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July 16, 2018

File Number: 24XD-193695

VIA EMAIL AND HAND DELIVERY

Hon. Mayor Tornek and Councilmembers Hampton, McAustin,
Kennedy, Masuda, Gordo, Madison, and Wilson
City of Pasadena City Council
175 N. Garfield Avenue
Pasadena, California 91109

Re: City of Pasadena City Council Meeting – July 16, 2018: Items 12, 18 & 19
ArtCenter College of Design Master Plan (PLN 2015-00341; FEIR SCH# 2016091009)

Dear Honorable Mayor and City Councilmembers:

This letter is submitted on behalf of our client, ArtCenter College of Design ("ArtCenter"), to support approval of the above-referenced project. After many years of working in close coordination with the City of Pasadena ("City") Planning and Community Development Department staff and considerable outreach to ArtCenter students, staff, neighbors, and community members, along with a distinguished design team and other professionals, we are pleased to present the ArtCenter College of Design Master Plan (the "Project") before you this evening. The Project represents the culmination of many years of careful planning and is a crucial next step in continuing ArtCenter's investment in Pasadena and its tradition of art and design excellence.

We urge you to support all aspects of the Project, and we summarize the substance of this letter as follows:

- For over four years, ArtCenter has engaged in widespread public outreach to inform community stakeholders about the Project and solicit feedback, which has been folded into the Project along the way.
- During the master planning process, ArtCenter has invested millions of dollars into its existing facilities and, upon approval of the Project Entitlements (defined below), expects to invest hundreds of millions of dollars on campus and public improvements over the next fifteen years, including hundreds of temporary and permanent jobs.
- ArtCenter has worked closely with City staff and the City Attorney's office to negotiate and finalize the Development Agreement, which we believe provides substantial benefits to the City.
- ArtCenter requests that the City Council adopt the Code Amendment (defined below) to permit the Digital Gallery (defined below). The decision on the Digital Gallery is limited; it provides for a narrow zoning text amendment to allow a thorough and thoughtful process

to continue with decision makers and the public. The Digital Gallery will be subject to a subsequent approval that will ensure that it will not cause a safety hazard. The zoning code amendment necessary before you is drafted narrowly to limit proliferation of electronic signs throughout the City.

- ArtCenter respectfully requests that the City Council approve the Project Entitlements, which would include critical student housing and other community-wide benefits and adopt the Code Amendment.

I. Background & Request

ArtCenter started its current master planning process over four years ago. After its initial pre-development plan review consultation with the City in 2014 and our pre-development plan hearing in front of this body, ArtCenter embarked upon a public outreach campaign to present the Project to the community and receive input from stakeholders. ArtCenter has hosted numerous public meetings and information sessions since then and through 2016, when ArtCenter first presented the Project to the Planning Commission.

Throughout this process, ArtCenter has carefully considered the comments and concerns expressed by the Planning Commission, City staff, and the public, and, in response, has worked diligently to modify and improve the Project. Perhaps most importantly, ArtCenter has continued the dialogue with the City and community and increased efforts to inform neighbors about the Project, listen to their feedback and address any comments. In addition to ongoing conversations with several neighborhood associations, ArtCenter hosted multiple open house community meetings, most recently on January 17 and 22, 2018. ArtCenter sent out updates and reminders to more than 500 community members for these meetings, which included presentations by numerous members of the Project team, including architect Marc Salette of Michael Maltzan Architecture, landscape architect Tina Chee of Tina Chee Landscape Studio, and Rollin Homer, Vice President of Facilities and Campus Planning of ArtCenter College of Design.

Additionally, ArtCenter is excited to have the opportunity to substantially expand its investment in the future of its South Campus and in turn support the revitalization of the neighborhood. Since the beginning of the Master Plan process, ArtCenter has already invested over $45 million in its existing buildings across both campuses. The Project is estimated to be an additional $400 million-dollar investment over fifteen years, providing approximately 2,600 construction jobs, and 770 permanent jobs.

The request before the City Council includes the following entitlements (collectively, the "Project Entitlements"): (i) the Master Plan, (ii) a minor conditional use permit for reduced parking, (iii) a minor conditional use permit for tandem parking, (iv) a private tree removal permit, (v) an exception to the City's noise ordinance to permit limited night-time construction, (vi) a zoning map amendment, and (vii) a development agreement.

On May 9, 2018, after a duly noticed public hearing, the City Planning Commission voted to recommend approval of the Project Entitlements to the City Council. Additionally, the Planning Commission supported a zoning code amendment that would modify the City's sign regulations

to permit digital signs in order to permit a digital art gallery (the "Digital Gallery") proposed by ArtCenter. Because the City Council cannot approve the Digital Gallery until the City's zoning code is amended, ArtCenter respectfully requests that the City Council support the necessary zoning code amendment and direct City staff to prepare an ordinance that would modify the City's zoning code to permit electronic signs subject only to approval of a Master Sign Plan pursuant to Zoning Code Section 17.48.060.

We are grateful to City staff for their careful review and hard work, and, with the exception of Staff not recommending approval of the zoning code amendment necessary to permit the Digital Gallery, ArtCenter supports staff's recommendations included in the staff reports attached to Agenda Items 12, 18 and 19.

II. Master Plan & Conditions of Approval

The Project Conditions of Approval are a critical component of the Master Plan. ArtCenter has worked closely and cooperatively with City staff to ensure that the Conditions of Approval address the concerns of various City departments and clearly articulate ArtCenter's development obligations. The Conditions of Approval also clearly establish the development regulations applicable to the Project (e.g., density, building heights, landscaping).

The Conditions of Approval attached to the Master Plan represent a balanced approach to developing the Project in phases over a fifteen-year period. Accordingly, ArtCenter respectfully requests that the City Council approve the Master Plan, including the Conditions of Approval as proposed.

III. Development Agreement

ArtCenter has committed significant resources and incurred significant costs to bring the Project to this point. And, as described above, ArtCenter will be investing hundreds of millions of dollars in the City over the next fifteen years to implement the Project. The Development Agreement is critically important to ArtCenter and the City in order to protect this investment and to ensure that ArtCenter is able to implement the Project over the next fifteen years.

ArtCenter has worked closely with City staff and the City Attorney's office to negotiate and finalize the terms of the Development Agreement. ArtCenter respectfully requests that the City Council approve the Development Agreement in the form attached to Agenda Item No. 19, subject to minor non-substantive revisions by the City Attorney for form and legality.

IV. Zone Code Amendment for Digital Gallery

Art Center envisions a digital gallery at the 1111 Arroyo Parkway building on South Campus for the purpose of displaying student art (not for advertising). City staff determined that the Digital Gallery is not permitted under the zoning code and that a zoning code amendment (the "Code Amendment") is necessary to establish a review and approval process for permitting electronic signs. Despite staff's recommendation to not approve the Code Amendment, the Planning Commission voted to support it. While the City Council is unable to approve the Digital Gallery at this time, ArtCenter requests that the City Council support the Code Amendment and direct

staff to prepare and report back with an ordinance that would amend the zoning code to permit electronic signs like the Digital Gallery subject to approval of a Master Sign Plan. This will be a narrowly tailored Code Amendment to allow institutions to display digital art.

While the City staff report for Item No. 12 (the "Staff Report") states that City staff does not support the Code Amendment or the Digital Gallery, the Staff Report includes the legal findings and justification necessary for the City Council to adopt the Code Amendment. Specifically, Attachment "A" to the Staff Report finds that the Code Amendment is in conformance with the goals, policies and objectives of the General Plan, stating that the amendment will "enhance architectural diversity and creativity while requiring design review through the Master Sign Plan process to ensure compatibility with community character, while promoting creativity, innovation, and design quality. The Staff Report further finds that, with the Master Sign Plan review process, the Digital Gallery will not be detrimental to the public interest, health, safety, convenience, or general welfare or the City.

The Digital Gallery was discussed at length during the Planning Commission hearing. Several people spoke in favor, while a handful of community members spoke in opposition to the Digital Gallery and the Code Amendment. Opponents focused on two primary issues: proliferation of digital signs in the City and driver safety.

A. Proliferation of Electronic Signs

As described in the Staff Report, the Code Amendment can be drafted in a way to avoid proliferation of digital signs. The Staff Report proposes several eligibility criteria for digital signs, including, (i) only permitting digital signs on properties zoned PS, (ii) prohibiting electronic signs on properties located adjacent to residentially zoned properties, and (iii) the properties where the digital signs are proposed are subject to a master plan and development agreement. This eligibility criteria places significant limits on the locations within the City where digital signs can be permitted, thereby eliminating the concern that the Code Amendment will result in a proliferation of electronic signs throughout the City. Additionally, approval of digital signs would be subject to a future discretionary action (i.e., Master Sign Plan approval) thereby giving the City control over the number of electronic signs in the City.

B. Driver Safety

With respect to the safety concerns raised during the Planning Commission meeting, ArtCenter has studied whether the Digital Gallery will create a safety hazard and has determined that it will not. The safety of ArtCenter students, faculty and staff, and that of the community is paramount. And ArtCenter would not be proposing the Digital Gallery if research established that it would cause a safety hazard.

The Project Environmental Impact Report demonstrates that the Digital Gallery will not result in any adverse environmental impacts. Specifically, concerns regarding safety have been studied and determined not to be significant. Nevertheless, in response to concerns raised by the Department of Transportation, ArtCenter will raise the height of the display above the height of the traffic signals to avoid confusion.

Additionally, to ensure that the Digital Gallery will not cause a safety hazard, ArtCenter engaged Urban Systems Associates, Inc. to analyze the Digital Gallery and any potential safety issues relating to its installation and operation. The full analysis prepared by Urban Systems is enclosed as Exhibit "A". The report concludes that the Digital Gallery can be safely installed and operated subject to reasonable operational conditions. The report also provides examples of several other similar digital signs in the United States that have not created a safety hazard, noting that such signs (especially those showing art) "can become iconic fixtures of a dynamic streetscape and can be an important element of placemaking."

Lastly, it is important to reiterate that the Digital Gallery, while the staff has determined that it must be treated as an electronic sign per the zoning code, is not true signage but, instead, is a curated art display of the work produced by ArtCenter students and alums. The Digital Gallery will give ArtCenter an opportunity to connect with the community by displaying works that were created at the college and provide the public insight as to creativity taking place at the college. The intention and vision is that the Digital Gallery will display art – and will not resemble the electronic signage in Hollywood or at LA Live in Downtown Los Angeles.

Because the Code Amendment can be drafted to limit proliferation of digital signs, and on the basis that the technical analysis has determined that the Digital Gallery does not constitute a safety hazard, ArtCenter respectfully requests that the City Council adopt the Code Amendment and direct staff to prepare an ordinance to implement the Code Amendment so that the Digital Gallery can be processed subsequently on a separate path.

V. Conclusion

ArtCenter is pleased to appear before you tonight to present the Master Plan to the public and the City Council after all of these years of planning, public input, and review. It represents an important investment in the future of the school that will benefit not only ArtCenter students, but also the larger Pasadena community. ArtCenter looks forward to continuing to work closely with City staff to implement the Master Plan as proposed and the Development Agreement. ArtCenter respectfully requests that the City Council certify the Final Environmental Impact Report and approve the Project Entitlements. ArtCenter also requests that the City Council adopt the Code Amendment.

Please do not hesitate to contact the undersigned with any questions or concerns. ArtCenter appreciates your time and consideration in this matter

Very truly yours,

Alfred Fraijo Jr.
for SHEPPARD, MULLIN, RICHTER & HAMPTON LLP

Enclosures
SMRH:487058844.3

cc:

David Sinclair, Senior Planner
Natsue Sheppard, City Planning
Rollin Homer, ArtCenter College of Design
Loren Montgomery, Montgomery Clark Advisors
Justin Mahramas, Montgomery Clark Advisors
Rick Rodriguez, Sheppard Mullin

Exhibit "A"

URBAN SYSTEMS ASSOCIATES INC. DIGITAL GALLERY SAFETY ANALYSIS

(See following 117 pages)

URBAN SYSTEMS ASSOCIATES, INC.
PLANNING & TRAFFIC ENGINEERING, MARKETING & PROJECT SUPPORT
CONSULTANTS TO INDUSTRY AND GOVERNMENT

MEMO

ATTN:	***Justin Mahramas*** ***Montgomery Clark Advisors***	***E-Mail: ▼*** ***Justin@mcadvise.com***	
FROM:	***Justin P. Schlaefli, PE TE PTOE***	***TOTAL PAGES (Including Cover):***	7 +Attachments
DATE:	***July 11, 2018***	***TIME: 4:55:44 PM JOB NUMBER: N/A***	
SUBJECT:	***ArtCenter Digital Gallery- Preliminary Findings***		

As requested, we have completed a preliminary evaluation of the proposal for a digital art display (Digital Gallery) at the ArtCenter campus in Pasadena. After reviewing a variety of standards, literature, research and examining similar installations across the nation, we have found that the Digital Gallery located at the intersection of Arroyo Parkway and Glenarm Street can be safely installed and operated subject to reasonable conditions. Signs of this type are currently successfully operated in many areas of the nation. However, reasonable measures should be taken to limit and/or eliminate potential for driver distraction and improve safety. This research and some recommended limitations on operation are discussed further below.

