOGY

1. What are digital billboards?

Digital billboards are freestanding signs that are greater than four square metres in size. There are two types of digital billboards which are becoming increasingly prevalent in international jurisdictions such as the USA, the United Kingdom (UK) and Europe:

a) *Static electronic displays:* are signs capable of displaying words, symbols, figures or images that can be electronically or mechanically changed by remote or automatic means. These displays contain static images only and do not have movement of any part of the sign structure, design or pictoral segment of the sign, including the movement of any illumination or the flashing, scintillating or varying of light intensity.
b) *Non-static electronic displays:* are signs capable of displaying words, symbols, figures, images, animation, vision and moving pictures that can be electronically or mechanically changed by remote or automatic means.

2. What are the benefits of digital billboards?

There are numerous benefits of digital billboards, which include:

- They can lead to the consolidation of outdoor signage, as multiple advertising copy can be displayed on the one piece of infrastructure.
- The signs can be changed electronically and remotely, reducing occupational health and safety issues and interruptions to the road network which are associated with the physical changeover of copy on current billboards.
- They can be contracted by emergency services to quickly get messages to the public in the event of an emergency. Examples include the *Amber Alert* program in the USA which is activated when children go missing.
- They can be used by road authorities to publicise traffic interruptions and alternative routes to drivers in the event of a crash, road works or special events.
- Advertisers can align brands with geographically relevant locations and provide real time message delivery.

3. How do digital billboards operate?

Digital billboards feature LED (light emitting diode) technology. Brightness levels can be controlled through the use of light sensors, which measure the amount of light available in the surrounding environment, or altered remotely. In the brightest sun, the sign is at its brightest to provide the necessary contrast and enhance legibility. At night, the billboard is much dimmer according to the surrounding light conditions[1].

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[1] Source: Outdoor Advertising Association of America (OAAA): www.oaaa.org

The copy displayed on digital billboards is changed remotely, which minimises OH&S risk and provides opportunities for local authorities to display messages in times of emergency.

SECTION II: THE POLICIES

Digital signage is a technology that is being implemented worldwide. Below is a sample of international jurisdictions that currently permit this technology. An attempt has been made to summarise the current policies, regulations and standards to govern the use and implementation of these signs. The latter half of this section then describes the national policies that currently exist to allow the implementation of digital billboards in Australia.

International

USA

In September 2007, the Federal Highway Administration (FHWA) issued a memorandum to its 50 state-based Division Offices to provide guidance on effective control of digital billboards under the *Highway Beautification Act* (HBA). The aim was to achieve national consistency in the approval of such signage, given the variations in existing Federal/State Agreements (FSA) and state laws, regulations, policies and procedures.

Digital billboards are considered to be acceptable if they are found to be consistent with the FSA and any approved state regulations, policies and procedures. Under this memorandum, if the Division Office determines that the FSA and other state regulations and policies permit digital billboards, the following standards should also be considered before allowing the broader implementation of these signs. These standards outline the ranges of acceptability for certain features of digital billboards and were based on what had already been approved by some Division Offices prior to the issuing of the memorandum:

- Duration of message: Duration of each display is to be within 4 and 10 seconds. 8 seconds is recommended.
- Transition time: Transition between messages is generally between 1 and 4 seconds. 1-2 seconds is recommended.
- Brightness: Brightness should be adjusted in response to changes in light levels so that the signs are not unreasonably bright for the safety of the motoring public.
- Spacing: Spacing between such signs should not be less than the minimum spacing requirements for signs under the FSA, or greater if determined appropriate to ensure the safety of the motoring public.
- Locations: Locations where allowed for signs under the FSA except such locations where determined inappropriate to ensure safety of the motoring public.

It is not clear, however, how these standards have been derived and whether they are based on any sound empirical data.

Other standards that the states had found helpful to ensure driver safety include:

- A default designed to freeze a display in one still position if a malfunction occurs.
- A process for modifying displays and lighting levels where directed by the State Department of Transport to ensure the safety of the motoring public.
- Requirements that a display contain static images without movement such as animation, flashing, scrolling, intermittent or full-motion video.

At present, there are 40 states in the USA that permit static digital signage. A further 2 states allow tri-action signs[2] only. Only 4 states prohibit the use of digital billboards. A summary of the standards applied by each state are outlined in Table 1 below. The Outdoor Advertising Association (OAAA) of America promotes the display of static electronic images only, and recommends prohibition of signs which contain, include or are illuminated by any flashing, intermittent, or moving light/s.[3]

Regarding illumination, digital billboards use the minimum amount of light necessary to provide legible copy, a practice which meets federal criteria and the lighting industry's standards. In the USA, the outdoor media industry's lighting standards for digital billboards are stricter than the lighting standards used by the Government for signs on the right of way.

The OAAA recommends the following brightness criteria for digital billboards:

- Light produced by a digital billboard should not exceed 0.3 footcandles over ambient light levels.
- Measurement should be taken using a footcandle (lux) meter from the following distances perpendicular to the face of the digital sign:
    - Posters: 150 feet (approximately 46 metres).
    - 10'6x36 Bulletins: 200 feet (approximately 61 metres).
    - 14x48 Bulletins: 250 feet (approximately 76 metres).
    - 20x60 Bulletins: 350 feet (approximately 107 metres).

  These measurement distances are based on the average minimum viewing distances for each type of sign. If the difference in measurements is less than 0.3 footcandles, the digital billboard is in compliance with regulations.

- Digital billboards must have automatic dimming capability. This means that the billboard must be able to automatically adjust brightness levels as ambient light conditions change. An automatic sensing device (such as photocell or similar technology) should be utilised for adjusting the digital billboard's brightness.

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[2] Tri-action signs provide one of three views using rotating cylinders and generate mechanical motion or movement.
[3] OAAA - A suggested ordinance for the regulation of off-premise digital outdoor advertising (2011)

Sunrise/sunset tables and manual methods of controlling brightness are not acceptable as a primary means of controlling brightness.

These criteria are based on recommendations by a lighting expert to meet the following guidelines:

- The digital copy needs to be legible but not overly bright.
- The measurement of brightness of the sign needs to be simple to understand, easily measureable and enforceable.
- The criteria must be based on established scientific methodology and industry standards from the Illuminating Engineering Society of North America publication TM-11-00 “light trespass” theory. This is an accepted standard in the lighting industry.
- Brightness must be able to be adjusted in a variety of lighting environments.

NOTE: A footcandle meter is also known as a lux meter. It measures the amount of light arriving at the meter (illuminance) as opposed to an absolute measurement of the amount of light emanating from a light source or light sources (luminance). A footcandle is a measure of lumens (light rays) that fall on one square foot area. Lux is the metric equivalent of a footcandle.

In contrast, a candela meter measures the amount of light emanating from a specific light source (luminance). It measures candelas (a measure of luminance or brightness) emanating from a specific light source. It excludes ambient light (which may include light from many sources) from the measurement. The OAAA does not recommend using standard candela levels and/or the use of a candela meter to measure the brightness of digital billboards.

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TABLE 1: Summary of US states' standards for digital billboards

State	Dwell time (sec)	Transition time (sec)	Spacing (feet/metres)
Alabama	6	None	500/152
Arkansas	8 or more	2 or less	1500/457
Arizona	6	1	500/152
California	4	4	1000/305
Colorado	4	2	1000/305
Connecticut	6	3	500/152
Delaware	10	1	2500/762
Florida	6	2	1500/457
Georgia	10	3	5000/1524
Idaho	8	2	500/152
Illinois	10	3	500/152
Indiana	8	2	500/152
Iowa	6	1	500/152
Kansas	8	2	1000/305
Louisiana	8	4	1000/152
Maryland	No regulations	No regulations	1000/305
Massachusetts	pilot	pilot	500/152
Michigan	6	1	1000/305
Minnesota	6	none	500/152
Mississippi	8	instantaneous	500/152

Missouri	8	2	1400/427
Nebraska	10	2	5000/1524
Nevada	6	3	500/152
New Hampshire	No regulation s	No regulations	500/152
New Jersey	8	1	3000/914
New Mexico	5	1-2	500/152
New York	6	3	500/152
North Carolina	8	2	1000/305
Ohio	8	3	1000/305
Oklahoma	8	4	1000/305
Pennsylvania	5	1	500/152
Rhode Island	5-7	2-3	750/229
South Dakota	6	none	500/152
South Carolina	8	2-3	500/152
Tennessee	8	2	2000/610
Texas	8	2	1500/457
Utah	8	3	500/152
Virginia	4	none	500/152
West Virginia	8	2	1500/457
Wisconsin	6	1	500/152

Canada

Digital signage in Canada has seen significant grown in the last years. In Montreal local and provincial authorities have mandated a 10 second dwell time and requested a "quick" resolution time between images. While non specific, their objective is to have a rapid transition between images and no slow fades. Light intensity has not been regulated.

The approval process for digital billboards in Toronto is slightly different to the approval process in Montreal. In Toronto, provincial approval is not required but each proposed location for digital billboards must be approved on a ward-by-ward basis. The City of Toronto currently allows full-motion video in a small number of districts.

There is currently a major bylaw review in Toronto which is addressing the issue of digital billboards. The consulting group responsible for this review is considering regulating certain aspects of these signs such as their location, size, lighting and message dwell time.

Digital billboards have not been introduced in any other markets with the exception of Calgary in Western Canada where one sign has been installed on a test basis.

United Kingdom – London

The *Town and Country Planning Act (Regulation of Outdoor Signage 2007)* has one broad definition of outdoor advertising and therefore accommodates digital billboards. Local authorities are then required to develop Unitary Development Plans (UDPs) to outline what advertising is permitted in certain locations. Signage rules and regulations can be used by relevant authorities to prevent a digital billboard from being built or converted.

