Outdoor Media Association Inc.

ABN 59 004 233 489

DISCUSSION PAPER

Digital billboards and road safety: An analysis of current policy and research findings

Introduction

Victoria is the first Australian State to have introduced a small number of digital billboards. However, there is some concern that there are no clear standards surrounding the installation and use of these signs to minimise their potential impact on road safety. A working group has therefore recently been established by VicRoads to address this. The Outdoor Media Association (OMA) is aware that other Australian states such as New South Wales and Queensland are also considering introducing regulations and/or standards to govern the installation and use of these types of signs.

This discussion paper has therefore been prepared to outline:

a) Current national and international policy in regards to the installation of digital billboards near or on the roadside.
b) Research findings in regards to the proposed relationship between digital billboards and driver distraction.

The aim of this paper is to provide the most current information on digital billboards and road safety to assist Australian road authorities 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.

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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].

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.

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

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SECTION II: THE POLICIES

Digital signage is an emerging 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.

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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 38 states in the USA that permit static digital signage. A further 3 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 on page 7. The Outdoor Advertising Association (OAAA) of America promotes the display of static electronic images only.

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

[2] Tri-action signs provide one of three views using rotating cylinders and generate mechanical motion or movement.

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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. 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	8	1	500/152
Arkansas	8 or more	2 or less	1500/457
Arizona	6	1	500/152
California	4	4	1000/305
Colorado	4	1	1000/305
Connecticut	6	3	500/152
Delaware	10	1	2500/762
Florida	6	2	1000-1500/305-457
Georgia	10	2	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	500/152
Massachusetts	pilot	pilot	pilot
Michigan	6	1	500/152
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 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	500/152
Pennsylvania	5	1	500/152
Rhode Island	5-7	2-3	500/152
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

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Canada

The advent of digital signage is still in its early stages in Canada. Approximately 10 digital billboards will soon be converted from traditional billboards in Montreal, the country's second largest city. 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.

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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[3]	Zone E2[4]	Zone E3[5]	Zone E4[6]
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.

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

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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);
        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.

Japan - Osaka

Outdoor advertising is regulated in Osaka by the *Outdoor Advertising Act 189*. Like London, Osaka does not have particular definitions for individual types of signs, which means that evolving outdoor technologies such as digital billboards can be considered as permissible development. It is not clear at this stage whether any specific standards have been applied to existing digital billboards within Osaka to manage any potential impacts on road safety. The OMA is currently awaiting further advice in this regard.

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National

Victoria

Victoria is 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* 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 is currently assessing the standards which should be applied to this form of signage.

OMA members currently have five digital billboards in operation in Victoria. Of these five signs, one displays static images only and four display animated images. The planning permits for all five signs have been issued on the sign's merits and road safety issues have been taken into consideration also.

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 NSW Department of Planning is currently conducting a review of this legislation and may consider introducing provisions to allow the implementation of this signage.

In the last 12 months, the OMA has been in discussions with the NSW Department of Planning and the Roads and Traffic Authority (RTA) regarding digital billboards and the RTA in particular has made it clear that they are unlikely to permit digital billboards of an animated nature. Therefore, in its

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submission to the review of SEPP 64, the OMA has recommended that a Clause be introduced in the legislation to permit the introduction of static digital billboards as a minimum position. It is expected that the outcomes of the review of SEPP 64 will be released in the next few months.

Queensland

Regulation for outdoor advertising in Queensland is primarily administered at a local level through local laws and planning schemes; therefore digital billboards will be permitted in some local jurisdictions and not others.
Brisbane City Council's *Advertisements Subordinate Local Law 2005* permits the licensing of electronic graphic display screens[7] in certain zones according to the following criteria:

a) The sign is to be a maximum of 20m^2 in area and be a maximum of 12m from the ground to the highest part of the screen.
b) The sign must not to project beyond the front alignment of a property and expose an unsightly back view to a road or other public place.
c) The sign must not to be located on a street frontage along which is located another electronic graphic display screen, unless such a screen is located at least 200m away.

The OMA understands that Brisbane City Council is currently preparing an internal practice note to establish further standards around the operation of such signs. This practice note is likely to include factors such as message dwell times, transition times, etc. The OMA will be provided the opportunity to comment on this practice note once it has been drafted.