Research:

As digital advertising and artwork displays have become more common, a significant amount of research has been produced concerning potential safety effects of such installations. Of primary concern is the element of driver distraction caused by illuminated and/or moving displays. Compendiums of research have been prepared at various times for different State Departments of Transportation and or Federal Governments and recommendations for sign regulations have been prepared for a variety of jurisdictions including Caltrans. Sources for research include the National Cooperative Highway Research Program (NCHRP), Transportation Research Board (TRB), the American Association of State Highway and Transportation Officials (AASHTO), Caltrans Division of Research and Innovation, various Universities and more. At times, this research led to contradictory conclusions. However, there is a significant body of research on this subject.

Two major compendiums of research are attached to this memo. **Attachment 1** includes a Preliminary Investigation completed for Caltrans Division of Research and Innovation titled, Effects of Outdoor Advertising Displays on Driver Safety, October 11, 2012. This and subsequent reports and regulations represent the primary research efforts conducted by Caltrans and various California State Agencies. It is not all-inclusive but it is included as an attachment to this memo as a good starting point and relatively succinct and complete examination of the subject. In addition, **Attachment 2** includes a research report completed by Austroads in Australia titled, Impact of Roadside Advertising on Road Safety. Both reports represent significant efforts and reviews of the relevant research on the subject and were used to inform important regulations on the subject. As

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mentioned, additional reports and research was reviewed and is available if requested. Some more recent research was omitted if the results seemed to be significantly disputed.

Research Findings:

One seminal 2009 report was produced by Jerry Wachtel titled, Safety Impacts of the Emerging Digital Display Technology for Outdoor Advertising Signs. This report indicates that research regularly demonstrates that roadside advertising and digital billboards contribute to driver distraction. Research has produced consistent recommendations related to various factors of sign operation including brightness, message duration, change interval and more. These guidelines help limit the potential for driver distraction but do not fully eliminate all distraction. The recommendations include (as summarized in Attachment 1):

- Minimum message display duration: The FHWA recommends 6 seconds, the OAAA recommends 4 seconds, and the OAAA reports that 41 states have set display minimums ranging from 4 seconds to 10 seconds. Wachtel is not aware of any research on this issue to support such guidelines, and notes that "good human factors practice would suggest that minimum display duration should differ with sight distance, prevailing speeds, and other factors." The author recommends the following formula to minimize the chance that a motorist will see more than two successive messages: Sight distance to the digital billboards (ft) / Speed limit (ft/sec) = Minimum display duration (sec)
- Interval between successive displays: This interval should be as close to instantaneous as possible so that a driver cannot perceive any blanking of the display screen.
- Visual effects between successive displays: Visual effects should be prohibited.
- Message sequencing: Sequencing should be prohibited.
- Amount of information displayed: To the author's knowledge, no U.S. jurisdiction places restrictions on the amount of information that may be presented on billboards, including digital billboards (although some agencies outside the United States do). There is not enough research to make recommendations, although a good starting point are guidelines for South Africa and the Netherlands (which limit information based on how much a driver can read at a given speed and while the sign is visible).
- Information presentation: Considerable guidance is available to advertisers and digital billboard owners from sources inside the outdoor advertising industry as well as human factors and traffic safety experts, and the MUTCD itself. Digital billboards should facilitate rapid, error-free reading of roadside advertisements with lower levels of driver attentional demand and distraction. Typeface, font, color and contrast of figure and background, character size, etc., all play a role in the legibility and readability of a display.
- Digital billboard size: Recommendations for size limitations are beyond the scope of the report. The most common size for billboards of any kind is 14 feet high by 48 feet wide.
- Brightness, luminance and illuminance: Since perceived brightness can change depending on ambient light conditions, it is necessary to establish objective, measurable limits on the amount of light that such billboards actually emit, and set different upper bounds for different environmental and ambient conditions.
- Display luminance in the event of failure: Roadway authorities should incorporate into their guidelines verifiable requirements that, in the event of any failure or combination of failures that

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affect DBB luminance, the display will default to an output level no higher than that which has been independently determined to be the acceptable maximum under normal operation.

- Longitudinal spacing between billboards: An approaching driver should not be faced with two or more digital billboard displays within his field of view at the same time.
- Digital billboard placement with relation to traffic control devices and driver decision and action points: Prohibitions against the placement of distracting irrelevant stimuli in roadway settings where drivers must make decisions and take actions should be imposed. The guidance for Queensland, Australia, might serve as a model.
- Annual operating permits: Government agencies and roadway operating authorities might consider the practice adopted in Oakdale, MN, where owners of digital billboards are granted a permit to operate a sign for a year and must renew the permit annually.

Research also found that digital displays can draw longer glances than non-digital displays (although this is disputed in some sources). Many of these recommendations do not apply to the proposed ArtCenter display but should be considered if regulations are considered by the City of Pasadena.

According to the research report contained in Attachment 2, key findings include:

> "Most drivers, in most driving situations, most of the time, probably possess substantial spare cognitive capacity for the processing of driving-irrelevant information. Given this, and given the exploratory nature of human cognition and the likelihood that drivers attempt to maintain an optimal level of arousal via task difficulty homeostasis (Fuller 2005), it may be very difficult to prevent drivers from directing attention away from the driving task (Trick & Enns 2009). This in itself is not necessarily undesirable as it may serve to maintain an appropriate level of arousal, thus combating the negative effects of monotony (e.g. Oron-Gilad, Ronen & Shinar 2008). Indeed, in a recent Austroads (2011) study it was found that roadside signage that was designed to engage drivers in some mental activity, improved driver alertness."
>
> "The key question is whether there are situations or individuals where processing is recruited or interfered with by driving-irrelevant material to the detriment of driving performance. The considerations reviewed above suggest that the answer to this is in the affirmative. While attention may be less likely to be captured by irrelevant material in a demanding driving situation, it is clear that in some driving situations it is likely that movement or changes in luminance will involuntarily capture attention and that particularly salient emotional and engaging material will recruit attention to the detriment of driving performance, particularly in inexperienced drivers."
>
> "While the function of roadside advertising is clearly to capture attention, this is undesirable from a safety perspective if it results in attention being diverted involuntarily from the central task of driving. In order to minimise the possibility that such automatic attentional capture occurs, the following principles should be considered.
> **6.1.1 Movement**
> The potential for sudden movement and change in the environment to capture attention in a way that is outside volition suggests that digital billboards should not display moving or flashing images (or lighting) or change in a way that produces an impression of movement.
> **6.1.2 Dwell Time**

For similar reasons, the length of time for which an image is displayed should be as long as possible to reduce the frequency of those sudden environmental changes that can capture attention involuntarily.

6.1.3 Transition Time

Again, the transition time between images should be instantaneous in order to reduce the number of sudden environmental changes that could capture attention.

6.1.4 Luminance

Signs that have luminance levels that are high relative to other objects in the environment are likely to gain preferential attention and be particularly good at capturing attention when they change. As a result, digital signs should have luminance levels similar to other lighted signs, billboards or retroreflective signs and preferably lower than non-changeable signs.

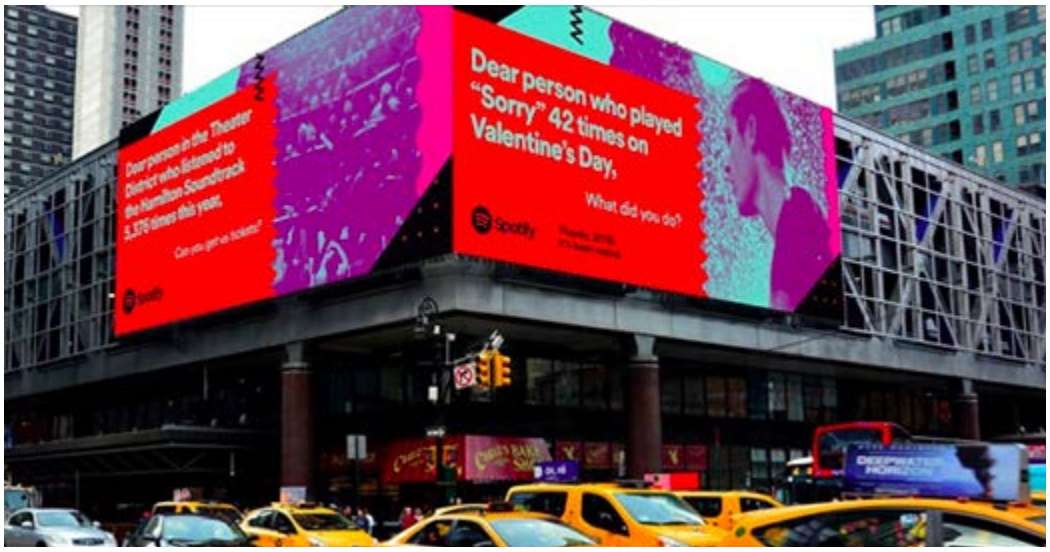
6.1.5 Content

As some content, particularly emotional content, can capture attention automatically, it is undesirable for such content to be used in roadside advertising. For a similar reason, content that mimics the content of traffic signs would also be undesirable."

Similar Installations:

The proposed Digital Gallery at ArtCenter is similar to other displays which have been installed all over the nation. Many of these intense environments are intentionally located on lower speed roads in urban areas. Naturally, the ArtCenter Digital Gallery is not nearly as intense as either of the two examples listed above and such an environment may not be appropriate for Pasadena. Nonetheless, it is an illustration that such displays can successfully be installed without causing unacceptable safety issues. In many cases, such signage (particularly displaying art) can become iconic fixtures of a dynamic streetscape and can be an important element of placemaking. The following locations and illustrations show similar displays in environments similar to the proposed ArtCenter Digital Gallery:

New York:



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Cleveland Institute of Art:

Philadelphia:

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Washington D.C.- Hirshorn Museum:

Boston- WGBH:

San Francisco- Salesforce Tower:

Suggested Operational Conditions:

Based on the review of literature research, the site itself and similar installations nationwide, the following conditions are recommended:

- An operational and thematic guide be prepared to guide ArtCenter in the operation of the proposed Digital Gallery. This guide should include operating parameters based on consultation with the City of Pasadena and Caltrans.
- An operational report should be prepared each year for the first three years of operation followed by a report each five years of operation containing information regarding what was displayed, any reported complaints or difficulties, any major changes in operation and an examination of accident rates for abnormalities attributable to sign operation. Adjustments or reasonable limitations in operation should be discussed if applicable in the report and discussed with the City of Pasadena Department of Transportation.
- Significant changes in sudden movement or flashing images or colors should be minimized and/or eliminated in such a way to avoid driver distraction at all times.

- The Digital Gallery should be mounted such that it is not in the cone of vision as defined by the CAMUTCD for each traffic signal head at the intersection of Arroyo Parkway and Glenarm Street.
- The length of time for which an image is displayed should be as long as possible to reduce the frequency of sudden environmental changes that can capture attention involuntarily. A minimum of six seconds is widely recommended in research but longer display times should be considered.
- The transition time between images should be instantaneous in order to reduce the number of sudden environmental changes that could capture attention.
- Maximum changeable electronic variable message sign brightness of 5,000 cd/m2 in daylight and 280 cd/m2 at night. This requirement should be adjusted downward as appropriate based on further evaluation of brightness levels of surrounding signage.
- The Digital Gallery should be non-reflective.
- As some content, particularly emotional content, can capture attention automatically, such content should be limited as much as possible.
- Messages containing text or information should be kept simple such that a driver wouldn't require significant attention to understand the content or meaning.
- Any content resembling or containing roadside traffic signs or traffic signals should be prohibited.

Additional consultation with Caltrans and the City of Pasadena is recommended. The Digital Gallery may need to comply with the Outdoor Advertising Act and Regulations by the State of California and other applicable regulations.

Attachment 1

AP-R420-13

AUSTROADS RESEARCH REPORT

Impact of Roadside Advertising on Road Safety

Austroads

Impact of Roadside Advertising on Road Safety

Impact of Roadside Advertising on Road Safety

Published January 2013

Impact of Roadside Advertising on Road Safety

ISBN 978-1-921991-72-1

Austroads Project No. ST1651

Austroads Publication No. AP-R420-13

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Impact of Roadside Advertising on Road Safety

Austroads

Sydney 2013

About Austroads

Austroads' purpose is to:

- promote improved Australian and New Zealand transport outcomes
- provide expert technical input to national policy development on road and road transport issues
- promote improved practice and capability by road agencies.
- promote consistency in road and road agency operations.