One well-known site for digital billboards in the UK is Piccadilly Circus (see Figure 1 below). Piccadilly Circus is a famous road junction linking approximately five roads. Its status as a major traffic-intersection has made Piccadilly Circus a busy meeting place and a tourist attraction in its own right. Illuminated signs have existed at Piccadilly Circus since the early 1900s with the signs gradually moving to LED displays in the early 2000s.

Figure 1. Digital billboards at Piccadilly Circus, London, UK.

The UK Outdoor Advertising Association has introduced a *Digital Large Format Roadside Code* with the following recommendations for the installation and use of digital billboards:

- Mirroring current roadside legislation, there shall be no moving images, animation, video or full-motion images displayed unless consent has been granted for such displays.
- The advertising copy on digital roadside billboards should not change more frequently than every 5 seconds unless consent has been granted for such displays.
- The luminance of a digital roadside billboard shall comply with the Institute of Lighting Engineers Technical Report no.5 (2003). The recommendations for maximum luminance (cd/m^2) are as follows:

Illuminated area (m^2)	Zone E1[4]	Zone E2[5]	Zone E3[6]	Zone E4[7]
Up to 10	100	600	800	1000
Over 10	n/a	300	600	600

NOTE: The above recommendations for maximum luminance may not apply to recognised display centres, such as Piccadilly Circus, which must be considered as special cases. Recognised display centres usually exhibit the following features:

a) A concentration of illuminated advertisements, some of which do not relate to the business premises on which they are erected.
b) Extensive use of animation.
c) Mounting of illuminated advertisements well above the building frontage height.

In such instances, an approach based on advertisements with an illuminated area greater than $10m^2$ having a maximum luminance of 1000 cd/m^2 would be a reasonable starting point, depending on the precise nature and extent of the installation.

- Roadside digital displays in England will conform to the five standard conditions specified in Schedule 2 of the *Town and Country Planning (Control of Advertisements)(England) Regulations 2007*:
    1. No advertisement is to be displayed without the permission of the owner of the site or any other person with an interest in the site entitled to grant permission.
    2. No advertisement shall be sited or displayed so as to:
        a) Endanger persons using any highway, railway, waterway, dock, harbour or aerodrome (civil or military);

[4] Zone E1 is classified as an intrinsically dark area (e.g. national parks, areas of outstanding natural beauty or other dark landscapes).
[5] Zone E2 is classified as a low district brightness area (e.g. rural or small village locations).
[6] Zone E3 is classified as a medium district brightness area (e.g. small town centres, urban locations).
[7] Zone E4 is classified as a high district brightness area (e.g. city and town centres with high levels of night-time activity).

b) Obscure or hinder the ready interpretation of any traffic sign, railway signal or aid to navigation by water or air; or
c) Hinder the operation of any device used for the purpose of security or surveillance or for measuring the speed of any vehicle.
3. Any advertisement displayed, and any site used for the display of advertisements, shall be maintained in a condition that does not impair the visual amenity of the site.
4. Any structure or hoarding erected or used principally for the purpose of displaying advertisements shall be maintained in a condition that does not endanger the public.
5. Where an advertisement is required under these Regulations to be removed, the site shall be left in a condition that does not endanger the public or impair visual amenity.

New Zealand

In New Zealand, the NZ Transport Agency addresses signage in its "Traffic control devices manual - Part 3: Advertising signs". The NZTA has also produced a leaflet "State highways - advertising signs" and an "Advertising 'how to' guide".

These documents state:

- Animated or flashing signs should not be used as roadside advertising if they incorporate a revolving light or rotate about any axis other than a vertical one.

- Proposals to install VMS should be carefully assessed where each separate display is not static from first appearance to replacement.

- Advertising signs which move or give the appearance of motion or that include lights or light sources which flash, revolve, move or vary in intensity are unlikely to be considered acceptable.

- Flashing lights cannot be used on vehicles to promote vehicle-mounted advertising.

- Proposals to erect VMS should be carefully assessed where the minimum time for any separate display is less than 5 seconds and where the time to change from one display to the next is greater than 2 seconds.

- Animated or flashing signs should not be used as roadside advertising if the message is more complex than a single word, logo or symbol displayed in any direction at one time. Signs should have a maximum of 6 words and/or symbols, with a maximum of 40 characters.

- Guidance is also provided about lettering height, colours that may conflict with traffic signs.

- Any advertising signs or devices which are internally or externally illuminated should:

- comply with the maximum luminance stated below;
- have all floodlights or concealed lighting directed solely on to the advertisement and its surrounds;
- have any light source shielded so that glare does not extend beyond the advertisement;
- with the exception of neon signs, have no light source visible to passing motorists with a light output greater than that of a 65 watt incandescent bulb.

- Maximum luminance of illuminated advertising devices in areas with street lighting varies from 2000 cd/m^2 for illuminated areas up to 0.5m^2 to 800 cd/m^2 for areas over 10.0m^2. In areas without street lighting, the maximum luminance varies from 1000cd/m^2 for illuminated areas up to 0.5m^2 to 400cd/m^2 for areas over 10.0m^2.

- Billboards must not be more than 6m wide or 3m high.

National

Victoria

Victoria was the first state in Australia to introduce a small number of digital billboards. On 17 September 2007, Amendment VC45 was introduced into the *Victorian Planning Provisions*. This Amendment introduced the following definition for electronic billboards:

> "A sign that can be updated electronically. It includes screens running television footage, large screen video displays and the like."

The Amendment also established VicRoads as the referral authority for electronic billboards within 60 metres of a declared road or freeway.

In 2008, the Advisory Committee established to review the advertising billboards provisions contained in Clause 52.05 of the *Victorian Planning Provisions* (VPPs) recommended that VicRoads establish a working group to develop a more consistent and stringent approach to the installation, use and content of scrolling, moving and video-style advertising within and adjacent to road reserves. They suggested that part of the working group's consideration should be to determine the different standards that may need to be applied to billboards with moving electronic displays and billboards with static electronic displays.

A working group has since been established by VicRoads and in early 2009 was assessing the standards which should be applied to this form of signage. In late 2009 the working group was postponed until certain draft provisions from the Victorian Signage Review have been implemented in the VPPs.

As they stand at the date of this document, the VPPs state that a sign is considered to be a safety hazard if it could dazzle or distract drivers due to its size, design or colouring, or it being illuminated, reflective, animated or flashing.

The VPPs also state that before deciding on an application to display a sign, the responsible authority must consider the impact of any glare and illumination on teh safety of pedestrians and vehicles, and on the amenity of the area.

New South Wales

There are currently no legislative provisions within the *State Environmental Planning Policy No 64 – Advertising and signage* (SEPP 64) to allow the installation of digital billboards within NSW. However, the OMA has been working with Transport NSW and the Department of Planning to include a digital component to the Transport Corridor Guidelines. It is expected that the changes to the SEPP and the Guideline should be finalised in mid-2014.

Queensland

Regulation for outdoor advertising in Queensland is administered at a local level through local laws and planning schemes; therefore digital billboards will be permitted in some local jurisdictions and not others. The Department of Transport and Main Roads has jurisdiction over state controlled roads, including motorways.

Brisbane City Council is the only local council in Australia to have its own advertising guide that includes standards around the operation of digital signs on their local roads. This guideline includes provisions around dwell times (10 seconds on roads under 80km/h), luminance and sign distances. The regulations for advertising are set out in the *Advertisements Local Law 2013* and *the Advertisements Subordinate Local Law 2013*.

If a proposed advertising sign is within the boundaries of a state-controlled road, it must be referred to the Queensland Department of Main Roads in the assessment process for consideration against the provisions contained within their *Guide to the Management of Roadside Advertising* (the Guide). The distraction potential of advertising signs is considered to be related to the signs size, content, illumination and its longitudinal, lateral and vertical placement. Under the current Guide, "Appendix N - Supplementary Guideline for the Management of Electronic Billboard Advertising Devices" deals with regulations for digital billboards that are within state road corridors or visible from state roads. Under the Supplementary Guideline, non-static electronic displays (i.e., animated, video, flashing, active display changes etc.) are prohibited. The regulations for static electronic displays are as follows:

- Different placement restriction distances apply at various types of road locations.
- Other placement restrictions apply where traffic conditions require additional driver attention, or due to the crash history at a given location.
- There must be adequate advance visibility to view and read the digital billboard.
- There are different minimum spacing distances, depending on road type:
  - On motorways or motorway standard roads, a minimum of 500 metres distance is required between 2 digital billboards that are both visible to a driver at the same time. This distance is reduced to 250 metres if they are not both visible to a driver at the same time.
  - On other state controlled roads with a speed limit of 80km/hr or greater, the minimum distance is 375 metres (when both visible at the same time) or 190 metres (if not both visible at the same time).
  - On other state controlled roads with a speed limit of 70km/hr, the minimum distance is 250 metres (when both visible at the same time) or 125 metres (if not both visible at the same time).

- On other state controlled roads with a speed limit of 60km/hr or less, the minimum distance is 150 metres (when both visible at the same time) or 75 metres (if not both visible at the same time).