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, non-static illuminated advertising devices[8] and moving, rotating or variable message advertising devices[9] are not permitted within the boundaries of state-controlled roads. This permission criteria, however, does not apply to variable message displays

[7] An Electronic Graphic Display Screen is a sign usually including Light Emitting Diode technology and associated technology and software, capable of producing still images, video replay and live television broadcasts and animations as programmed.
[8] Non-static illuminated advertising device means an illuminated advertising device where the illumination of the entire advertising device is not constant in form, intensity and colour.
[9] A Variable Message Advertising Device is defined as an advertising device with an electronic display that is automatically changed in form and/or shape and/or layout and/or colour and/or any other matter whatsoever (e.g. changes in words, symbols, pictorial displays and devices).

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used by road authorities for traffic information or for displaying other corporate information.

The Guide also outlines the following road safety considerations for electronic/mechanical advertising signs that are located outside the boundaries of a state-controlled road which should be considered by local government when assessing signage applications:

- Rotating advertising devices should be permitted only when movement within the advertising device is about a vertical axis and where the speed environment is 80km/h or less.
- The message dwell times for tri-vision signs[10] and illuminated multi-advertisement signs[11] should be 8 seconds or greater. The transition between two messages should be completed within 0.1 seconds.
- For electronic signs which contain graphics with or without text
    1. The complete screen display should change instantaneously. Methods of change such as 'fly in' or 'scroll', or any other type of message change are not recommended.
    2. Sequential message sets are not recommended.
    3. The time limits will be viewed periodically.

[10] Trivision sign means an advertising device where the face compromises a series of vertical prisms (usually three-sided) turning in unison, but where the supporting structure is stationary.
[11] Illuminated multi-advertisement scrolling sign means an illuminated advertising device with a number of translucent or non-transparent advertising panels connected to form a strip that may be wound to sequentially display the advertising panels.

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SECTION III: THE RESEARCH

Below is a summary of the most recent articles in regards to the proposed relationship between digital billboards and driver distraction:

1. 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. These billboards were converted from traditional PVC billboards between 2006 and 2008.

   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.

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2. 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 11 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.

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3. 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).

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- 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.

4. 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).

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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.

5. 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

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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.

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6. 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.

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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.

7. 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 7 digital billboards located on interstate routes in Cuyahoga County, Ohio. These 7 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.

8. 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.

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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.

9. 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

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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.

10. 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.

11. 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.

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- 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

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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.

12. 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.

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SECTION IV: DISCUSSION AND RECOMMENDATIONS

Digital billboards are an emerging outdoor advertising format and most jurisdictions are still in the very early stages of implementing these types of signs. Whilst a number of jurisdictions have some form of regulations to govern the planning approval of these signs, there does not appear to be many standards specifying how these signs should operate to minimise their potential impact on road safety. The exception to this is the USA and to some extent, Queensland.

The research findings on the potential impact of these signs on road safety are also inconclusive. From a human factors perspective, what is clear from the research is that drivers tend to look at digital billboards for longer periods of time on occasions than other types of signage. What is yet to be determined, however, is whether these glances have a significant impact on driver performance and if so, is this degradation in driver performance enough to cause a crash?

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.

The policies and regulations established by other jurisdictions aim to mitigate features of digital billboards that could contribute to driver distraction. These relate to the sign's message dwell time, message transition time, illumination of the sign and whether the operation of the sign is static or animated.

Therefore, based on the review of the current international and national policies and regulations for digital billboards and of the most recent research findings, the OMA recommends the following standards for the implementation of digital billboards in Australia:

- 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.

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- 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.
- Digital billboards should 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 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):
  - At 80km/h, stopping sight distance with 2.5 second reaction time is 114 metres.
  - At 90 km/h, stopping sight distance with 2.5 second reaction time is 140 metres.
  - At 100km/h, stopping sight distance with 2.5 second reaction time is 170 metres).

  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.
- Only one digital billboard shall be permitted at a single location on a freeway or motorway facing the same direction.
- No message sequencing is permitted between two or more advertising copies on the same digital billboard.
- Digital billboards shall contain a default design that will freeze the device in one position if a malfunction occurs. Please note, however, that on the small number of signs that currently exist, OMA members have voluntarily installed CCTV cameras to constantly monitor the operation of the sign.
- 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.
- Digital billboards must have automatic dimming capability.
- Both static and animated digital billboards shall be considered for planning permits on their individual merits.
- 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 OMA will develop guidelines for creative agencies to ensure that the amount of information displayed on a digital billboard is kept to a minimum.

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