Austroads membership comprises the six state and two territory road transport and traffic authorities, the Commonwealth Department of Infrastructure and Transport, the Australian Local Government Association, and NZ Transport Agency. Austroads is governed by a Board consisting of the chief executive officer (or an alternative senior executive officer) of each of its eleven member organisations:

- Roads and Maritime Services New South Wales
- Roads Corporation Victoria
- Department of Transport and Main Roads Queensland
- Main Roads Western Australia
- Department of Planning, Transport and Infrastructure South Australia
- Department of Infrastructure, Energy and Resources Tasmania
- Department of Transport Northern Territory
- Department of Territory and Municipal Services Australian Capital Territory
- Commonwealth Department of Infrastructure and Transport
- Australian Local Government Association
- New Zealand Transport Agency.

The success of Austroads is derived from the collaboration of member organisations and others in the road industry. It aims to be the Australasian leader in providing high quality information, advice and fostering research in the road transport sector.

CONTENTS

TABLES

FIGURES

SUMMARY

It is now widely recognised that distraction is a significant contributor to crashes. While there has been a focus on in-vehicle distraction, especially from mobile phone use, in recent years there has been a growing recognition that distraction may arise from sources outside the vehicle. In particular, roadside advertising has been suggested to have the potential to create a crash risk in this way. With the emergence of digital technology it is now the case that advertising scenes can change frequently and may even contain motion and it is this potential for movement in the visual scene that is of special concern from a distraction perspective.

Currently, while most road authorities have applicable guidelines to inform the design and placement of roadside advertising, these are quite diverse across jurisdictions and often do not deal appropriately with digital technology. In addition, the actual distraction risk associated with roadside advertising is not incorporated and communicated well in these guidelines.

Therefore, the aims of this project were to; firstly, review the extant literature on the distraction risk associated with roadside advertising and to communicate this. The second aim was to document and review the existing guidelines across road agencies so that inconsistencies and gaps could be identified. Finally, these outputs were to be used to inform guiding principles and make guidance recommendations that can be used to create guidelines and to harmonise guidelines across road agencies.

1 INTRODUCTION

1.1 Background

Australia's new National Road Safety Strategy notes that, 'Driving is a complex task and sources of driver distraction, both within the vehicle and in the general road environment, have increased substantially in recent years' (National Road Safety Strategy 2011–2020, p. 83). While it is recognised that inattentive driving is a contributor to road crashes and that roadside advertising may be one of the contributors to such inattention, criteria for the management of roadside advertising devices vary considerably between jurisdictions. In a number of jurisdictions, responsibility for the criteria resides with the planning agency, while in others it is a road agency function. A number of road agencies have sponsored projects to better inform themselves about the safety implications of outdoor advertising, which also has contributed to variations in jurisdictional practice. Given that the income derived from outdoor advertising can be significant, particularly on high volume corridors, the state practice guidelines are able to be 'played off' against each other by the outdoor advertising industry.

In addition, a significant emerging safety issue is the use of digital display technology for outdoor advertising signs. This new technology will enable the advertising industry to display more attention-getting messages that are likely to cause drivers to be less attentive to the driving task. Some recent work in the United States, submitted under NCHRP Project 20-7 (256) by the Veridian Group, reports that

> 'the newest digital billboards are also increasingly capable of 'interacting' with approaching drivers. In some cases, the Radio Frequency Identification Device (RFID) embedded in a vehicle's key or on-board computer system, can trigger a personalised message on a digital billboard; in other cases, the billboard can display a message tailored to the radio frequency of passing vehicles. Still other billboards encourage drivers to interact with the sign by 'texting' a message or calling a number displayed on the billboard' (Wachtel 2009).

1.2 Purpose and Outline of the Project

For these reasons there is considerable interest in coming to a definitive understanding of the risks associated with roadside advertising in its various guises so that informed guidelines for the regulation of such advertising can be formulated.

This project is designed to facilitate the harmonisation of agency criteria for the management of roadside advertising devices and promote improved and consistent practice by road agencies. Most importantly, it will assist road agencies to understand and address a significant emerging safety issue – the use of digital display technology for outdoor advertising signs.

There are four major tasks in this project:

- review the human factors elements relevant to understanding the possible safety implications of roadside advertising
- undertake a literature review of existing research investigating the distraction potential of roadside advertising
- document the guidelines, practices (and underpinning rationale) adopted by road and planning agencies for the management of roadside advertising
- develop 'best practice' guiding principles and guidelines for the placement of outdoor advertising signs.

2 METHOD

The research method included extensive desktop research, including internet, library and database searches to locate all relevant material (English language only).

This process was conducted with the aid of the M.G. Lay Library. The M.G. Lay Library contains the most comprehensive and up-to-date collection of international literature on land transport issues (particularly roads) in Australia, and is one of the leading technical libraries in its field in the world. The library is staffed by a team of full time professionally qualified staff. The ARRB Group library has close contact with major libraries both in Australia and overseas, for example the Library at the UK Transport Research Laboratory. Inter-library loans are easily arranged, or document abstracts in other libraries can be accessed via on-line communications. The Australian Transport Index (ATRI), the International Transport Research Documentation database (ITRD), and the Transportation Research Information Services (TRIS) were all searched for relevant information.

ATRI is a database produced by ARRB Group. The Australian Transport Index provides a record of significant material published about roads and land transport in Australia, the United Kingdom, the USA, Europe and Asia. Many of the records include an abstract. The Australian Transport Index is available online and on CD-ROM through Informit, the electronic publishing arm of RMIT University. ATRI contains over 143 000 records. ITRD is managed by the OECD Division of Transport. ITRD covers published technical literature from around the world as well as details of current research projects. The database contains information from 40 major technical institutes from 24 countries and more than 350 000 references including an informative abstract. TRIS is a database prepared by the US Transportation Research Board and covers all modes of transport. It includes publications and descriptions of research projects and contains over 450 000 references.

Following the preparation of the review of the research literature and existing guidelines a workshop was held to disseminate and discuss the outputs of these reviews and to come to some agreement about their implications. Attendees included representatives of state and territory road agencies and academics with expertise in the area. The list of attendees is shown in Appendix A.

3 ROADSIDE ADVERTISING DEVICES

Roadside advertising devices are defined in this report as all advertising signs and devices which are visible to road users (intentionally or otherwise) and are used to display advertising copy that promotes a product, service, event or any other activity for an organisation that would derive a benefit from the display of the advertising. For the purpose of this project, the focus is on advertising devices which are located within or are visible from the boundaries of state-controlled roads[1].

Definitions and terminology used to describe different types of roadside advertising devices can vary considerably, both internationally and across Australian states. The sections below provide a comprehensive summary of the most commonly used devices in Australia that are likely to impact on road safety, detailing industry standards where appropriate. The categories adopted here reflect common industry classification schemes.

Within the summary, devices have been primarily categorised as non-changeable or changeable. Another important characteristic used to distinguish between devices is luminance. Both non-changeable and changeable devices can be illuminated, as discussed in greater detail in Section 3.3.

3.1 Non-changeable Advertising Devices

Non-changeable devices display a single advertisement copy that can only be changed manually on-site. The content of the advertising copy remains static (i.e. constant) for the duration of the display.

Conventional billboards and posters

These devices refer to large advertising signs, greater than 4 m^2, with messages that incorporate words, symbols or pictorial displays and are printed on paper or alternative materials such as computer generated woven polyester panels or ‘skins’. As illustrated in Figure 3.1, the advertising copy may be mounted on freestanding structures or attached to building walls, roofs and overhead transport infrastructure (e.g. bridges and overpasses). The messages displayed on these conventional devices do not change unless manually replaced on-site.

A variety of sizes are used; the 24 Sheet poster, or traditional ‘Billboard’, is the most frequently used format in outdoor advertising. The messages may be illuminated through external power sources, although this does not usually achieve the same perceived brightness as the digital billboards described in Section 3.2.2. Table 3.1 provides an overview of the different formats of poster used in roadside advertising in Australia.

[1] It should be noted that considerable roadside advertising is situated adjacent to non state-controlled roads.

Source: Department of Planning NSW (2007).

Figure 3.1: Examples of a freestanding billboard (top), wall-mounted billboard (left) and bridge-mounted billboard (right)

Table 3.1: Conventional billboard and poster formats used in outdoor advertising

Category	Format	Typical industry dimensions/area	Markets	Illumination
Large format	Spectaculars	18.9 m x 4.5 m (> 50 m^2)	City and regional – principal arterial roads, highways and freeways	Yes
	Supersites	12.66 m x 3.35 m (42.4 m^2)	City and regional – principal arterial roads, highways and freeways	Yes
Poster	24 sheets	6.0 m x 3.0 m (18.0 m^2)	City and regional – including highways, primary / secondary arterial roads, railway interchanges, suburban commercial and industrial areas	Often
	6 sheet	3.0 m x 1.5 m (4.5 m^2)	City – mainly displayed on building walls in suburban locations	Occasionally

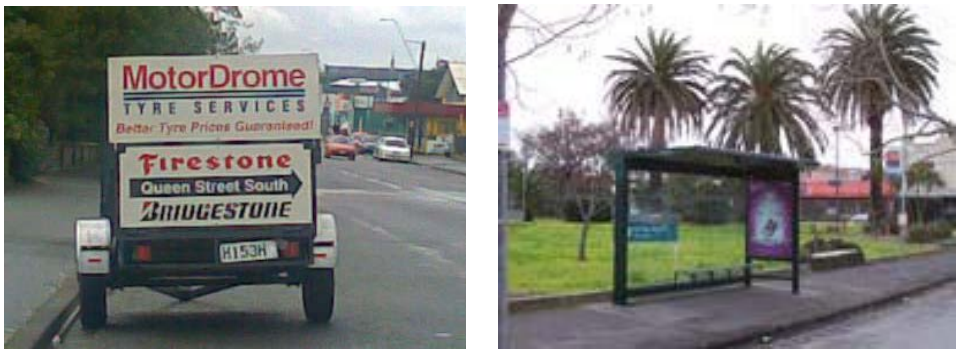
Other contexts in which conventional billboard or poster formats are displayed are described below and illustrated in Figure 3.2.

Mobile/portable billboards

Mobile or portable billboards generally consist of posters mounted on small commercial vehicles or trailers, sometimes illuminated and with two-sided displays. The vehicle remains motionless while the advertisement is displayed.

Public transport shelter and street furniture poster displays

Posters are commonly displayed as an integral part of freestanding structures such as bus stop shelters or on street furniture in business and entertainment areas of city centres. They are usually illuminated and typical dimensions are 1.8 m x 1.2 m or 1.5 m x 1.0 m.



Source: NZTA (2011) (left) and Department of Planning and Community Development (2007) (right).

Figure 3.2: Examples of a mobile billboard (left) and a billboard displayed as part of a bus shelter (right)

Other

There are numerous other miscellaneous formats of non-changeable advertising devices that are commonly used on the road network, although often prohibited on some roads such as freeways and motorways. These include but are not limited to:

- local business, community and event signs
- real estate signs
- tourist information signs
- banners and flags
- paintings or murals on building walls
- building wrap and hoarding
- transit displays (i.e. on moving vehicles such as buses, trams and taxis)
- aerial displays.

3.2 Changeable Advertising Devices

Changeable advertising devices have the capability to mechanically or electronically change the advertising message being displayed automatically or remotely i.e. without the requirement for human intervention on-site. This enables more than one advertisement to be presented, either through the rotation of static images at specified intervals or the use of dynamic displays.

3.2.1 Mechanically-changed

These devices allow the presentation of two or more static messages that are rotated mechanically (i.e. by a motor) through a pre-determined sequence at regular intervals, while the supporting structure remains stationary. There are motionless periods in between the presentation of different messages and the number of messages that can be displayed is restricted. Unlike electronic devices, the change between advertising messages cannot be instantaneous.

Trivision

In trivision devices, messages are printed onto a series of adjacent vertical prisms (usually three-sided), which when aligned display a single advertising image. The prisms are rotated in unison, typically every four to ten seconds, to show one of three messages. They are also referred to as 'tri-action', 'tri-panel' or 'changing slat' signs. These devices are typically 3 m x 6 m or 12 m x 3 m in dimension.

Multi-advertisement scrolling

Also referred to as rolling devices, these devices have multiple advertisements printed onto a looped canvas or connected to form a single scroll. The scroll is usually wound around a vertical axis using a motorised spool, so that the adverts are sequentially presented in the front display panel. These are often smaller signs installed at street level or incorporated into public transport infrastructure such as bus stops. The advertisements are often illuminated or backlit.