- Message sequencing on one billboard, or between billboards, is not permitted.
- In the event of a malfunction, the advertising display must default to a blank screen.
- The minimum message dwell time ranges from 10 seconds to 25 seconds, depending on road type. For example, dwell time is 25 seconds when the device is visible from road with a speed limit of more than 80km/h, and 10 seconds if visible from other state controlled roads with a speed limit of less than 80km/hr.
- Luminance levels are to be determined based on site specific requirements, but the following values are suggested maximums:
  - Daytime - 6000 cd/m^2
  - Dawn/dusk - 600 cd/m^2
  - Night - 300 cd/m^2

Western Australia

In Western Australia, Main Roads WA oversees roadside advertising and is in the process of updating the Policy and Application Guidelines for Advertising Signs Within and Beyond State Road Reserves. This Guideline will provide a range of provisions for state controlled roads for static and digital signage in both large and small formats.

Tasmania and Northern Territory

Tasmania's Department of Infrastructure, Energy and Resources has produced the "Tasmanian Roadside Signs Manual - Part G: Advertising and Commercial Signage" and a policy statement "OPS22 - Electronic billboards on state roads." The Northern Territory Department of Construction and Infrastructure has "Guidelines for permanent roadside advertising signs on road reserves."

In both states, electronic advertising billboards are prohibited.

SECTION III: THE RESEARCH

There are two categories of relevant research. One examines the 'human factors' that are generally involved in distraction, attention and awareness, which have been argued to apply more generally to distraction as it relates to the driving task. The other category is research that has focussed directly on driver behaviour or driving outcomes (studies of crash statistics) in relation to outdoor advertising. Below is a summary of the most recent and relevant articles in each category:

1. US Department of Transport Federal Highway Administration (2012) **Driver visual behavior in the presence of commercial electronic variable message signs (CEVMS)**

This study was conducted to investigate the effect of digital billboards (CEVMS) on driver visual behaviour in a roadway driving environment. An instrumented vehicle with an eye tracking system was used. Roads containing digital billboards, standard billboards, and control areas with no billboard advertising were selected. Data were collected on arterial roads and freeways, during the daytime and at night. The field studies were conducted in two cities where the same methodology was used but there were differences in the roadway visual environment. The digital billboards had dwell times of between 8 and 10 seconds.

The study found that the presence of digital billboards did not decrease the percentage of time drivers spent looking toward the road ahead.

The study also found that the average fixation duration to a digital billboard was 0.379 seconds, and to a standard billboard it was 0.335 seconds. It found that the longest fixation to a digital billboard was 1.335 seconds, and to a standard billboard was 1.284 seconds. The current widely accepted threshold for durations of glances away from the road ahead that result in higher crash risk is 2 seconds, so the longest glances for both types of billboards in this study fell below that threshold. That is, the results did not provide evidence indicating that digital billboards were associated with unacceptably long glances away from the road.

Four dwell times (aggregate of consecutive fixations to the same object) greater than 2 seconds were observed in the study. Three were to standard billboards and one was to a digital billboard, however in all cases these signs were not far from the forward view while the participant's gaze dwelled on them, and the study concluded that the drivers still had access to information about what was in front of them through peripheral vision, so the road ahead was still in the driver's field of view.

Although drivers did not glance unreasonably long towards digital or standard billboards, the study did find that drivers were generally more likely to gaze at digital billboards than at standard billboards. However, the study concluded that drivers still directed the majority of their visual attention to areas of the roadway that were relevant to the driving task. The study also speculates that it is likely that when drivers looked away from the forward roadway in the absence of billboards, they may have elected to glance at other objects that were not relevant to the driving task. The study concludes that when billboards were present, the drivers sometimes looked at them, but not such that overall attention to the forward roadway decreased. The study is consistent with other research that shows that in the driving environment, gaze allocation is principally controlled by the requirements of the driving task.

As with all on-road research in this area, the results are limited by the fact that the road environment around each sign could not be consistently controlled. The results may have also been affected by the presence of two experimenters travelling in the vehicle with the drivers, as well as a possibly limited participant demographic distribution that may not have been representative of the general driving population. Therefore, while the study certainly adds to the knowledge base on the issues examined, it does not present definitive answers to the research questions investigated.

2. Edquist, J., Horberry, T., Hosking, S., and Johnston, I. (2011) **Effects of advertising billboards during simulated driving.** *Applied Ergonomics*, volume 42, pp. 619-626.

A driving simulator experiment examined visual behaviour and responses to road signs in the presence and absence of billboards (both static and changing), including for older and inexperienced drivers. Head and eye movements were tracked. The simulated drive was along arterial roads through commercial and industrial environments, and billboards popped up when the participant was 140 metres from the billboard location. The image on the changing billboard changed once, when the participant was 85 metres from the billboard location.

The study found that in the presence of billboards, drivers spent less time fixating on the road ahead, made more errors and took longer to change lanes in response to road signs. This finding should not be interpreted without reference to the findings of the US Department of Transport Federal Highway Administration (2012), that drivers in an on-road study directed the majority of their visual attention to areas of the roadway that were relevant to the driving task.

Scanning patterns for novice and older drivers were both more affected by billboards than scanning for comparison drivers. Older drivers made more lane change errors overall, but more so when billboards were present. This effect was not so marked for novice drivers.

The changeable billboards did not show greater effects than static billboards. The researchers speculate that this is because, due to technology limitations, only one image change could be programmed on each changeable billboard. They state that future research should examine the effect of billboards that change more frequently than once during the period for which they are visible, as change frequency is currently under debate in many jurisdictions.

The researchers acknowledge that simulator experiments are limited in their ability to emulate the visual complexity of real road scenes. They go on to say that, "while the absolute values for simulator measures may not precisely match values obtained on road, relative differences between conditions still hold, and simulator measures have been found to be valid predictors of accident risk (Rudin-Brown and Lenne, 2010)."

In this study, 50% of the participants were also told to report on the billboards that they saw. While the researchers chose this variable to reflect a real-life scenario where a driver sees a billboard that interests them, it could also have affected the results in this study because those drivers instructed to report on billboards would have been intentionally looking out for billboards. While the results were analysed to take into account the different instructions given to people, this variable cannot be generalised to real-life scenarios when drivers will glance at billboards randomly.

3. Hollingworth, H., Simons, D.J. and Franconeri, S.L., (2010) **New objects do not capture attention without a sensory transient.** *Attention, Perception & Psychophysics*, volume 72(5), pp. 1298-1310.

There are two competing theories to explain how attention is captured by salient visual events. Under the *transient hypothesis*, attention is drawn by the abrupt sensory transients created when an object undergoes a salient change. For example, if an object moves into view, the motion transient generated by that object will capture attention. Under the *new-object hypothesis*, the only event that is proposed to capture attention reliably is the appearance of a new object in the visual field. Under this view, capture does not depend on the sensory transient created by the object's appearance.

This study tested whether a new object captures attention without a sensory transient, through a series of search tasks conducted on computer screens. The tasks introduced new objects into a search display, either with or without a unique luminance transient.

The researchers found that when the new object's transient was masked by a brief interstimulus interval, a new object did not capture attention. The results suggested that a new object does not capture attention involuntarily, unless the new object creates a unique transient signal, such as a change in luminance.

As with all human factors research, caution should be applied when generalising results of computer-screen tests such as this, to real world driving scenarios.

4. Tantala, M.W. & Tantala, A.M. (2010). **A study of the relationship between digital billboards and traffic safety in the Greater Reading Area,Berks County, Pennsylvania.** Submitted to the Foundation for Outdoor Advertising Research and Education (FOARE).

The purpose of the study was to examine the statistical relationship between digital billboards and traffic safety in the Greater Reading Area, Berks County, Pennsylvania. The study analysed eight years of traffic and crash data for roads near 26 digital billboards in the area. Most of the billboards were freestanding, single-pole structures with one digital face; however six locations had two digital billboards on the same upright. Each billboard displayed static images (text and graphics) with message dwell times of 8 or 10 seconds, except for a six month period in 2006 when some of the billboards displayed dwell times of 6 seconds.

The analysis consisted of three parts: a temporal analysis of the occurrence of crashes around the billboards for an equal amount of time before and after they were converted to digital; a spacial analysis to establish the correlation between digital billboards and crashes; and a comparison of crash rates after the introduction of digital billboards with the crash rates that would have been predicted if no digital billboards had been introduced. Crash statistics were summarised for vicinity ranges within 0.1, 0.2, 0.3, 0.4 and 0.5 miles both upstream and downstream of the billboard, with 8 and 10 second dwell times. Additionally, subsets of crash data for daytime and night-time crashes and for the age of the driver were analysed for before and after comparisons. Metrics included traffic volumes, total number of crashes, average number of crashes in any given month, peak number of crashes in any given month and vehicle-miles travelled.

The overall conclusion of the study was that the digital billboards in the Greater Reading Area had no statistically significant relationship with the occurrence of accidents, and the results were consistent for 8 and 10 second dwell times. Specific findings of the study included:

- The number and rates of crashes near the digital billboards decreased in all vicinity ranges for both 8 and 10 second dwell locations. For example, at the 0.5-mile vicinity range, the rate of accidents decreased by 11.1%.
- The difference in crash data before and after the conversion of the billboards to digital was not statistically significant. Crash statistics also remained consistent for before and after comparisons of the 6 month period in 2006 when the dwell time was 6 seconds.
- The total number of accidents after the conversion of the signs to digital billboards was approximately equivalent to what would have been statistically expected without the introduction of digital technology.
- Crash statistics remained consistent when comparing day and night-time crashes before and after the sign conversion and when comparing the age of the driver.
- Crash rates have not increased following the conversion of the signs to digital billboards.

5. Tantala, M.W. & Tantala, A.M. (2010). **A study of the relationship between digital billboards and traffic safety in Albuquerque, New Mexico.** Submitted to the Foundation for Outdoor Advertising Research and Education (FOARE).

The purpose of the study was to examine the statistical relationship between digital billboards and traffic safety in Albuquerque, New Mexico.