3.2.2 Electronically-changed

These devices use digital technology to display bright, high quality electronic images which are uploaded and changed using a computer and modem via a secure network. Digital billboards feature LED (light emitting diode) technology which enables luminance to be controlled and adjusted automatically. Within Australia, Victoria was the first state to permit these types of signs on its road network.

Digital billboards

Similar to conventional billboards, digital billboards are generally large signs with dimensions greater than 4 m^2 displaying messages which incorporate text, symbols and other pictorial or graphical images. Digital billboards can utilise static electronic displays or non-static electronic displays. They are also known by a large variety of terms including electronic billboards, electronic message displays, dynamic message signs, commercial electronic variable message signs, video billboards and moving or animated electronic signs. The two display types are described below.

- *Static electronic displays* contain static images only which are presented successively but do not contain or imply motion within the message itself. The device is programmed to alternate the static images at short intervals. Dwell time, transition time and luminance can all be controlled and changed electronically. Different approaches can be taken to the transition between messages e.g. scroll, dissolve, fade or fly-in. In the USA, typical dwell times for digital billboards range between four and ten seconds (with restrictions on proximity to entry and exit ramps), with transition times varying between instantaneous to four seconds (OMA 2010). These times are comparable to standards in other countries such as Canada and the UK. Some Australian states however currently utilise longer dwell times, as detailed in Section 7. It is worth noting that a number of jurisdictions in the USA also depart from these parameters quite substantially, with mandated dwell times of up to many minutes (e.g. Minnetonka, MN; Bloomington, MN) or outright prohibition of digital billboards (e.g. Pennsylvania DOT).

- *Non-static or dynamic electronic displays* present moving images, or images with features that give the impression of motion and change dynamically similar to a video. This includes animation, flashing, scrolling, intermittent or full-motion video and special effects. These displays are not commonly permitted in many countries, including the UK and the majority of jurisdictions in Australia and America.

Figure 3.3: Examples of digital billboards located within the boundaries of (left) or visible from (right) state-controlled roads

Furthermore, rapidly developing technology is enabling more advanced functions which allow digital billboards to interact with road users, for example by the sign displaying a personal message for a specific driver as they approach or by allowing road users to download images and data.

Variable message signs (VMS)

VMS are primarily used by road authorities with the purpose to present messages to motorists to facilitate more effective management of traffic and to promote road safety. VMS have the capability to present text and/or graphical displays.

In Australia, traffic VMS are generally static electronic text-only displays and are most commonly used to display a single message for a significant period of time. Road agencies usually prescribe detailed specifications regarding the format and content of these signs, including size of text, use of colour and permitted words. Messages may be tactical (e.g. incident warnings) or advisory (e.g. safe driving advice or journey time information). Under normal traffic conditions, when there is no need for a safety-critical instruction, the road authority may authorise use of the sign to display other information which may have relevance for both traffic management and advertising; for example, details of upcoming special events.

VMS can also be used solely for commercial advertising purposes. These are often in the form of portable devices located on lower speed roads and adjacent to business premises, as illustrated in Figure 3.4.

Figure 3.4: Example of a variable message sign displaying advertising content

Projection on to buildings

It is also possible to project both still and video images directly on to buildings. While this approach is quite common in some parts of North America and Europe, it has been uncommon in Australia until quite recently. It is now becoming more common in Australia for special events such as New Year's Eve celebrations and the like. However, the advantages of such an approach (reduced infrastructure and installation costs) suggest that there is likely to be increasing interest in deploying this technique in Australia in the future.

Source: http://www.nuformer.com/.

Figure 3.5: Example of advertising projected on to a building

3.3 Illumination

It is important that advertising devices are illuminated appropriately for the ambient light conditions to ensure there is no unacceptable glare (making it difficult to read the sign because of excessive external light sources) or reflectance (making the sign itself so bright that it is distracting) that may result in safety issues for road users or that will produce unacceptable light spillage to the local environment. Advertising devices can be classified according to the following definitions:

Non-illuminated devices do not have specifically designed internal or external means of illumination, although they may be indirectly illuminated by street lighting or other local light sources. They may be non-reflective, retro-reflective or partially retro-reflective.

Illuminated devices have specifically designed internal and/or external means of illumination of the entire advertising copy or a portion of the device. Both changeable and non-changeable devices can be illuminated.

Externally illuminated devices have an external light source which is used to illuminate the advertising copy (see Figure 3.6). For example, through the use of fluorescent and/or incandescent bulbs. They may also be referred to as floodlit signs, and most commonly consist of conventional billboards and posters.

Internally illuminated devices have internal lighting to illuminate the advertising copy, see Figure 3.6. This includes digital billboards which use LED technology, as well as devices which contain lights or illuminated tubes arranged as an advertisement such as neon signs. The lighting can be adjusted, either automatically using sensors or manually, to match the appropriate luminance for ambient light conditions.

Static illumination refers to illuminated advertising devices where the illumination of the entire device is constant in form, intensity and colour; for example, an externally-lit conventional billboard.

Non-static illumination refers to an illuminated advertising device where the illumination of the entire device is not constant in form, intensity and colour. For example, animated and video displays or advertisements incorporating flashing, scintillating or blinking lights which emit light intermittently.

Source: Department of Planning NSW (2007) (right).

Figure 3.6: Example of an externally illuminated advertising device (left) and an internally illuminated advertising device (right)

4 GENERAL HUMAN FACTORS CONSIDERATIONS

4.1 Introduction

Driving a motor vehicle is a complex task that requires the ability to divide one's attention between numerous competing tasks. Drivers must simultaneously maintain an appropriate and legal speed, change lanes, navigate traffic and intersections and read and interpret signs of various kinds. Furthermore, drivers are often challenged by conditions that can change almost instantaneously. Some of these changing conditions can be critical to the driving task while others are not. When they are not they are therefore potential distractions from the driving task. Such distractions can result from factors either internal or external to the vehicle.

This review is focussed on distraction from an external source; advertising billboards. The fundamental logic of roadside advertising is to attract attention to something that is not part of the driving task. In order to contribute to the current evaluation of whether this might have an impact on driving safety, the following sections review the nature of attention and some perceptual issues that are likely to be important to the driving task.

4.2 The Nature of Attention

There are two key aspects of attention that are important for understanding the problem of distraction from advertising billboards. One is the automatic capture of attention and the other is the limited capacity of human attention.

4.2.1 Automatic Capture of Attention

One concern with digital billboards in particular is that drivers will deliberately attend to them at the expense of the driving task purely to see what is displayed in the next transition (the Zeigarnik Effect; see e.g. Watchel 2009[2]). Contrary to this concern however, it has been found that drivers typically modulate their off-road glances, not looking away from the forward roadway for more than 1.5 seconds at a time (Dingus et al. 1989). Despite this, there is concern that such self-regulation could be involuntarily disrupted by the attention-grabbing properties of roadside advertising.

While the notion of attention is to some extent synonymous with voluntary, goal-directed activity, nevertheless it appears that attention may sometimes be captured involuntarily by certain events. For example, most people would have had the experience of sudden movement in their peripheral vision resulting in a seemingly automatic orienting in that direction. The question for the current purpose is, when and to what extent this is likely to occur. If one is walking alone on a dark street in a bad neighbourhood then the answer is likely to be; frequently and dramatically. But what about when it is not important, or not desirable, to display such vigilance? What happens when a digital billboard changes or animates in peripheral vision when driving? Can we avoid being distracted by such stimuli?

In recent years researchers have been investigating to what extent this attentional capture is outside of voluntary control and what kinds of stimuli give rise to it. This interest has been driven by purely theoretical considerations, but obviously has important implications for understanding the distraction potential of various kinds of roadside advertising. While there is still debate over some of the theoretical subtleties in this research, there are some clear findings of relevance to the issue of the distraction potential of roadside advertising.

[2] There is good evidence that people have a need to complete a task once initiated and that if the task is not completed there will be some continuing cognitive effort devoted to this, potentially to the detriment of other ongoing cognitive activity such as driving for example (see Greist-Bousquet, S., Schiffman, N. 1992).

While some early research suggested that the appearance of new objects in the visual field was the key to predicting attentional capture (e.g. Yantis & Hillstrom 1994), other research suggested that luminance changes were necessary to capture attention (Theeuwes 1995). More recent research appears to suggest that the presence of unique sensory transients may be the key to predicting attentional capture (Hollingworth, Simons & Franconeri 2010). That is, in order to capture attention there must be a salient change in the environment that creates a new event in the observer's sensory system. This could be luminance changes, which could arise from the appearance of a new object, or motion in a previously immobile object.

With respect to the issue of the extent to which the capture of attention is involuntary; the research is similarly complicated. While some research appears to show that involuntary attentional capture by environmental events does occur, other research suggests that this attentional capture can be suppressed (Yantis & Jonides 1990). The key seems to be that this suppression is more likely if the primary task is very demanding and requires a focussed attentional state, but that such suppression becomes less likely as the primary task becomes less demanding, requiring a less focussed attentional state (Lamy & Tsal 1999; Ruz & Lupianez 2002). The results of Young et al. (2009) showing poorer recall of road signs (suggesting greater attention to roadside advertisements) are consistent with this and are discussed in more detail below.

The typical driving task and driving environment is quite undemanding, with a diffuse focus of attention. Generally drive while talking to a passenger and looking at the scenery and roadside environment generally. Only when, for example, they are on an unfamiliar road, driving at high speed, in heavy traffic, while trying to navigate to an unfamiliar destination is the driving task likely to become demanding. Thus, the fundamental research reviewed above suggests that in typical everyday driving environments attention is likely to be captured involuntarily. In addition, this fundamental research also suggests that motion and luminance changes in digital billboards are likely to be highly effective in capturing attention involuntarily.

4.2.2 Attentional Biases

It is well known that attention may be controlled by the emotionality of information. For example, the sound of someone crying will likely attract our attention. This is not surprising as emotional content is likely to signify that the information is important from a survival perspective. Less well appreciated within road safety is the fact that personality factors appear to dictate how attention to emotional material is controlled. For example, in a seminal study, MacLeod, Matthews and Tata (1986) demonstrated that clinically anxious subjects directed attention towards threatening material, at the cost of attention to other material, while non-anxious subjects directed attention away from threatening material. This processing bias appears to occur automatically and outside of awareness (MacLeod & Rutherford 1992).

Most et al. (2005) provided another demonstration of how the emotionality of material may distract attention away from critical target material. They presented a series of photographs and asked participants to respond to a particular target. When the target was preceded by a photograph with a negative emotional content, participants more often missed the target than when it was preceded by a neutral photograph. This 'blindness' was evident up to 800 msec after the presentation of the emotional photograph. Participants who scored low on harm avoidance were more easily able to modify their cognitive processing to reduce the induced blindness when given appropriate instructions than were participants who scored high on harm avoidance.

These considerations suggest that billboards with emotional content have a greater capacity to attract and hold the attention of individuals for whom that emotional content is significant, and this may result in decrements in driver performance.

4.2.3 Limited Capacity of Attention

Once attention is captured or is strategically focussed, the processing of the material within the focus of attention competes with other ongoing for cognitive resources. It is well understood that processing resources may have limited capacity (Wickens 2002). This can be seen very clearly in everyday tasks such as trying to follow a news item on television while having a phone conversation; comprehension of one or the other is likely to suffer.

However, drivers can drive quite successfully most of the time while having a conversation. This is because large chunks of the task of driving are relatively automated and/or do not draw on the same processing resources. When this is not the case driving performance is apt to suffer. For example, because driving relies so heavily on visual information processing, driving and comprehension performance are better when instructions are presented verbally while driving than if they are presented visually (Parkes & Coleman 1990). For the same reason, billboards always have the potential to interfere with driving performance.

Even if billboards do not deflect gaze direction away from the forward roadway, to the extent that they have captured attention they are likely to reduce the processing capacity available for other visual information processing required for driving. Furthermore, as Strayer and Johnston (2001) have shown in the case of mobile phone conversations, some driving-irrelevant stimuli can sometimes be so engaging that essentially all spare capacity is recruited to the secondary task, with serious consequences for driving performance. A billboard that was this engaging would undoubtedly be a serious safety risk for driving.

Concerns about irrelevant processing consuming resources required for optimal driving performance are even more salient for inexperienced drivers. Inexperienced drivers demonstrate significantly greater impairment from secondary tasks while driving (Shinar, Meir & Ben-Shoham 1998). The most likely explanation for this is that many of the tasks involved in driving are not yet as automatised as they are for experienced drivers and therefore compete for limited processing resources to a greater extent.

4.3 Perceptual Issues

4.3.1 Eyes Off the Forward Roadway

Thus far consideration has been given to how the capture of attention and the consumption of processing capacity by roadside advertising might impact on driving performance. Another way in which roadside advertising is likely to impact on driving performance is via inappropriate visual fixation, usually away from the forward roadway. That is, even if cognitive capacity is not being consumed to such a degree as to impair driving performance in itself, the fact that a driver is not looking in the correct direction to safely negotiate the road and other traffic may result in an incident, especially if conditions change suddenly.

In a key finding in this area, Klauer et al. (2006), in an analysis of the 100-Car Naturalistic Driving Study, found that glances away from the forward roadway for more than two seconds doubled the near-crash and crash risk compared to baseline. This result is averaged across all road types and traffic conditions. One can imagine that in challenging road environments in heavy traffic this risk would be much greater. At 70 km/h a two second glance away from the forward roadway equates to just under 40 m of travel down the roadway. In certain road environments and in heavy traffic it becomes quite likely that conditions in the forward roadway will have changed over this distance and hence that a driver not looking ahead will not be able to respond appropriately to these changes.

4.3.2 Visual Clutter

It seems intuitively plausible that the presence of driving-irrelevant material in the driving environment will hinder the apprehension of driving relevant information. A key prediction from this hypothesis is that increased visual clutter (defined as driving irrelevant stimuli) will result in decreased ability to locate critical information. Consistent with this, when Ho et al. (2001) asked participants in their experiment to rate driving scenes as either high or low clutter, they found that scenes rated as high clutter resulted in more errors when searching for a target sign. McPhee et al. (2004) found that this kind of impairment was further exacerbated by requiring participants to engage in a listening and comprehension task simultaneously with the search task. In addition they found that older adults performed more poorly than younger adults on the search task.

While these results imply that care should be taken to not clutter the road environment with driving irrelevant items, including roadside advertising, it does not provide an easy-to-use, objective measure of clutter that could be used to make decisions about the installation of additional objects in the road environment. While there has been some recent research aimed at deriving a metric for clutter (Rosenholtz, Li & Nakano 2007) this is not sufficiently developed to allow its application to a road environment. On the other hand, given that subjective estimates of clutter appear to be reliable and predict key aspects of driving performance (Ho et al. 2001; McPhee et al. 2004), it may be sufficient for practical application to use a subjective judgement of clutter until clutter assessment tools are available.

A better approach is currently being developed by Edquist et al. (in prep). They have provided evidence that clutter can usefully be conceptualised as falling into three categories – Built (buildings and other infrastructure), Designed (road markings and traffic control devices) and Situational (vehicles and other road users). Their experiments suggest that multi-storey buildings close to the road (such as typical commercial developments) and a larger number of traffic control devices on view (more than three at any one time) have a negative effect on driving performance. It also seems likely that high traffic volumes (high situational clutter) will also have a negative effect on driving performance although this has not been clearly demonstrated in their research to date.

4.4 Summary

Most drivers, in most driving situations, most of the time, probably possess substantial spare cognitive capacity for the processing of driving-irrelevant information. Given this, and given the exploratory nature of human cognition and the likelihood that drivers attempt to maintain an optimal level of arousal via task difficulty homeostasis (Fuller 2005), it may be very difficult to prevent drivers from directing attention away from the driving task (Trick & Enns 2009). This in itself is not necessarily undesirable as it may serve to maintain an appropriate level of arousal, thus combating the negative effects of monotony (e.g. Oron-Gilad, Ronen & Shinar 2008). Indeed, in a recent Austroads (2011) study it was found that roadside signage that was designed to engage drivers in some mental activity, improved driver alertness.

The key question is whether there are situations or individuals where processing is recruited or interfered with by driving-irrelevant material to the detriment of driving performance. The considerations reviewed above suggest that the answer to this is in the affirmative. While attention may be less likely to be captured by irrelevant material in a demanding driving situation, it is clear that in some driving situations it is likely that movement or changes in luminance will involuntarily capture attention and that particularly salient emotional and engaging material will recruit attention to the detriment of driving performance, particularly in inexperienced drivers. Where this happens in a driving situation that is also cognitively demanding, the consequences for driving performance are likely to be significant. Furthermore, if this attentional capture also results in a situation where a driver's eyes are off the forward roadway for a significant amount of time this will further reduce safety. Additionally, road environments cluttered with driving-irrelevant material may make it difficult to extract the information that is necessary for safe driving, particularly for older drivers.

5 REVIEW OF RESEARCH ON THE SAFETY IMPACT OF ROADSIDE ADVERTISING

The consideration of relevant human factors issues, outlined above, suggests that roadside advertising, especially billboards that exhibit movement and/or luminance changes, that are in an already cluttered road environment and that are especially salient and engaging, could reasonably be expected to have a detrimental effect on driving performance. This is likely to be especially true for inexperienced drivers and older drivers. However, this analysis does not directly answer the question of whether roadside advertising is actually distracting in any real driving environments, to such an extent that it leads to reduced safety and contributes to crashes. In order to evaluate this issue further the review below first discusses the evidence for the involvement of distraction in crashes and then the evidence for the involvement of roadside advertising in distraction and crashes.

5.1 Distraction as a Safety Issue

Studies based on crash reports suggest that perhaps 30% of all crashes involve driver distraction (Wang, Knipling & Goodman 1996) and in around 30% of those the distraction is from outside the vehicle (Stutts et al. 2001). However this source of data is likely to underestimate the contribution of distraction to crashes as drivers are unlikely to admit to such a cause and police may be unwilling to assign distraction as a cause without eyewitness testimony.

In one of the most compelling studies to date, Klauer et al. (2006) analysed the consequences of driver inattention using data from the 100-Car Naturalistic Driving Study. While brief glances away from the forward roadway for the purpose of scanning the driving environment were found to actually decrease the crash risk, glances of two seconds or more doubled the crash risk. In addition, this risk was further increased for certain demanding traffic environments such as intersections and high density traffic.

Some of the riskiest kinds of inattentive driving that contributed to crashes and near crashes in the Klauer et al. (2006) study originated from either drowsiness or in-vehicle distractions. Importantly, looking at an external object exhibited the second highest significant odds ratio of all distractions, (reaching for a moving object produced the highest significant odds ratio) with a driver 3.7 times more likely to have a crash or near crash when looking at an external object. However this kind of distraction accounted for less than 1% of all crashes and near crashes in the study. Thus while looking at an external object appears to be quite risky behaviour when it is engaged in, it is not a frequent cause of crashes overall.

5.2 Roadside Advertising as a Safety Issue

While the Klauer et al. (2006) study does not identify which external objects drivers were looking at when they were so looking, a number of studies have attempted to investigate whether distraction from roadside advertising specifically, might contribute to crashes.

Crundall et al. (2006) showed participants in their study video clips taken from the driver's perspective and asked them to either scan for hazards only or to look for advertisements also. Advertisements were either at street level or raised 3 m above street level. The core finding from this study was that street level advertisements attracted more attention than raised advertisements when drivers were instructed to look for hazards. Crundall et al. (2006) suggest that this occurs because street level advertisements fall within the normal window within which drivers habitually scan for hazards and that advertisements within this window are inappropriately capturing attention.

Of course this study is somewhat removed from the experience of actually driving, simply requiring, as it does, that drivers passively watch a video (although note that Crundall et al. (2006) discuss why there is good reason to believe that their methodology in this study appropriately taps the key aspects of the driving task).

This concern does not arise in the study by Lee, McElheny and Gibbons (2007). In this naturalistic study drivers drove an instrumented vehicle around a 50 mile loop in Cleveland Ohio. They found that drivers took longer glances at digital billboards than at conventional billboards and baseline sites. While there has been some criticism of their methodology and conclusions (Wachtel 2009) it would be agreed by all parties that Lee, McElheny and Gibbon's results show that in real world driving, digital billboards can be more distracting than conventional billboards.

Young et al. (2009) conducted a simulator study to investigate the effect of conventional roadside advertising on driver attention and performance. Drivers experienced urban, rural and motorway environments, with and without billboards. The presence of billboards was found to impair lateral control. Similarly, Edquist et al. (2011) found increased delay in the time taken to change lanes in response to signs in a simulator study was delayed by the presence of billboards, although not to a greater extent for changeable digital billboards. The negative impact of roadside advertising on lateral control has also been reported by Bendak and Al-Saleh (2010) in their simulator study. While the frequency of 'crashes' in Young et al.'s study was too low for statistical analysis, it is worth noting that there were three times as many crashes in the presence of billboards compared to driving conditions where billboards were absent. Interestingly, they also found that participants displayed significantly poorer recall of traffic control in the motorway and rural driving conditions, compared to urban driving conditions, suggesting that participants were spending more time processing advertisements in these less demanding driving scenarios, at the expense of attending to information that is important for safe driving.

Chattington et al. (2009) conducted a simulator study comparing the effect of static roadside advertising and moving video advertisements. They found that video advertising was significantly more distracting than static advertising, as indicated by more and longer glances towards the advertising. In addition, video advertising was found to reduce the ability to maintain a constant speed and lane position to a greater extent than static advertising.

In recent times, very few studies have attempted to investigate the impact of roadside advertising on actual crash rates. Smiley et al. (2005) investigated the impact of video advertising in Toronto on driving performance in a series of studies, including a before – after installation comparison of crash rates. While Smiley et al. found no statistically significant effect on crash rates overall, they note that sample sizes were not large enough to detect any effect that might accrue from the presence of the billboards. The descriptive statistics in this study however, are consistent with a relative increase in collisions, of all the various types, at the approaches to the video advertising sites.

There are a number of much older studies investigating the effect of roadside advertising on crash rates, but of course these do not deal with modern digital technology. In a review of these older studies, Wallace (2003) concluded that, while many are correlational, thus making it difficult to unambiguously attribute causality, nevertheless, 'the case for arguing that visual 'clutter' at junctions (associated with billboards and signs) can lead to unsafe driving is very strong' (p. ii).

5.3 Summary

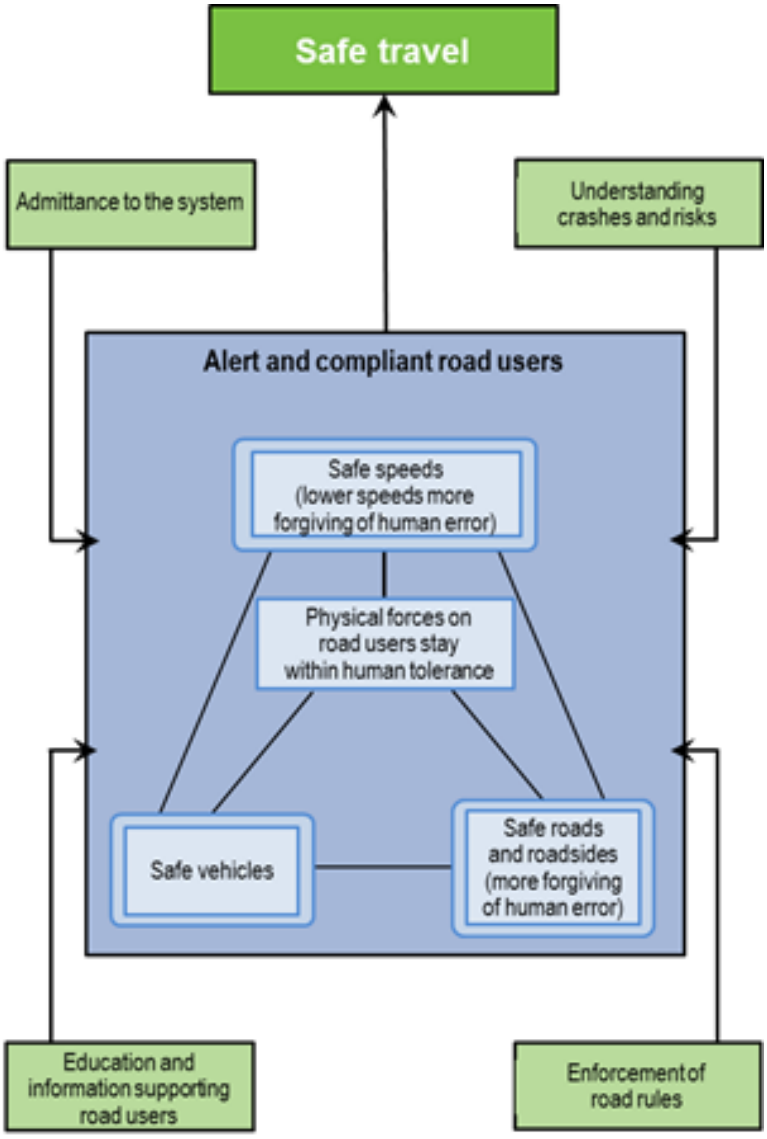
There is compelling evidence that distraction is a major contributor to crashes. However, studies providing direct evidence that roadside advertising plays a significant role in these distraction based crashes are currently not available. The studies that have been conducted show convincingly that roadside advertising is distracting and that it may lead to poorer vehicle control. However, the evidence is presently only suggestive of, although clearly consistent with, the notion that this in turn results in crashes.