The study analysed traffic and crash data for a seven-year period for local roads near 17 existing digital billboards. Each of the 17 digital billboards was a freestanding, single-pole structure with one digital face. These billboards were converted from traditional PVC billboards between 2006 and 2007 and displayed static images with a message dwell time of 8 seconds.

The analysis consisted of two parts: a temporal analysis of the occurrence of crashes around the billboards for an equal amount of time before and after they were converted to digital and a spatial analysis to establish the correlation between the digital billboards and crashes. Crash statistics were summarised for vicinity ranges within 0.2, 0.4, 0.6, 0.8 and 1.0 miles both upstream and downstream of the billboard. Additionally, subsets of crash data for daytime and night-time crashes and for the age of the driver were analysed for before and after comparisons. Metrics included total number of crashes, average number of crashes in any given month, peak number of crashes in any given month, average annual daily traffic and vehicle miles travelled.

The overall conclusion of the study is that the 17 digital billboards in Albuquerque have no statistically significant relationship with crashes. Specific findings of the study are as follows:

- Crash rates near the five digital billboards showed a 0.3% decrease in the rate of crashes within 0.6 miles of the 17 digital signs over an average 6 years.
- Crash statistics remained consistent and showed statistically insignificant variations at each of the digital billboard sites.
- Crash statistics remained consistent when comparing day and night-time crashes before and after the sign conversion and when comparing the age of the driver.
- Crash rates have not increased following the conversion of the signs to digital billboards.

6. Bendak, S. & Al-Saleh, K (2010) **The role of roadside advertising signs in distracting drivers.** *International Journal of Industrial Ergonomics*, vol 40, pp 233-236.

This study involved a driving simulator task, in which drivers followed two routes. One route had roadside advertising signs, and one had none. The roadside advertising signs included illuminated signs, animated signs, banners, shop fronts, billboards and VMS. The results indicated that two driving performance indicators, drifting from lane and recklessly crossing dangerous intersections, were significantly worse in the path with advertising signs as compared with performance on the other path. The latter of these was said to be due to a delayed reaction to hazards, caused by distraction from the signage. The researchers recommended that advertising signs should not be placed along roads where maximum attention is required, such as 'dangerous bends', areas where high accident rates are recorded, and intersections.

Caution should be applied when generalising these results to OOH advertising, because the study focussed on all types of advertising rather than just OOH. This study also carries the limitations of all simulator studies, in that it could not perfectly replicate a real-world scenario. In addition, the participant demographic was males between the ages of 23 and 28 years old, so the results may not be representative of the general driving population.

7. Chan, E., Pradhan, A.K., Pollatsek, A., Knodler, M.A., Fisher, D.L. (2010) **Are driving simulators effective tools for evaluating novice drivers' hazard anticipation, speed management, and attention maintenance skills?** *Transportation Research Part F*, vol 13, pp. 343-353.

This study involved a driving simulator and the participants' eyes were tracked throughout each drive. Newly-licensed and experienced drivers (with at least 5 years driving experience) performed various distracting tasks that were located either inside or outside the vehicle while driving. Out-of-vehicle tasks included identifying a target on a sign, and in-vehicle tasks included looking for a CD.

The eye tracking measured how long a driver's eyes were moved away from the forward roadway (as opposed to how long they fixated on one particular item away from the forward roadway). It found that the maximum glance durations were much longer for the out-of-vehicle tasks than for the in-vehicle tasks. This seems to indicate an awareness on the part of the drivers that they should not look away too long when dealing with in-vehicle distractions.

The results also showed that novice drivers are much more willing to glance for long periods of time inside the vehicle than are experienced drivers. This may be a relevant factor in the increased crash-rate of less experienced drivers.

The results also indicate that both novice and experienced drivers spend equal amounts of time glancing at tasks external to the vehicle and in the periphery. This tends to undermine the argument that is often put forward, that inexperienced drivers are more distracted by external factors such as outdoor advertising.

The researchers conclude from the results that even experienced drivers haven't learned to limit the durations of their glances off to the side of the vehicle because there is an illusion of how much visual information they can process - they are unaware that they are unable to fully process the visual information in their periphery of vision (ie, the forward roadway, where hazards and other information need to be processed for safe driving). However, any conclusions should be interpreted while keeping in mind that the participants in this study were told to complete certain tasks which required them to actively search inside and outside the vehicle. This does not happen in real-world driving scenarios as they relate to OOH advertising.

The researchers questioned whether the results of this study could be generalised to the real world. They state that, "A billboard or external display which required overlong glances in the driving simulator might not require overlong glances in the real world. Since we did not test particular billboards, our only claim is that billboards in the field that require reading times much longer than 2 seconds present potential problems, especially when they are located far into the periphery." This 2-second measure appears to be based on the study of Klauer et al. (2006), referred to below.

8. Tantala, M.W. & Tantala, A.M. (2009). **An update of a study of the relationship between digital billboards and traffic safety in Cuyahoga County, Ohio.** Submitted to the Foundation for Outdoor Advertising Research and Education (FOARE).

This 2009 study is an update of the 2007 study listed at item 16 below. The study revisited the same seven digital billboards in Ohio for longer periods of time and looked more closely at comparisons of specific attributes within crash reports, such as driver age (young/elderly) and time of day (day/night). The purpose of the 2007 study was to examine the statistical relationship between digital billboards and traffic safety to determine whether a correlation exists.

Specifically, the study analysed eight years of traffic and crash data near seven digital billboards located on interstate routes in Cuyahoga County, Ohio. These seven billboards were converted from traditional fixed billboards to digital billboards in 2005 and displayed static messages with a message dwell time of 8 seconds.

The analysis consisted of two parts: a temporal analysis of the occurrence of crashes around the billboards for an equal amount of time before and after they were converted to digital and a spatial analysis to establish the correlation between the digital billboards and crashes. Crash statistics were summarised for vicinity ranges within 0.2, 0.4, 0.6, 0.8 and 1.0 miles both upstream and downstream of the billboard. Additionally, subsets of crash data for daytime and night-time crashes and for the age of the driver were analysed for before and after comparisons. Metrics included total number of crashes, average number of crashes in any given month, peak number of crashes in any given month, average annual daily traffic and vehicle miles travelled.

Overall, the study reinforced the findings from the original 2007 study which found that digital billboards in Cuyahoga County did not have any statistical relationship with crash occurrence. Specific findings of the study are as follows:

- Crash rates near the seven digital billboards collectively decreased in all vicinity ranges. The benchmark 0.6 mile vicinity experienced a 14.9% decrease (a normalised 2.2% decrease) in the rate of crashes over the eight-year period for all signs.
- Crash statistics remained consistent and showed statistically insignificant variations at each of the digital billboard sites.
- Crash statistics remained consistent when comparing day and night-time crashes before and after the sign conversion and when comparing the age of the driver.
- Crash rates have not increased following the conversion of the signs to digital billboards.

9. Tantala, M.W. & Tantala, A.M. (2009). **Digital billboards and traffic safety in Rochester, Minnesota.** Submitted to the Foundation for Outdoor Advertising Research and Education (FOARE).

The purpose of the study was to examine the statistical relationship between digital billboards and traffic safety in Rochester, Minnesota.

The study analysed traffic and crash data for a five year period for local roads near five existing digital billboards. Each of the five digital billboards were freestanding, single pole, double-faced structures with one digital face. These billboards were converted from traditional PVC billboards between 2006 and 2008 and displayed static images with a message dwell time of 8 seconds.

The analysis consisted of two parts: a temporal analysis of the occurrence of crashes around the billboards for an equal amount of time before and after they were converted to digital and a spatial analysis to establish the correlation between the digital billboards and crashes. Crash statistics were summarised for vicinity ranges within 0.2, 0.4, 0.6, 0.8 and 1.0 miles both upstream and downstream of the billboard. Additionally, subsets of crash data for daytime and night-time crashes were analysed for before and after comparisons. Metrics included total number of crashes, average number of crashes in any given month, peak number of crashes in any given month, average annual daily traffic and vehicle miles travelled.

The overall conclusion of the study is that the five digital billboards in Rochester have no statistically significant relationship with crashes. Specific findings of the study are as follows:

- Crash rates near the five digital billboards showed a 5% decrease in the rate of crashes within 0.6 miles of digital signs over an average 3.2 years.
- Crash statistics remained consistent when comparing day and night-time crashes before and after the sign conversion.
- Crashes statistics on sections of road near the billboards were comparable to crash statistics on similar sections of road without billboards.

10. Molino, J.A., Wachtel, J., Farbry, J.E., Hermosillo, M.B. & Granda, T.M. (2009). **The effects of Commercial Electronic Variable Message Signs (CEVMS) on driver attention and distraction: An update.** Federal Highway Administration (FHWA), USA.

This report reviewed the findings of a number of research studies investigating the possible effects of digital billboards on road safety. This report is an update of a previous 2001 literature review by Farbry and colleagues, also commissioned by the FHWA (see article 24 below). It also recommends a number of factors that should be considered for future research in this area.

The basic research question that was addressed in this report was whether the presence of digital billboards along the roadside is associated with a reduction in driving safety for the public. The authors found that from a scientific perspective, the literature review could not adequately answer this question because the findings of the studies that were reviewed were inconclusive and/or contradictory. The authors go on to state that "nowhere in the web of literature reviewed can one find a convincing set of interlocking experiments and demonstrations that firmly establishes the link between CEVMS exposure and sufficient driver distraction to impair safe driving performance."

Whilst the literature review found that there were more studies showing possible road safety impacts from digital billboards, the authors caution against assuming that this means that there must be a road safety impact as opposed to no road safety impact. This assumption neglects to weight the studies according to the intrinsic strength of the experimental design, the statistical power needed to generalise the results and the general care taken in their execution. The other concern that the authors have is in regards to the nature of the current scientific model of inquiry which seeks to prove that differences exist, rather than proving that differences do not exist. For example, in instances where research findings are small or subtle, researchers often seek out the worst case examples of signs to prove that such an effect exists, which then makes it hard to generalise these findings to the broader population of signs where there may not be any negligible road safety impact.

11. Wachtel, J. (2009). **Safety impacts of the emerging digital display technology for outdoor advertising signs.** Final report submitted to the National Cooperative Highway Research Program (NCHRP) Project 20-7 (256).

This report reviewed the findings of 43 studies conducted from 1984 to 2008 on the possible road safety impacts of both traditional and digital billboards. It also reviewed the regulations from a number of jurisdictions and recommended a number of guidelines for the operation of these signs in the USA.

The literature review found that there is still very little research specifically focused on the possible road safety impacts from digital billboards. The author acknowledges that this issue is very difficult to study because every sign, road and driver is different; for example, a study evaluating a four-second message display interval might obtain different results from another evaluating an eight-second display, and a study conducted with free-flowing traffic may have a different outcome than one that examines the same road and the same sign when traffic demands are greater, etc.

The author’s conclusions from reviewing this latest literature are similar not only to the FHWA report listed above, but also to a similar literature review which was conducted 28 years ago:

a) No definitive conclusions can be made about the presence or strength of adverse road safety impacts from digital billboards.
b) Although some studies found a relationship between outdoor advertising signs and a deterioration in driving performance, other studies have found no such relationship.
c) A number of the studies confuse the term causation with correlation. It would be very difficult to prove a cause-and-effect relationship between signage and crashes, even if a methodology did exist to assist in this task.

Based on an analysis of other jurisdictions existing regulations for digital billboards, the author recommends the following:

- To reduce the likelihood of a driver seeing more than one message at a time on a digital billboard, the message display time should be calculated using the following formula:

  Sight distance to the digital sign (metres)/speed limit (metres/sec) = minimum display duration (sec).

- The interval between successive displays should be essentially zero, so that the approaching driver cannot perceive any blanking of the display screen.
- There should be no visual effects between successive displays.
- There should be no message sequencing where a message is spread across more than one advertisement.
- Specific upper limits should be set on the amount of information that should be permitted on digital signs.
- Criteria around luminance and illumination should be established. The author has concerns about OAAA's guidelines of 0.3 footcandles because illumination levels do not increase in a linear fashion. Day time fog could also be an issue with OAAA criteria. The author does agree however with the OAAA's policy that sensors should be used to measure ambient brightness and dimmers should be used to control the lighting output to predetermined levels.
- If there are any failures that affect the luminance of a digital sign, the display will default to an output level no higher than that which has been determined to be the acceptable maximum in normal operations. If this cannot be achieved, the display should be required to default to an 'off' position.
- Drivers should not be faced with two or more digital sign displays in their field of vision at the same time.
- Digital signs should be prohibited near locations where drivers must make critical decisions.

12. Young, M.S., Mahfoud, J.M., Stanton, N.A., Salmon, P.M., Jenkins, D.P. and Walker, G.H. (2009) **Conflicts of interest: The implications of roadside advertising for driver attention.** *Transportation Research Part F: Traffic Psychology and Behaviour*, Volume 12F(5), pp. 381-388.

This simulator study attempted to quantify the effects of billboards on driver attention, mental workload and performance in urban, motorway and rural environments.

The results showed that drivers spent more time out of their lane in the presence of billboards, in both motorway and rural environments. Drivers also departed from their lanes more frequently in the presence of billboards, in motorway and rural environments.

No effect from billboards was found in relation to the driver's interaction with the lead vehicles (time to contact the vehicle ahead).

While there was some indication that more crashed occurred in the presence of billboards, this was not statistically significant.

The study also found that drivers' eye fixations away from the forward road increased in the presence of billboards, although not total duration of glances. This suggests that drivers may have changed their visual attention strategies, towards more but shorter glances.

While not investigating digital billboards specifically, this study lends some support to the theory that the presence of billboards may impair lateral control. However, several methodological flaws with this research (acknowledged by the researchers) should be borne in mind:

- The simulated image can never offer the resolution of the real world, and so there may have been some legibility issues with the billboards that could have affected viewing behaviour.
- The instructions given to participants in one trial to recall signs and/or billboards may have influenced the performance on subsequent trials, which may have interefered with the attention data.

13. Kettwich, C. & Lemmer, U. (2008). **Do advertisements at the roadside distract the driver?** Optical sensors. Proceedings of the SPIE, Volume 7003, pp. 70032J-70032J-5

The aim of the research was to investigate whether advertisements at the roadside distract the driver.

This on-road study tracked the eye movements of 16 subjects on a predetermined route of approximately 18.5km, which comprised of highways, arterial roads, main roads, one way streets and shopping strips. Drivers' eye fixations on 44 advertising signs were then analysed. Advertisements were assigned to the following categories:

- Advertising pillars (9 signs in total).
- Event posters (25 signs in total).
- Company logos (9 signs in total).
- Video screens (1 sign in total).

The research found no measurable impact of the 44 advertising signs on road safety. Gaze duration at all types of advertising while driving was under 1 second. Advertising pillars recorded the longest gaze durations of 0.95 seconds while driving, followed by the video screen, event posters and company logos (0.73 seconds, 0.65 seconds and 0.59 seconds, respectively). Previous research has found that glances for longer than 2 seconds can significantly increase crash risk and that focusing on an item does not necessarily mean the initiation of a cognitive event (see article 7 below). The present research study also found that longer gaze durations at signs typically occurred when the car was stationary. In these instances, the video advertisement was looked at for longer periods of time than the other advertisement types.

The finding that "there was no measurable impact of the 44 advertising signs on road safety" should be interpreted with some caution as it is not clear how driver performance was measured in this study. The other limitation of the study is that only one video screen was located on the route, which limits the ability to generalise the findings to other similar signs.

14. SRF Consulting Group, Inc. (2007). **“Dynamic” signage: Research related to driver distraction and ordinance recommendations.** Prepared for City of Minnetonka, USA.

This study was precipitated by concerns raised by the City of Minnetonka, Minnesota, USA in regards to the installation of two LED billboards along two interstate highways. The report examines the potential driver distraction and safety implications of ‘dynamic’ signage which the authors defined as:

“any characteristic of a sign that appears to have movement or that appear to change, caused by any method other than physically removing the sign or its components, whether the apparent movement or change is in the display, the sign structure itself or any other component of the sign. This includes a display that incorporates a technology or method allowing the sign face to change the image without having to physically or mechanically replace the sign face or its components. This also includes any rotating, revolving, moving, flashing, blinking, or animated display and any display that incorporates rotating panels, LED lights manipulated through digital input, ‘digital ink’ or any method or technology that allows the sign face to present a series of images or displays.”

The information collected for the report came from a variety of sources including interviews with experts on the subject matter, government and academic research and policies that have already been developed to regulate various types of signage.

The authors concluded, based on their literature review, that drivers that are subjected to information-rich content that is irrelevant to the driving task may be temporarily distracted enough to lead to a degradation in their driving performance which could perhaps contribute to a crash. It appears that there might be some kind of relationship between driver distraction and digital signage; however the research findings are still largely inconclusive (as already discussed in the two major literature reviews above) and it is likely that only some signs would be particularly distracting depending on their individual qualities, location, etc.

The report recommended a number of factors to address when developing guidelines for the implementation of digital signage:

a) Identify specific areas where digital signs are prohibited according to zoning requirements, etc.
b) Determine the acceptable level of operational modes in conjunction with zoning requirements. The various levels could include:
   - Static display only, with no transition between messages.
   - Static display with fade or dissolve transitions, or transitions that do not have the effect of moving text or images.
   - Static display with scrolling, travelling, spinning or zooming in, or similar special effects that have the appearance of movement,

animation, or changing in size, or get revealed sequentially rather than all at once (e.g. letters dropping into place, etc.).
  - Full animation or video.

c) If one of the static forms of display is identified as the preferred operational mode, determine the minimum display time and transition time for each advertisement in the sequence. It is recommended that drivers are only exposed to one advertisement in the sequence as they pass by.
d) If full animation or video is permitted, establish a minimum and maximum duration for the video message. This is to ensure that the message is conveyed in a short, concise timeframe that does not cause the slowing of traffic to allow drivers to see the entire message.
e) Consider the minimum spacing requirements between digital signs according to the zoning requirements or the roads on which they are to be located.
f) Consider the size limitations for digital signs according to zoning requirements.
g) Establish requirements that address the brightness of digital signs.

15. Lee, S.E., McElheny, M.J. & Gibbons, R. (2007). **Driving performance and digital billboards.** Virginia Tech Transportation Institute.

This research study was conducted to determine whether digital billboards cause a change in driver behaviour.

This on-road study tracked the eye movements of 36 subjects. Of these 36 subjects, 18 were aged 18-35 years and 18 were aged 50-75 years. A total of 12 participants returned for a night-time session to explore the potential safety impacts of these signs at night. Along the route, participants encountered a total of 5 digital billboards, 15 conventional billboards, 12 comparison sites (similar to items you might encounter in everyday driving such as on-premise signs) and 12 baseline sites (sites with no signs). Driving performance was measured by speed and lane deviation.