It is also worth noting, on the basis of Klauer et al.'s (2006) results, that while looking at an external object increased the crash risk by nearly four times, 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. Thus, while it is not possible to tell from the reported results, it is reasonable to conclude that far less than 1% of all crashes and near crashes involved distraction from roadside advertising.

While the Klauer et al. (2006) study may not be representative of all driving events, it does suggest that the contribution of roadside advertising to crashes is likely to be relatively minor. On the other hand, from a Safe System perspective it would be difficult to justify adding any infrastructure to the road environment that could result in increased distraction for drivers. The exception to this may be in the case of very monotonous roads where drivers are likely to suffer the effects of passive fatigue.

6 BEST PRACTICE PRINCIPLES

Australian and New Zealand jurisdictions are now firmly committed to the Safe Systems approach to road safety (see Figure 6.1). This approach, which is derived from the Swedish Vision Zero and Dutch, Sustainable Safety approaches to road safety, has at its core the recognition that road users are fallible and will make mistakes, even if alert and intending to comply with the road rules. As a result, vehicles and road infrastructure need to be designed to discourage errors and protect against the consequences of errors when they do occur. Within this philosophical context it is difficult to see how adding roadside infrastructure that has the potential, however minor, to encourage driver error (through distraction) could be justified.



Source: Australian Transport Council (2009).

Figure 6.1: Austroads Safe Systems diagram

However, as noted earlier, the human factors issues are not straightforward when attempting to be definitive about what is and is not desirable from a distraction perspective. Firstly, in some environments, some level of appropriate roadside 'distraction' may be desirable. Secondly, it seems very likely that if drivers are not completely engaged by the driving environment they will spontaneously engage in other 'distracting' activities. Finally, it appears that in many cases drivers regulate their engagement with potentially distracting stimuli so that its distraction potential is controlled to some extent. This does not mean that roadside advertising is of no concern, but it does mean that there are situations where it is unlikely to compromise the integrity of the Safe System. The key is to specify the principles that are important in determining those situations.

Based on the human factors issues and the specific research outlined above, the following principles should be considered when formulating guidelines for the approval and placement of roadside advertising.

6.1 Potential for Capturing Attention Involuntarily

While the function of roadside advertising is clearly to capture attention, this is undesirable from a safety perspective if it results in attention being diverted involuntarily from the central task of driving. In order to minimise the possibility that such automatic attentional capture occurs, the following principles should be considered.

6.1.1 Movement

The potential for sudden movement and change in the environment to capture attention in a way that is outside volition suggests that digital billboards should not display moving or flashing images (or lighting) or change in a way that produces an impression of movement.

6.1.2 Dwell Time

For similar reasons, the length of time for which an image is displayed should be as long as possible to reduce the frequency of those sudden environmental changes that can capture attention involuntarily.

6.1.3 Transition Time

Again, the transition time between images should be instantaneous in order to reduce the number of sudden environmental changes that could capture attention.

6.1.4 Luminance

Signs that have luminance levels that are high relative to other objects in the environment are likely to gain preferential attention and be particularly good at capturing attention when they change. As a result, digital signs should have luminance levels no greater than any other sign and preferably lower than non-changeable signs.

6.1.5 Content

As some content, particularly emotional content, can capture attention automatically, it is undesirable for such content to be used in roadside advertising. For a similar reason, content that mimics the content of traffic signs would also be undesirable.

6.2 Mental Workload

Because humans have a limited capacity for processing information simultaneously there is the potential for the processing of roadside advertising to interfere with the processing of information critical for safe driving. In order to minimise the possibility that attention is consumed to an unsafe degree the following principles should be considered.

6.2.1 Visual Clutter

A highly cluttered visual field makes it difficult to locate and prioritise processing of driving-critical information. Therefore, roadside advertising should not be placed in locations where there are already a number of existing signs and distracting material visible to a driver. The subjective impression that the driving environment is already cluttered is likely to be a good indication that further signage should be avoided.

6.2.2 Driving Demand

Aspects of the driving environment other than visual clutter are likely to increase mental workload and decrease capacity to process task-irrelevant material such as roadside advertising. In particular, intersections, decision-making points and merge points are likely to be demanding of attention. This suggests that in these and similarly demanding driving environments roadside advertising should not be visible.

6.2.3 Content

The greater the quantity of information in an advertising display, the longer it will take to process and hence the longer a driver's eyes will be off the road. This suggests that the informational load of the advertising message should be minimised as much as possible so that the content can be processed as rapidly as possible. This will minimise the time during which drivers' eyes are off the road. Similarly, advertising messages should not be displayed to create a meaningful sequence across transitions as this is likely to create an excessive quantity of information to be processed. In addition it is undesirable for more than one sign to be visible at a time as this will also increase the amount of information to be processed.

6.3 Gaze Direction

Safe driving requires that drivers are looking in the appropriate direction to maximise their information gain about critical aspects of the driving environment. Clearly if they are looking in a direction that is well outside the visual envelope of normal driving-relevant information there is the risk that such relevant information will be missed. As a result it is important that roadside advertising that attracts attention is only located in positions which obviate this possibility.

This consideration suggests that roadside advertising is best located in the line of sight of the forward roadway, provided that it does not obscure or background critical other signage, signals or infrastructure. The following principles are suggested.

6.3.1 Offset

Roadside advertising should not be substantially offset from the travel lane it is desired to be viewed from as this could move gaze direction away from the forward roadway.

6.3.2 Elevation

Roadside advertising should not be elevated to the extent that it draws gaze away from the forward roadway.

6.4 Road Environment

A final consideration is the existing safety profile of the road environment in question. For example, a road with an existing high crash rate would probably be a poor choice for installation of roadside advertising. By the same token, a road rated as risky by any of the road assessment methods (e.g. AusRAP) would also be an environment in which roadside advertising probably should not be introduced. These considerations give rise to the following principles.

6.4.1 Crash Rate Assessment

Black spot locations should not be sites for roadside advertising, especially where crash types are likely to be exacerbated by distraction (e.g. rear end).

6.4.2 Risk Assessment

Roads assessed as having an unacceptable risk profile should not be sites for roadside advertising.

7 CURRENT GUIDELINES

A review of relevant documentation was undertaken to determine the current guidance provided by each state and territory road and/or planning authority, as well as the main industry representative in Australia, the Outdoor Media Association (OMA). A summary of the review, evaluated against sign design and sign placement criteria derived from the best practice principles outlined above, is provided in Table 7.2 and Table 7.3 with ratings assigned on the following basis:

Key:

✓ – criterion is given detailed coverage in relevant policy documents and guidelines, with quantitative permission thresholds provided if appropriate.

~ – criterion is referred to within relevant policy documents or guidelines, however guidance is highly subjective or non-definitive (i.e. tends to be qualitative).

X – criterion is not covered within relevant policy documents or guidelines. This may be because it relates to a certain type of advertising device (i.e. changeable) that is not permitted by the jurisdictions.

Table 7.1 outlines the key relevant guidance documents for each jurisdiction; further details of the reference sources for the information included in Table 7.2 and Table 7.3 are provided in the accompanying spreadsheet.

Table 7.1: Key jurisdiction and/or planning authority and industry guidance documents for roadside advertising

Jurisdiction	Organisation	Document title	Date
Queensland	Department of Transport and Main Roads (TMR)	Roadside Advertising Guide	2009
South Australia	Department for Transport, Energy and Infrastructure (DTEI)(1)	Roadside Advertising In Unincorporated Areas – Operational Instruction 19.6	2008
	Department for Transport, Energy and Infrastructure (DTEI)	Roadside Advertising In Unincorporated Areas – Operational Instruction 19.7	2008
Tasmania	Department of Infrastructure, Energy and Resources (DIER)	Tasmanian Roadside Signs Manual – Part G: Advertising and Commercial Signage	2006
	Department of Infrastructure, Energy and Resources (DIER)	DIER Policy Statement OPS22 – Electronic billboards on state roads	2007
Northern Territory	Department of Construction and Infrastructure (DCI)	Guidelines for Permanent Roadside Advertising Signs on Road Reserves	2010
Australian Capital Territory	Australian Capital Territory Government	Consolidated National Capital Plan	2009
	Australian Capital Territory Government	The Code of Practice for the placement of moveable signs in public places	2005
Victoria	Department of Planning and Community Development/VicRoads	Victoria Planning Provisions 1999: Advertising Signs Clauses 52.05 (VC49), 36.04 (VC 62) and 73 (VC37), and Amendment VC45	Various
	Review of VPP Advertising Sign Provisions Advisory Committee	Advisory Committee Reviewing Advertising Sign Provisions in Victoria Planning Schemes – Issues and Options Paper	2007

Jurisdiction	Organisation	Document title	Date
Western Australia	Main Roads Western Australia (MRWA)	Roadside Advertising Standard	2000 (updated 2007)
New South Wales	Department of Planning[2] – with input from Roads and Traffic Authority (RTA)[3]	Transport Corridor Outdoor Advertising and Signage Guidelines Assessing Development Applications Under SEPP 64	2007
	Roads and Traffic Authority (RTA)	Technical Direction: Use of Variable Message Signs (VMS) – RTA Policy. TDT 2010/07	2010
New Zealand	New Zealand Transport Agency (NZTA)	Traffic control devices manual – Part 3: Advertising signs	2011
	New Zealand Transport Agency (NZTA)	Leaflet – State highways – advertising signs	2011
	New Zealand Transport Agency (NZTA)	Advertising – 'how to' guide	2011
N/A	Outdoor Media Association	Discussion Paper - Digital billboards and road safety: An analysis of current policy and research findings	2010

1 Now Department of Planning, Transport and Infrastructure (DPTI).
2 Now Department of Planning and Infrastructure.
3 Now Roads and Maritime Services (RMS).

Table 7.2: Overview of jurisdiction and industry guidance for human factors criteria relating to sign design (as at July 2010)

Sign design criteria	Movement	Flashing lights	Dwell time	Transition time	Message sequencing	Quantity of information	Information presentation	Colour	Information content/meaning	Luminance	Dimensions
Description	Covers presence of motion in the advertisement, including video and special effects within a single display/message as well as transition, movement and rotation between successive displays.	Covers use of flashing, blinking, revolving, pulsating or intermittent lights.	Also referred to as the message display duration, message on-time or exposure time.	Interval between successive displays or message. Also referred to as message change time.	Covers use of a sequence of displays and messages as part of a single advertisement.	Includes message length, quantity of text or number of informational elements.	Covers format of information including font type, text size and spacing, layout and arrangement.	Covers use of colour in general or in relation to a specific area of sign.	Covers the content and meaning of the information contained within the message including textual and graphical elements.	Covers use of luminance (or referred to as illumination) and criteria relevant to retro-reflectivity and glare.	Includes size and shape of advertising device.
Refer to Section:	6.1.1	6.1.1	6.1.2	6.1.3	6.2.3	6.2.3	6.2.3	6.1.5	6.1.5	6.1.4	6.1, 6.2 and 6.3
Jurisdiction guidelines											
Queensland – DTMR	✓ Devices with changing illumination or variable messages are not permitted within the boundaries of state-controlled roads. These devices are not permitted to be visible from Motorways/Freeways or state-controlled roads with a speed limit of 80 km/h or more. Rotating devices are permitted only when movement is about a vertical axis and where the speed limit is less than 80 km/h.	✓ Advertising devices within and outside the boundaries of, but visible from, state-controlled roads shall not contain flashing red, blue or amber point light sources. The maximum flash rate permitted for devices visible from state-controlled roads in Lighting Environments Zones 1 and 2 (central city and suburban areas with high to moderate off-street ambient lighting levels) = 2 flashes/sec. Flashing lights are not permitted when visible from road in Lighting Environment Zone 3 (rural/residential areas with low off-street ambient lighting levels). Large free-standing billboards shall not contain flashing point light sources.	✓ For trivision, VMS and illuminated multi-advertisement scrolling signs, minimum dwell time = ≥ 8 secs. For large screen VMS or strip type 'text only' VMS – where a display is part of a sequential message set, minimum dwell time = 2.5 to 3.5 secs (for a corresponding message length of two to six familiar words).	✓ For trivision and illuminated multi-advertisement scrolling signs = ≤1 sec. For VMS or strip type 'text only' VMS = ≤ 0.1 sec. The complete screen display should change instantaneously.	✓ For VMS, sequential messages not recommended. For large screen VMS or strip type 'text only' VMS, the number of sequential messages that are part of a message set may range from one to a maximum of three. In locations with high traffic volumes or a high demand on driver concentration, the number of sequential messages should be limited to two.trivision	~ For large screen VMS or strip type 'text only' VMS, the number and complexity of words used in a message should be consistent with the display duration.	~ Requirements with regards to legibility are generally advisory – provides guidance based on application of Austroads methodology.	✓ Advertising devices should not be coloured like an official traffic sign. Where a VMS is used as a 'text only' display in a sequential message set, the background colour should be uniform, non-conspicuous in colour, and should not change across the sequential message set. Where background colours do not change between series of message sets, the end of a message should be denoted by a blank time of 1 sec. Where background colours change between series of message sets, the end of a message should be denoted by a blank time of 2 secs.	✓ An advertising device may be considered a traffic hazard if it imitates a traffic control device or if it gives instructions to traffic to 'stop', 'halt' or other (e.g. give way or merge). Advertising devices should be quickly and easily interpreted.	✓ Only static illuminated and non-illuminated devices are permitted within the boundaries of state-controlled roads. Advertising devices should not be illuminated like an official traffic sign. Maximum average luminance for devices on state-controlled roads for different lighting environments: ▪ Zone 1 (central city areas) = 500 cd/m^2 ▪ Zone 2 (suburban areas) = 350 cd/m^2 ▪ Zone 3 (rural/residential areas) = 300 cd/m^2 External illumination sources shall be shielded to ensure that external 'spot' light sources are not directed at approaching motorists. Any light source shall be shielded so that glare does not extend beyond the device. The supporting structure shall have a non-reflective finish to prevent glare. Devices containing retro-reflective material shall be rotated approximately five degrees away from the	✓ Advertising devices should not be shaped like an official traffic sign. Max. area of any face of a Category 1 Advertising Device = 43 m^2. For Category 3 advertising devices (passenger transport shelters and seats), the max. area of each device = 2.2 m^2. For Category 2 advertising devices (illuminated advertising panels above illuminated street name plates), the max. area of each face = 2.2 m^2. Devices attached to overhead transport infrastructure should be contained within the silhouette or major portion of structure. Signs within the boundaries of state-controlled roads may be limited to accepted industry standards.