The overall conclusion from this study was that digital billboards appeared to attract more attention than conventional billboards (average glance durations of 0.92 seconds compared to 0.73 seconds, respectively). There were no significant differences in glance durations between the digital signs and comparison signs (on-premise signs), some of which contained a digital element (average glance durations of 0.92 seconds compared to 0.87 seconds, respectively). It therefore appears that there is some aspect of the digital signs that holds the driver's attention once the driver has glanced in that direction. The authors suggest that it is due to the intrinsic lighting of the digital billboard which is noticeable even during the daytime. At night, comparison sites had longer average glance durations than digital billboards and conventional signs (0.86 seconds compared to 0.78 seconds and 0.68 seconds).

The research found only minor differences in speed and lane deviation for the four event types. Although there were measurable changes in driver performance in the presence of digital billboards, in many cases these were considered to be on-par with those associated with everyday driving, such as on-premise signs located on businesses.

The authors considered the 5 LED billboards in the study to be safety-neutral in their design and operation from a human factors perspective in that:

- They changed once every 8 seconds.
- They changed instantaneously with no special effects or video.
- They looked like conventional billboards.
- Their luminance was adjusted at night.

The authors felt that it would be quite likely that digital signs with video, movement, higher luminance, shorter message duration, longer transition times and special effects would be related to differences in driver behaviour and performance.

16. Tantala, A.M. & Tantala, M.W. (2007). **A study of the relationship between digital billboards and traffic safety in Cuyahoga County, Ohio.** Submitted to the Foundation for Outdoor Advertising Research and Education (FOARE).

The purpose of the study was to examine the statistical relationship between digital billboards and traffic safety to determine whether a correlation exists.

Specifically, the study analysed the traffic and crash data near seven digital billboards located on interstate routes in Cuyahoga County, Ohio. These seven billboards were converted from traditional fixed billboards to digital billboards in 2005. The analysis consisted of two parts: a temporal analysis of the occurrence of crashes around the billboards for an equal amount of time before and after they were converted to digital and a spatial analysis to establish the correlation between the digital billboards and crashes. A number of factors were considered in the latter spatial analysis, such as crash density, sign density, Viewer Reaction Distance (i.e. the distance from a billboard that a driver is potentially within the 'influence' of that billboard) and sign proximity.

Overall, the study found that digital billboards did not have any statistical relationship with crash occurrence. At each of the digital billboards, and for periods of 12 months before and 12 months after the conversion, the crash statistics and metrics remained consistent with no statistically significant variations. These conclusions account for variations in traffic volume and vehicle-miles travelled.

17. Klauer, S.G., Dingus, T.A., Neale, V.L., Sudweeks, J.D. & Ramsey, D.J. (2006). **The impact of driver inattention on near-crash/crash risk: An analysis using the 100 car naturalistic driving study data.** Virginia Tech Transportation Institute.

The purpose of this research was to conduct in-depth analyses of driver inattention using the data collected in the 100-car naturalistic driving study.

The data for the 100-car naturalistic driving study was collected over an 18-month period. Relative near-crash/crash risk was calculated using both crash and near crash data compared to normal, baseline driving data for various sources of inattention. Driver inattention was defined as:

a) Driver engagement in secondary tasks (those tasks not necessary to the primary task of driving).
b) Driver drowsiness.
c) Driving-related inattention to the forward roadway.
d) Non-specific eyeglance away from the forward roadway.

This particular piece of research did not study the impacts of digital billboards on driver inattention per say. However, there are two findings of direct relevance:

i. Total eyes-off-road durations of greater than 2 seconds significantly increased individual near-crash/crash risk whereas eyeglance durations for less than 2 seconds did not significantly increase crash risk relative to normal, baseline driving. This suggests the upper limit to which a driver can be distracted from the principal driving task.
ii. In secondary task engagement, if the task is simple and requires a short glance, the risk is only elevated slightly, if at all.

One could argue because outdoor advertising is intended to be a 'glance medium', the short glances that would be required to read and interpret the message would not have a significant impact on road safety.

In this study, looking at an external object increased the crash risk by nearly four times, however less than 1% of all crashes and near crashes were from this source of distraction. A substantial proportion of these external objects would not have been advertising signs, so it is reasonable to conclude that far less than 1% of all crashes and near crashes involved distraction from roadside advertising. This suggests that if roadside advertising contributes to crashes (which is not established), the effect is likely to be minor.

18. Crundall, D., Van Loon, E. and Underwood, G. (2006) **Attraction and distraction of attention with roadside advertisements.** *Accident Analysis and Prevention*, vol 38, pp. 671-677.

Previous research has indicated that when drivers are not looking straight ahead, the eyes tend to move to the left and right of the forward focus, looking at pedestrians, parked cars, side streets and other potential hazards. This creates a horizontal window of visual search where the majority of the fixations fall.

This study tested whether an advertisement placed within this horizontal window of inspection would get more fixations than other advertisements, and whether advertisements that fall outside this inspection window are less likely to distract attention away from scanning for hazards.

This study compared street-level advertisements (SLAs) with raised-level advertisements (RLAs) of the same size that were suspended 3m above the ground, on their ability to attract attention under different task conditions. Participants watched video clips of driving scenes, and rated them for hazardousness while their eye movements were recorded. One of the groups was also primed to pay attention to advertisements.

SLAs received the most fixations when participants were solely looking for hazards, and the fewest fixations when primed to look for advertisements. The researchers suggest that when drivers move their eyes towards an SLA, this is motivated by a search for hazards (favouring the horizontal search window), but the subsequent fixation upon the SLA is probably an inadvertent distraction of attention.

The SLAs also had longer fixations during the hazard-detection condition than when participants were looking for advertisements. From this, the researchers suggest that when a driver fixates on an SLA, this stops their search for other hazards, and potentially reduces peripheral attention as increased resources are devoted to the fixated stimulus.

SLAs also had longer fixations than RLAs, and the researchers conclude that this is due to the fact that SLAs tend to appear in more cluttered environments (with other street-level distractions) whereas RLAs are situated above this clutter and so require shorter fixations to extract the same level of information. Another explanation they put forward is that the RLAs require a driver to take their eyes further from the forward roadway, and drivers will naturally have an impulse to return their eyes to the forward position as soon as possible. They state, "the greater the distance between the fixation on an advertisement and the road ahead, the greater the impulse to return the eyes to the forward position as soon as possible."

The researchers raised the potential concern about the extent to which a person's eye movements while watching video clips of driving reflect the visual patterns that would occur with real driving. It may be that the participants responded to the video scenes more in the manner of passengers than drivers. However the researchers state that their results compare favourably with the few studies that have measured eye movements during real driving when looking at advertisements.

In conclusion, they found that SLAs tend to attract more attention than RLAs but this is predominantly when participants were more concerned with looking for hazards. They argue that this suggests that SLAs can capture (or distract) attention at inappropriate times, potentially reducing drivers' attention to task-relevant stimuli, which may increase the probability of an accident.

19. Most, S.B., Chun, M.M., Widders, D.M. and Zald, D.H. (2005) **Attentional rubbernecking: Cognitive control and personality in emotion-induced blindness.** *Psychonomic Bulletin & Review*, volume 12(4), pp. 654-661.

This study examined the degree to which emotional stimuli attract attention at the cost of processing other stimuli. Participants were asked to search for a single target within a rapid presentation of a series of pictures. An emotionally negative or neutral picture preceded the target. Negative pictures spontaneously induced greater deficits in target processing than neutral pictures did. The researchers concluded that attentional biases to emotional information induced a temporary inability to process stimuli that people actively sought.

The study also found that participants that scored low on the personality trait 'harm avoidance' were able to reduce the emotion-induced blindness under conditions designed to facilitate the ignoring of the emotional stimuli. Those higher in harm-avoidance were unable to do so.

Caution should be exercised when generalising the results of this study to any effects of emotional content on billboards, for the following reasons:

a) In the experiment, the negative and neutral pictures that preceded the target appeared while participants were actively, intently, searching for the target, whereas in real-world driving scenarios, drivers tend only to glance at billboards at random, rather than actively search for them.

b) In the experiment, the negative pictures were of people or animals, and included graphic images of violence, distress, and medical trauma. These types of graphic images are already prohibited from display on Australian outdoor advertising sites where they breach that AANA Code of Ethics.

20. Smiley, A., Bhagwant, P., Bahar, G., Mollett, C., Lyon, C., Smahel, T. & Kelman, W.L. (2005). **Traffic safety evaluation of video advertising signs.** *Transportation Research Record: Journal of the Transportation Research Board, 1937,* 105-112.

This research investigated whether video signs constitute a driving hazard. It consisted of a series of studies which examined eye fixations, conflicts, headways and speeds, crashes and public attitudes towards video signs.

The research involved an on-road component which measured the eye fixations and conflicts of 16 drivers aged 25-50 years along three downtown intersections and an urban expressway site in Toronto, Canada. There were four video signs located along these routes.

The results of the eye fixation study found that drivers looked at the video signs on approach on almost 50% of the occasions in which they were present. The average glance length was 0.5 seconds, which is similar to those found in studies of traffic signs. There was no effect of the installation of the video signs on crashes.

21. Smiley, A., Smahel, T. & Eizenman, M. (2004). **Impact of video advertising on driver fixation patterns.** *Transportation Research Record: Journal of the Transportation Research Board, 1899,* 76-83.

The research investigated the potential traffic safety impacts related to video advertising signs through a series of studies which examined eye fixations, headways and speeds, traffic conflicts, crashes and public attitudes towards video signs.

Eye movement data was collected from 25 drivers aged 25-50 years along a 6km section of an urban expressway in Toronto, Canada. There were 5 video signs located on this route.

The results of the eye fixation study found that the vast majority of glances (76%) were looking ahead at traffic. The next most prominent category was traffic signals and street name signs (7%), followed by pedestrians on the roadside (6%). Glances at advertising, static billboards or video signs constituted only 1.2% of the total glances. The average glance at the video signs was 0.48 seconds, with drivers looking at the signs on 45% of the occasions in which they were present.

The research also found that there were significantly longer headways between vehicles when subjects glanced at video signs, suggesting that the glances were made in safer driving conditions. There was no evidence that glances at video signs reduced the proportion of glances at traffic signs or signals.

22. Beijer, D., Smiley, A. & Eizenman, M. (2004). **Observed driver glance behaviour at roadside advertising signs.** *Transportation Research Record: Journal of the Transportation Research Board, 1899*, 96-103.

The aim of the research was to determine the possible distracting effects of outdoor advertising signs located next to the roadside on driver scanning behaviour.

The research was an on-road study involving 25 participants who drove a 6km section of expressway in Toronto, Canada. A total of 37 outdoor advertisements were located along this route, which were categorised as follows:

- Billboard (18 signs in total): were static advertisements only.
- Scrolling text (12 signs in total): had a minor active component, which usually consisted of a small strip of lights that formed words scrolling across the screen or, in some cases, a larger area capable of displaying text but not video.
- Video image (5 signs in total): had a much larger colour screen capable of displaying both moving text and, more importantly, moving images.
- Roller bar (2 signs in total): billboard advertisements placed on vertical rollers that could rotate to show one of three advertisements in succession (these signs are also called 'trivariate signs').

Participants' eye movements were recorded and reported in terms of glance duration, average glance duration, maximum glance duration and angle of glance. The authors state that average glance duration is one measure of how willing a subject is to shift their attention away from the road scene. No driving performance variables were included in this study.

The research found that there were no significant differences in the average glance duration or the maximum glance duration for the various sign types. The mean average glance duration was 0.57 seconds and the maximum glance duration was 2.07 seconds. Of the 890 recorded glances at advertising signs, 43% of glances were directed at scrolling text signs, 31% were directed at billboard signs, 19% were directed at video signs and 6% were directed at roller bar signs. The authors stated the results of the average glance duration indicate that on average, participants were not willing to shift their attention away from the road for longer than a set period of time; and that this period of time was consistent between participants, sign features and the prevailing traffic conditions.

There were, however significant differences in the number of long glances (greater than 0.75 seconds) according to sign type. Of the 196 long glances that were recorded, 40% were directed at scrolling text signs, 32% were directed at video signs, 22% were directed at billboard signs and 6% were directed at roller bar signs. However, these long glances accounted for only 22% of the total glances of all participants. Whilst some subjects were willing to take longer glances at some times, the authors state that for the majority of the time, driving conditions do not permit longer glances or the sign itself does not warrant longer glances.

One factor that did seem to influence glances was the proximity of the sign to the driver's central field of vision rather than the lateral distance of the sign from the roadside. Signs in the centre of the driver's field of view tended to receive more glances, regardless of their distance from the road. The fact that the greatest majority of glances were made within 25 degrees from the driver's central field of vision indicates that participants were unwilling or unable to look at sign at greater than that eccentricity.

23. Strayer, D.L. and Johnston, W.A. (2001), **Driven to Distraction: Dual task studies of simulated driving and conversing on a cellular telephone.** *Psychological Science*, Vol 12(6), pp. 462-466.

This research studied the effects of mobile-phone conversations on performance of a simulated driving task. Performance was not disrupted by listening to radio broadcasts or listening to a book on tape. The study also found that unconstrained conversations using a mobile phone resulted in a twofold increase in the failure to detect simulated traffic signals, and slower reactions to those signals that were detected.

This study is useful in relation to theories about the potential cognitive distraction that may be caused by billboards, because it has demonstrated that neither listening to radio broadcasts nor listening to a book on tape had a disruptive effect on driving performance. While any cognitive processing that takes place for drivers when viewing roadside advertising is triggered by a visual cue rather than an auditory cue, any cognitive processing is likely to be no more engaging than cognitive processing that takes place during radio broadcasts or book readings. This can be contrasted to cognitive processing that takes place during a two-way, in depth mobile phone conversation.

24. Farbry, J. Wochinger, K., Shafer, T., Owens, N. & Nedzesky, A. (2001). **Research review of potential safety effects of electronic billboards on driver attention and distraction.** Federal Highway Administration (FHWA), USA.

This report was commissioned by the FHWA to review the literature related to the safety implications of digital signage and to recommend a research plan to address knowledge gaps. The literature review included an analysis of state billboard regulations and policies relevant to digital signage (for the USA only), crash data and potential safety factors such as distraction, conspicuity and legibility; and driver and roadway characteristics.

Again, this research report could not locate many research articles specifically examining the potential road safety impacts of digital signage. For those articles that did, in most instances, the researchers were not able to verify that a digital sign was a major contributor to crashes.

The literature review also examined research regarding distraction, conspicuity and legibility of official changeable message signs used by government agencies to present information to drivers. The studies suggest that an increase in distraction, a decrease in conspicuity, or a decrease in legibility may contribute to an increase in crash rate. The authors suggested that there may be lessons from these studies that could be applied to commercial digital signs.

25. Shinar, D., Meir, M. and Ben Shoham, I. (1998) **How automatic is manual gear shifting?** *Human Factors*, volume 40(4), pp. 647-654.

This study examined the extent to which manual gear shifting is automated, by testing the sign detection skills of novice and experienced drivers while driving manual and automatic transmission cars.

The results showed that sign detection was better for the experienced drivers overall. They also showed that sign detection was better when driving an automatic transmission than a manual transmission, and this effect was very pronounced with novice drivers.

The results demonstrated that manual gear shifting is a complex psychomotor skill that is not easily (or quickly) automated and that until it becomes automated, it is an attention-demanding task that may impair other monitoring aspects of driving performance.

It may be said that this study shows how inexperienced drivers demonstrate significantly greater impairment from secondary tasks (e.g. sign detection) while driving. However, in relation to the context of OOH advertising, it may also be said that novice drivers are less likely to detect advertising signage because they are concentrating more on driving tasks that are not yet automated. This is consistent with comments by the US Department of Transport Federal Highway Administration (2012), that gaze allocation is principally controlled by the requirements of the task.

SECTION IV: DISCUSSION AND RECOMMENDATIONS

The OMA, as the peak national body representing the outdoor advertising industry, supports the reasonable regulation of outdoor advertising signs including digital billboards. As outlined in our *Code of Ethics,* we are also committed to working with the various road authorities to address road safety requirements for outdoor advertising.

Digital billboards are an emerging outdoor advertising format and most jurisdictions are still in the very early stages of implementing these types of signs. While a number of jurisdictions have some form of regulation to govern the planning approval of these signs (see section II, above), there is debate about how these signs should operate to minimise their potential impact on road safety. The policies and regulations aim to mitigate features of digital billboards that could contribute to driver distraction, such as the sign's message dwell time, message transition time, illumination and whether the operation of the sign is static or animated.

In spite of policies and regulations existing in several jurisdictions both nationally and internationally, the research findings on the potential impact of digital signs on road safety are inconclusive. The commentary on each of the studies summarised above outlines that each one is methodologically flawed and/or produces results that are directly contradicted by other studies. This is not surprising - as noted by Wachtel (2009), it is very difficult to study the effects of roadside advertising on driver behaviour because every sign, road and driver is different. Overall, the simulated driving studies referred to above are flawed because, among other things, they cannot replicate real-life. However the real-life studies are flawed because, among other things, they cannot sufficiently control for all variables in the real-world scenario.

Further, even where an effect in relation to digital billboards is found, there may not be clear evidence that this effect will reduce driver performance. For example, from a human factors perspective, one research study found that drivers tend to look at digital billboards for longer periods of time on occasions than other types of signage (Lee, McElheny and Gibbons (2007)). However, the body of research has generally found that glances at digital billboards are nonetheless shorter than 2 seconds, and it is the 2 second threshold which was found by Klauer et al. (2006) to increase the risk of crashes and near crashes.

Given that the on-road and simulated studies have not been able to provide definitive answers in relation to digital signage and driver performance, the OMA supports an approach that references real-world outcomes. The studies referred to above by Tantala and Tantala (2010, 2010 and 2009) looked at outcomes around the installation of digital billboards in Pennsylvania, New Mexico and Ohio. These studies suggest that there is no statistically significant relationship between digital billboards and crash rates. Likewise, Smiley et al. (2005) found no effect of the installation of video signs on crashes. While these studies are also subject to scrutiny (for example, they rely only on reported police statistics), they certainly contribute significantly to the body of knowledge surrounding the issues.

Finally, any discussion about the effects of billboards on driver performance must take into account the Klauer et al. (2006) finding that less than 1% of all crashes and near crashes were caused by drivers looking at an object outside their vehicle. This study did not record whether the external objects were advertising signs, but it is reasonable to conclude that far less than 1% of all crashes and near crashes involve distraction from roadside advertising. Therefore, regardless of the shortfalls in the body of research on these issues, it seems clear that the effect (if any) of roadside advertising is minor.

The OMA's recommendations for digital billboards aim at a balanced approach, taking into account existing regulatory policies, various concerns expressed within the community, the degree to which those concerns are supported by evidence, and the actual outcomes observed after installation of digital signage.

In view of the above, the OMA recommends the following standards for the implementation of digital billboards in Australia (in bold text):

1. Message dwell time

   Each message or copy shall remain fixed for a maximum of 8 seconds, with 5-7 seconds being the recommended dwell time depending on the sign's location (for example, signs with a dwell time of 5 seconds would be appropriate in lower speed commercial environments, whereas 7 seconds would be more appropriate on freeways and motorways).