Sign design criteria	Movement	Flashing lights	Dwell time	Transition time	Message sequencing	Quantity of information	Information presentation	Colour	Information content/meaning	Luminance	Dimensions
Queensland – DTMR (cont.)										normal line of vehicle headlight beams in order to minimise specular reflection.	
South Australia – DTEI[1] *(Note that criteria generally apply to advertising in incorporated areas only – advertising is not generally permitted in unincorporated areas. Advertising signs are generally not allowed on DTEI arterial roads and highways)*	X	✓ No advertising display shall be allowed to be placed or maintained if visible from the road and displaying any red or blinking or intermittent light likely to be mistaken for a warning or danger signal.	X	X	X	X	X	X	✓ No advertising display shall be allowed to be placed or maintained if imitating any directional, warning, regulatory or tourist sign, or any sign likely to be mistaken for any such permitted sign, or if likely to be construed as giving warning to traffic, such as by use of the words 'stop' or 'slow down'. Signs must be legible from an appropriate distance and designed and installed so that they may be identified and read by an approaching driver in advance to avoid driver distraction from their primary task of safely controlling the motor vehicle.	~ No advertising display shall be allowed to be placed or maintained if the illumination from the display is of such brilliance so positioned as to blind or dazzle the vision of travellers on the road.	X
Tasmania – DIER *(Note that criteria apply to temporary event advertising only as other sign types prohibited)*	✓ Electronic billboards are prohibited for advertising purposes.	✓ Flashing or animated signs, including those employing flashing lights, are prohibited.	X	X	X	X	~ The design and colouring of the sign must be simple and clear.	~ The sign must not conflict with the colour combinations of traffic signs.	~ The sign should not detract from the message of legitimate signs needed for the purposes of road safety, statutory control and guidance of road users. The message appearing on the signs must be clear and concise to ensure road users can interpret the message.	✓ Illuminated signs, or signs with retro-reflective materials, are prohibited.	✓ Maximum sign total area = 3.0 m^2. The sign must not conflict with the shape of traffic signs.

Sign design criteria	Movement	Flashing lights	Dwell time	Transition time	Message sequencing	Quantity of information	Information presentation	Colour	Information content/meaning	Luminance	Dimensions
Northern Territory – DCI *(Note that corporate 'product' advertising will not be approved on the road reserves, unless part of a tourist related sign)*	✓ Variable message displays and electronic signs will not be considered for private advertising purposes.	✓ Coloured or flashing lights may not be incorporated in any sign.	X	X	X	X	✓ Maximum height of lettering to be used in any worded legend is 130 mm, and the minimum height of lettering shall be 80 mm.	✓ The sign shall not be so designed as to bear resemblance to any traffic sign of a regulatory or warning nature. In particular, the colour scheme of black letters on a yellow background, red background with white or black lettering (similar to speed, stop, give way signs, and the like), shall not be used.	✓ For signs both within or visible from the NT Government road reserve, the sign shall not be so designed as to bear resemblance to any traffic sign of a regulatory or warning nature. Any symbols or wording that could be confused with or have a similar appearance to any regulatory or warning signs shall not be incorporated into any part of the sign or message.	~ If the sign face is manufactured partly or wholly with retro-reflective material, the design must be such that the night time appearance of the sign does not change significantly from the day time appearance. The back of the sign shall be a dull finish to prevent glare.	✓ The overall size of the freestanding sign shall not be in excess of 3.6 m wide by 1.8 m high.
Australian Capital Territory Government	✓ Animated signs generally not permitted (except within City Division).	✓ Flashing signs shall generally not be approved (except within City Division).	X	X	X	X	X	X	~ The Authority shall refuse to approve any sign which it considers offensive.	~ Signs illuminated by exposed lamps or neon tubes as distinct from backlighting or floodlighting, shall generally not be approved except where such signs are located on sites within the City Division. Advertising signs on bus shelters may be side illuminated. Illuminated signs attached to buildings must be located on ground storey level only. Advises that other sign types must not be highly reflective.	✓ Max.size of freestanding signs located on business leases and other locations is 3 m^2 to 6 m^2 depending on location (except billboards at Canberra Int. Airport). Advertising signs may be displayed on bus shelters subject to the sign dimensions not exceeding 1.5 m by 1 m. Canberra International Airport: Max. billboard advertising area = 12.66 m x 3.35 m Max.gantry advertising area = 22.8 m x 2.6 m.
Victoria – Dept. of Planning and Community Development/ VicRoads	✓ Policy that electronic variable message advertising signs should not display animated or moving images, but this can be overridden.	✓ Electronic variable message advertising signs with flashing or intermittent lights are viewed as a safety hazard.	✓ Any one display or set of graphics/text presented on electronic variable message advertising signs must remain static and unchanged for a minimum period of 30 secs.	X	X	X	X	✓ A sign is a safety hazard if the sign is likely to be mistaken for a traffic control device, because it contains red, green or yellow lighting, or has red circles, octagons, crosses, triangles or arrows.	~ A sign is a safety hazard if the sign could mislead drivers or be mistaken as an instruction to drivers.	✓ The luminance of electronic variable message advertising signs must be such that it does not give a veiling luminance to the driver of greater than 0.25 cd/m^2, throughout the driver's approach to the advertising sign.	~ A sign is a safety hazard if the sign could distract drivers due to its size.

Sign design criteria	Movement	Flashing lights	Dwell time	Transition time	Message sequencing	Quantity of information	Information presentation	Colour	Information content/meaning	Luminance	Dimensions
Western Australia – MRWA	✓ Advertising devices within the boundaries of state-controlled roads shall not include Moving, Rotating or Variable Message Advertising Devices (with the exception of Trivision Signs). Moving Advertising Devices situated in the vicinity of highways and main roads are only permitted when movement within the device is about a vertical axis or axes (i.e. where the Moving Advertising Device is a Rotating Advertising Device) and where the speed environment is 70 km/h or less. Variable Message Advertising Devices are subject to the movement within a Moving-Single Message Display not occurring for continuous periods greater than 1.5 sec.	✓ Flashing Illuminated Advertising Devices - the maximum flash rate permitted for devices visible from highways and main roads in Lighting Zone Environments 1 and 2 (city centre and suburban areas with high to moderate off-street ambient lighting levels) = 2 flashes/sec. Lighting Zone Environment 3 (rural/ residential area with low off-street ambient lighting levels) = 0 flashes/sec. The erection of Non-Static-Illuminated Advertising Devices within the boundaries of highways and main roads is prohibited, with the exception of Chasing Bulb and Scintillating Light Display Advertising Devices on premises adjacent to highways and main roads.	~ Trivision Signs erected within the boundaries of highways and main roads shall be controlled such that only a single display face should be viewed by motorists travelling at the nominated road speed environment.	✓ Variable Message Advertising Devices situated in the vicinity of a highways and main roads are subject to the Single Message Display being fully introduced within 1.5 secs.	✓ Variable Message Advertising Devices situated in the vicinity of highways and main roads are subject to continuing themes (a series of Single Message Displays, including Moving Single Message Displays, presented sequentially) being completed within 1.5 secs. Variable Message Advertising Devices situated in the vicinity of highways and main roads are subject to the movement of the content on one display not being, or not appearing to be, co-ordinated with the movement of the next display when a series of Moving Single Message Displays is presented sequentially. Election signs should be designed to display a whole message only. Signs which display segments of a whole message which are to be read sequentially in order to comprehend the whole message, are not permitted.	X	~ MRWA will consider general concepts in relation to legibility, including the relationship between legend height, sign content and speed environment (as discussed in NAASRA 1998 'Traffic Control Devices' document). Lettering used on banners should generally have a minimum height of 300 mm. Lettering less than 200 mm in height is unacceptable.	~ Colour combinations that could potentially result in an Advertising Device being mistaken for a traffic sign or a traffic control signal shall not be permitted.	✓ Considers a number of criteria relevant to message content (non-traffic focused). It is an offence to erect an advertising device that: ▪ is a false representation of, or a colourable imitation of, a traffic sign or traffic-control signal; ▪ not being a traffic sign, displays a word or direction ordinarily associated with a traffic sign.	✓ Max. average luminance for devices on state-controlled roads for different lighting environments: ▪ Zone 1 (central city areas) = 500 cd/m^2 ▪ Zone 2 (suburban areas) = 350 cd/m^2 ▪ Zone 3 (rural /residential areas) = 300 cd/m^2. External illumination sources shall be shielded to ensure that external 'spot' light sources are not directed at approaching motorists. The erection of Non-Static-Illuminated Advertising Devices within the boundaries of highways and main roads is prohibited, with the exception of Chasing Bulb and Scintillating Light Display Advertising Devices on premises adjacent to highways and main roads). Category 3 (local business and community signs) should be non-illuminated. Election signs should be non- illuminated and not incorporate reflective or fluorescent materials.	✓ The size and shape of Advertising Devices erected within highways and main roads is restricted to accepted industry standards (details provided). Device attached to overhead structures shall be contained within the silhouette of the major portion of the overhead structure. The maximum size of individual Advertising Devices attached to bus passenger shelters and roadside seats shall be approximately 1.5 m^2. No part of an Advertising Device attached to a bus passenger shelter shall project beyond the highest part of the roof or the walls of the structure. Category 3 devices (local business/ community advertising) must generally be less than 4.5 m^2 in size. Banners shall not be greater than 10 m or less than 7 m in length, and shall be 1 m in depth. Flags shall not be greater than 1.5 m in height, with a maximum length of 2 m with a minimum distance of 1 m to the nearest kerb when the flag is fully extended. Real estate signs must be less than 0.25 m^2 in size.