   Whilst the OMA has reviewed the formula proposed by Wachtel (2009) to set message durations on a case-by-case basis, it would be difficult for regulators to keep track of and enforce these approved intervals. Further, the OMA considers that the factors that are practically relevant in the real world are simply too varied for any formula to be sufficiently meaningful.

   Although the research has not demonstrated that dwell times on digital billboards have an effect on driver safety, the OMA acknowledges that it is difficult to study this area for the reasons outlined above. The OMA also acknowledges that this is an area of concern that has been expressed within the community. In this case, the OMA considers that there should be some minimum standard. The OMA's recommended and maximum dwell times are based on both research and current policies for digital billboards, namely:

   - Looking to international policy, the standard in the USA ranges between 4 and 10 seconds, the UK Outdoor Advertising Association recommends a minimum of 5 seconds, and there is a standard for a minimum of 5 seconds in New Zealand. With these international policies in mind, the OMA considers that a recommended dwell time of 5-7 seconds is fair and reasonable.

   - The US Department of Transport Federal Highway Administration (2012) found no significant negative effects in relation to digital billboards with 8 to 10 second dwell times. Likewise, the Tantala and Tantala studies examined digital billboards with dwell times between 8 and 10 seconds, and found no increase in crash rates after their installation. In this case, research strongly supports that an 8 second dwell time should be unproblematic, and the OMA's recommended maximum of 8 seconds reflects this.

2. Transition between images

The transition time between messages shall be no longer than 1 second, to reduce the likelihood of a driver perceiving any blanking of the display screen.

The current range in the USA is a transition time of 1 to 4 seconds. In Canada, a "quick" resolution time between images is recommended, and in New Zealand there is a 2 second standard. From these current international policies, the OMA's recommendation can be seen as a conservative approach.

In terms of the research papers summarised above, two are relevant to this recommendation. Wachtel (2009) suggested that the interval between successive displays should be essentially zero, so that the approaching driver cannot perceive any blanking of the display screen. Wachtel's recommendation appears to be cautious, given his acknowledgement that no definitive conclusions can be drawn about the presence or strength of adverse road safety impacts from digital billboards.

Lee et al. (2007) conducted research involving digital signs that changed instantaneously, and their report speculated (without evidence) that digital signs with longer transition times would be related to differences in driver behaviour and performance.

The OMA considers that a 1 second transition time represents a balanced acknowledgement of existing international policy as well as the above comments by researchers in this area.

3. Spacing and location

Digital billboards should not be spaced within 150 linear metres of each other if they are located on the same side of the road on a freeway or motorway only.

This recommendation is based on standards adopted by a majority of states in the USA and is relatively consistent with the following stopping sight distances (distance required to stop a vehicle travelling at a certain speed safely):

a. At 80km/h, stopping sight distance with 2.5 second reaction time is 114 metres.

b. At 90 km/h, stopping sight distance with 2.5 second reaction time is 140 metres.

c. At 100km/h, stopping sight distance with 2.5 second reaction time is 170 metres).

The OMA's recommendation also takes into account the recommendation by Wachtel (2009) that drivers should not be faced with two or more digital sign displays in their field of vision at the same time. Again, this recommendation was made by Wachtel in spite of his finding that no definitive conclusions can be drawn about the effect of digital billboards. Wachtel's recommendation is a particularly cautious approach, and the OMA considers that 150 metres is a sufficient distance in the driver's field of vision to overcome any concerns in relation to distraction.

In inner city locations where the speed limit is less than 70km/h, the spacing between billboards should be considered on a merit basis to allow for the consolidation of signs.

In the absence of any clear research to establish that digital billboards affect driving performance, the OMA considers that a less cautious approach is required in low speed environments, where consequences will generally be less serious than in high speed environments. This approach also takes into account the discussion above, that only 1% of all crashes and near crashes are the result of a driver looking at an external object, and that most (if not all) of these external objects would not be advertising signage. In this case, the 150 metre limitation may be flexible to the circumstances of any given sign.

Only one digital billboard shall be permitted at a single location on a freeway or motorway facing the same direction.

This recommendation takes into account Wachtel's (2009) recommendation that drivers should not be faced with two or more digital sign displays in their field of vision at the same time, and represents a cautious approach.

4. Message sequencing

No message sequencing is permitted between two or more advertising copies on the same digital billboard.

This recommendation acknowledges the comments and recommendations in the following studies:

- Wachtel (2009) recommends that there should be no message sequencing.
- In their literature review, SRF Consulting Group, Inc (2007) concluded that drivers that are subject to information-rich content that is irrelevant to the driving task may be temporarily distracted enough to lead to a degradation in their driving performance.
- Strayer and Johnston (2001) found that mobile phone conversations could distract drivers from detecting traffic signals, and suggested that this was due to the cognitive processing required in the conversations (as opposed

to the lower cognitive processing required to listen to radio broadcasts, where they found no such effect on the driver).

There appears to be potential for message sequencing to engage a driver's cognitive processing skills, although it is not clear that such cognitive processing would necessarily be complex or would be to the detriment of driving performance. Nevertheless, the OMA has erred on the side of caution in this recommendation, in response to the concerns expressed above.

5. Lighting issues

The light emitted from a digital billboard shall not exceed a certain threshold over ambient light levels. The OMA will consult with local lighting engineers on this matter to determine the most appropriate standard for local conditions.

Flashing lights should not be permitted.

Digital billboards must have automatic dimming capability.

These recommendations are consistent with standards in the USA, the UK and New Zealand. They also take into account the following research papers which are summarised above:

- Wachtel (2009) recommended that criteria around luminance and illumination should be established, and agreed with the OAAA's policy that sensors should be used to measure ambient brightness and dimmers should be used to control the lighting output.

- SRF Consulting Group, Inc. (2007) concluded from their literature review that some signs may be particularly distracting depending on their individual qualities, and they recommended establishing requirements that address the brightness of digital signs.

- Lee et al. (2007) speculated (without evidence) that digital signs with higher luminance might be related to differences in driver behaviour and performance. They also found that there is some aspect of the digital signs that holds the driver's attention once the driver has glanced in that direction, and they speculated(without evidence) that this may be due to the intrinsic lighting of digital signs. However, it must be noted that even when glancing at digital signs, glances in this study were significantly less than the 2 second threshold found by Klauer et al. (2006).

The OMA's recommendations acknowledge current controls and management in relation to lighting and brightness.

6. Default design

Digital billboards shall contain a default design that will freeze the device in one position if a malfunction occurs.

This is a standard that has been adopted in the USA and reflects a recommendation in Wachtel (2009) that if there are any failures that affect the luminance of a digital sign, the display should default to an output level no higher than that which has been determined to be the acceptable maximum in normal operations, or the display should default to an 'off' position. The aim of the standard is to reduce any potentially distracting qualities of the digital sign in the event of a default, such as brightness, flashing and movement, thereby addressing concerns in this regard.

7. Advertisement copy

To avoid situations where the digital billboard may be mistaken as a traffic signal, the advertisement copy should not be dominated by the colours red, yellow or green in combination if it is to be located near traffic lights.

The US Department of Transport Federal Highway Administration noted that sign content was not controlled or investigated in its 2012 study, and suggested that sign content may be an important factor to consider in future studies that investigate the distraction potential of advertising signs. Certainly in the study by Most et al. (2005) it was found that emotional information can affect a person's ability to process other stimuli (which may include important information on the roadway). In this regard, the OMA continues to support its Members' adherence to the AANA Code of Ethics, which prohibits display of graphic or otherwise inappropriate images on outdoor advertising.

However the OMA's recommendation here reflects standards in New Zealand which provide guidance about aspects of advertising copy such as lettering height and colours that may conflict with traffic signs. The OMA is concerned to ensure that no confusion is caused for drivers in mistaking an advertisement for a traffic light, as this could clearly affect their driving performance.

The OMA's recommendation also reflects the research that glances of more than 2 seconds can increase the risk of crashes or near crashes (Klauer et al. (2006)). In this case, the OMA's recommendation goes towards ensuring that advertising copy does not require lengthy glances for a driver to comprehend its message, and for outdoor advertising to remain a glance medium. This is consistent with the suggestion of Fabry et al (2001) that a decrease in legibility may contribute to an increase in crash rate.

8. Individual merits to be considered

Both static and animated digital billboards shall be considered for planning permits on their individual merits.

The OMA's recommendation that the individual merits of each sign should be considered reflects Wachtel's (2009) comment that no two roads, signs or drivers are the same. In this case, the OMA considers that all relevant circumstances should be considered, to enable a merit-based approach to both static and animated digital signage rather than a blanket rule to fit all scenarios.

Although the policies in the USA and New Zealand do not support animated digital billboards, the OMA agrees with the approach adopted in the UK, which acknowledges that animated signage can be appropriate in some circumstances. In this case, the OMA recommends that each set of circumstances should be given the opportunity for careful consideration on its merits.

The OMA's opinion that animated signage should not be prohibited takes into account the findings of Smiley et al. (2005), which found no effect of the installation of video signs on crashes, and found that the average glance duration towards video signs was 0.5 seconds, still well below the 2 second threshold. The other Smiley et al. research (2004) also found that the average glance at video signs was 0.48 seconds, and that there was no evidence that glances at video signs reduced the proportion of glances at traffic signs or signals.

However, Lee et al. (2007) have speculated (without evidence) that digital signs with video or movement may be related to differences in driver behaviour and performance. In this case, a merit based approach is warranted.

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