Sign design criteria	Movement	Flashing lights	Dwell time	Transition time	Message sequencing	Quantity of information	Information presentation	Colour	Information content/meaning	Luminance	Dimensions
New South Wales – Dept. of Planning RTA[2]	✓ VMS/moving signs that face the road reserve and are visible to drivers will only be approved if the display is completely static from its first appearance to the commencement of a change to another display. VMS will only be approved if the sign does not contain any scrolling messages (i.e. displayed text which moves up, down or across the screen so that a line of text or graphics appear at one edge of the screen for each line that moves off the opposite edge). Video and animated electronic signs, including any signs which contain any portion of video and/or animated content will not be approved if facing the road reserve and visible to drivers. According to the Safety Assessment Matrix for advertising on RTA infrastructure, a message is considered low risk (1–2 rating) if it is not animated/ changeable or remains static for at least 5 mins. It is considered medium risk (3) rating if the message stays static for less than 5 mins. Note: VMS not recommended for advertising in NSW.	✓ Flashing illumination will not be approved.	✓ Moving signs that face the road reserve and are visible to drivers will only be approved if the driver does not see more than one message in the period of exposure, under normal driving conditions.	✓ VMS will only be approved if the time to change the display is not greater than 1 sec. According to the Safety Assessment Matrix for advertising on RTA infrastructure (provides a 1–5 risk rating, where 5 is more risk), the grounds for immediate rejection of an advertising proposal are if the advertisement provides a moving message that takes longer than 4 secs to completely appear (risk rating 5). According to the Safety Assessment Matrix for advertising on RTA infrastructure, a message is considered low risk (1–2 rating) if it is not animated/ changeable or changes instantaneously. It is considered medium risk (3) rating if the message takes 1–2 secs to transition.	✓ The proposed advertising message should not spread the message across more than one adjoining sign.	✓ The amount of information supplied on a sign should be minimised so that the time required to read and understand the message is minimised. As a guide, each sign should be restricted to 6 units of information. The summation of units is to be calculated as follows: Words of up to 8 letters, inclusive = 1 unit, numbers up to 4 digits, inclusive = 0.5 unit, numbers of 5-8 digits = 1 unit, symbol/picture/logo or abbreviation = 0.5 unit.	✓ Advertisements should be legible. A clear font at least 150 mm high is advisable. According to the Safety Assessment Matrix for advertising on RTA infrastructure (provides a 1–5 risk rating, where 5 is more risk), the grounds for immediate rejection of an advertisement proposal are if the advertisement imitates the colour, shape and legend of a traffic control device (risk rating 4) and the layout as well (risk rating 5).	✓ Advertisements should not contain large areas of red display if they are to be illuminated. According to the Safety Assessment Matrix for advertising on RTA infrastructure (provides a 1–5 risk rating, where 5 is more risk), the grounds for immediate rejection of an advertisement proposal are if the advertisement imitates the colour, shape and legend of a traffic control device (risk rating 4) and the layout as well (risk rating 5).	✓ Advertisements must not imitate a traffic control device such as traffic lights. Advertisements must not instruct drivers to perform an action such as 'Stop', 'Halt' or 'Give Way'. Advertisements must not invite traffic to move contrary to any traffic control device, or turn where there is fast moving traffic. Advertisements should not contain messages that are distractive or otherwise inconsistent with road safety. According to the Safety Assessment Matrix for advertising on RTA infrastructure (provides a 1–5 risk rating, where 5 is more risk), the grounds for immediate rejection of an advertising proposal are if the sign instructs motorists to perform an action (3 risk rating), if it instructs motorists to perform an illegal action (4 risk rating) or if it instructs motorists to perform a dangerous or illegal action (5 risk rating). According to the Safety Assessment Matrix for advertising on RTA infrastructure (provides a 1–5 risk rating, where 5 is more risk), an advertisement with complex (i.e. not easily recognisable) static message and graphic may be immediately rejected (risk rating 4). The light sources for illuminated signs must focus solely on the sign and i) be shielded so that glare does not extend beyond the sign and ii) with the exception	✓ Guidelines include maximum allowable daytime luminance of illuminated advertisements categorised by illuminated area (m^2) and zone type (i.e. defined in relation to land use and ambient off-street lighting levels). ▪ No limit for Zones 1 (city centre areas) and 5 (train corridors). ▪ Range from 2900 cd/m^2 for an area up to 0.5 m to 2900 cd/m^2 for an area over 10 m in Zone 2 (major shopping/ commercial centres). ▪ Range from 2000 cd/m^2 for an area up to 0.5 m to 800 cd/m^2 for an area over 10 m in Zone 3 (medium shopping/ commercial centres). ▪ Range from 1000 cd/m^2 for an area up to 0.5 m to 400 cd/m^2 for an area over 10 m in Zone 4 (rural/residential). The maximum night-time luminance of signs must be 1/4 of the daytime prescribed values. For night time use, the sign (whether internally illuminated or lit from its exterior) must not cast a shadow on areas that were previously lit and that have a special lighting requirement, i.e. pedestrian crossings.	✓ Advertising on bridges must not exceed 42.4 m^2 in area. The actual sign dimensions should be determined by the design lines of the bridge and should not be dictated by industry standard (i.e. supersites – 12.66 m x 3.35 m). According to the Safety Assessment Matrix for advertising on RTA infrastructure (provides a 1–5 risk rating, where 5 is more risk), the grounds for immediate rejection of an advertisement proposal are if the advertisement imitates the colour, shape and legend of a traffic control device (risk rating 4) and the layout as well (risk rating 5).

Sign design criteria	Movement	Flashing lights	Dwell time	Transition time	Message sequencing	Quantity of information	Information presentation	Colour	Information content/meaning	Luminance	Dimensions
New South Wales – Dept. of Planning RTA[2] (cont.)									of back lit neon signs, have no light source visible to passing motorists with a light output greater than that of a 65 W incandescent bulb. The level of reflectance of an advertisement and its content is not to exceed the Minimum Coefficients of Luminous intensity per unit area for Class 2A Material (Australian Standard AS/NZS 1906:1:2007). Advertisements must not contain reflectors, which at night could be mistaken for a traffic control device. According to the Safety Assessment Matrix for advertising on RTA infrastructure (provides a 1–5 risk rating, where 5 is more risk), the grounds for immediate rejection are if the sign does not vary to match the ambient light and may cause discomfort or temporary night blindness.		

Sign design criteria	Movement	Flashing lights	Dwell time	Transition time	Message sequencing	Quantity of information	Information presentation	Colour	Information content/meaning	Luminance	Dimensions
New Zealand – NZTA	✓ Animated or flashing signs should not be used as roadside advertising if they: ▪ incorporate a revolving light of any colour ▪ rotate as a whole about any axis other than a vertical one. Proposals to install variable message signs should be carefully assessed where each separate display is not static from first appearance to replacement.	✓ Animated or flashing signs should not be used as roadside advertising if they incorporate a revolving light of any colour. Advertising signs which move or give the appearance of motion (e.g. by use of sequentially flashing lights) 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 as stated in clause 8.5 of the Road User Rule 2004.	✓ Proposals to erect variable message signs should be carefully assessed where the minimum time for any separate display is less than 5 secs.	✓ Proposals to erect variable message signs should be carefully assessed where the time to change from one display to the next is greater than 2 secs.	X	✓ 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.	✓ Signs should have a minimum lettering height of 120 mm where the speed limit is lower than 70 km/h, or 160 mm where the speed limit is 70 km/h or higher. Guidance provided on use of fonts i.e. Helvetica and Transport Medium considered good examples. Atlas and Baroque script are considered undesirable. Also discusses letter hierarchy, sign background and message contrast. Suggest the message on a sign should take up no more than 40% of the total sign area in commercial or industrial areas where there other competing signs, and 60% in rural / residential areas with few other signs.	✓ An advertising sign or device should not be displayed or constructed where visible from a roadway if it: ▪ is coloured red, green, orange, white or yellow in combinations of colours and/or shapes which may be mistaken for a traffic control device ▪ has red, green, orange, white or yellow in isolation or in combinations of colours and in a location where it is likely to form the foreground or background to or appear alongside a traffic control device of similar colour when viewed by approaching motorists ▪ contains large areas of red, green or orange display on illuminated signs which at night are likely to cause confusion with traffic control signals or stop or tail lights of vehicles.	✓ Advertising signs should not: ▪ imitate traffic signs ▪ give instructions to motorists that conflict with any traffic sign or traffic control device ▪ compete with existing direction signs ▪ in the case of a sign inviting motorists to turn, be located so close to the turning point that motorists have insufficient time to read the sign, signal and turn safely.	✓ All portable roadside advertising devices (including sandwich boards, vehicle-mounted signs, flags, banners and spinner) should not have any form of illumination or reflectorisation. Any advertising signs or devices which are internally or externally illuminated should: ▪ comply with the maximum luminances 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 W incandescent bulb. Maximum luminance of illuminated advertising devices (based on guidance from UK Institution of Lighting Engineers) – In areas with street lighting, the maximum luminance varies from 2000 cd/m^2 for illuminated areas up to 0.5 m2 to 800 cd/m^2 for areas over 10.0 m^2. In areas without street lighting, the maximum luminance varies from 1000 cd/m^2 for illuminated areas up to 0.5 m^2 to 400 cd/m^2 for areas over 10.0 m^2.	✓ State highway guidelines state that billboards must not be more than 6 m wide or 3 m high.

Sign design criteria	Movement	Flashing lights	Dwell time	Transition time	Message sequencing	Quantity of information	Information presentation	Colour	Information content/meaning	Luminance	Dimensions
OMA Recommendations (Refers to digital billboards only)	✓ Both static and animated digital billboards shall be considered for planning permits on their individual merits. Digital billboards shall contain a default design that will freeze the device in one position if a malfunction occurs.	X	✓ Each message shall remain fixed for a maximum of 8 secs, with 5–7 secs being the recommended dwell time depending on the sign's location (for example, signs with a dwell time of 5 secs would be appropriate in lower speed commercial environments, whereas 7 secs would be more appropriate on freeways and motorways).	✓ The transition time between messages shall be no longer than 1 sec to reduce the likelihood of a driver perceiving any blanking of the display screen.	✓ No message sequencing is permitted between two or more advertising copies on the same digital billboard.	X	~ 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.	✓ 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.	X	~ 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.	X

Sign design criteria	Movement	Flashing lights	Dwell time	Transition time	Message sequencing	Quantity of information	Information presentation	Colour	Information content/meaning	Luminance	Dimensions
SUMMARY	There is considerable variation in the policies of agency towards the approval of advertising devices which contain movement. Some jurisdictions have a complete ban on electronic billboards and VMS that are located within (or visible from) state-controlled roads. Some jurisdictions allow the latter devices but require that there is no animation or dynamic images (i.e. the message remains static until display of the next message). Queensland and Western Australia do not permit VMS or changeable signs within the boundaries of state-controlled roads, and only allow them to be visible from such roads where the speed limit is below 80 or 70 km/h respectively. These states do permit rotating devices within the boundaries of state-controlled roads provided they meet certain criteria.	All but two jurisdictions will not approve the use of flashing lights on advertising devices on or within visibility of state-controlled roads. In Queensland and Western Australia, flashing lights may be approved provided they meet specific criteria. This may include the colour of the lamps, the rate of flashing, the location of the sign relative to road speed and land use or the type of sign. The proposed acceptable rate of flashing is identical for both jurisdictions – two flashes per second in environments with high to moderate off-street ambient lighting levels, and zero flashes per second for environments with low off-street ambient lighting levels.	This criterion is not always covered in the guidance, presumably because some jurisdictions do not generally approve advertising devices that contain movement or changeable messages. Three jurisdictions indicate required or advisory minimum dwell times, ranging from 2.5 to 30 secs (also depending on sign type). The OMA recommends that the maximum dwell time for digital billboards should be 8 secs, with reduced times for lower speed environments. Two other jurisdictions require that the driver does not see more than one message in the period of exposure, under normal driving conditions.	This criterion is not always covered in the guidance, presumably because some jurisdictions do not generally approve advertising devices that contain movement or changeable messages. Four jurisdictions provided quantitative guidance on maximum transition times. Required times range from 0.1 to 4 seconds. Times are sometimes dependent on whether the device has an electronic display or is mechanically changed. The OMA recommends that the transition time for digital billboards should be under 1 second. Queensland advises that for electronic devices, the screen should change instantaneously.	This criterion is not always covered in the guidance, presumably because some jurisdictions do not generally approve advertising devices that contain movement or changeable messages. Where referenced, the general approach is that sequential messaging is not recommended or prohibited. Queensland and Western Australia provide more detailed guidance, with Queensland specifying that a maximum number of 3 sequential messages are permitted on VMS, or 2 in higher trafficked locations.	The majority of jurisdictions do not refer to this criterion explicitly. Only New South Wales and New Zealand provide quantitative restrictions on the number of information elements or words/symbols.	Legibility is recognised by over half of the jurisdictions as being significant for road safety. Four jurisdictions provide specific guidance on requirements for the presentation and format of information within the message. This mainly focuses on the minimum letter heights, which ranges from 80 mm to 200 m (also depending on sign type). New Zealand provides further guidance, for example, on appropriate fonts.	The large majority of jurisdictions will not approve advertising devices with a message that is coloured in such a way that they may be confused with an official traffic sign or signal. Queensland also provides guidance on requirements for background colouring of text-only VMS.	Nearly all jurisdictions will not allow advertising devices with a message that imitates a traffic control device, traffic sign or any other advisory or regulatory sign permitted by the road authority. For example, many jurisdictions require that the message does not provide instruction to drivers.	All jurisdictions refer to luminance/illumination in their guidance. A few jurisdictions have a ban on illuminated messages for specific types of advertising device. Some jurisdictions will not approve non-static illuminated devices within the boundaries of state roads. Four jurisdictions have provided quantitative guidance on permitted maximum luminance levels for zones with different ambient light conditions; the most stringent of these are in Queensland and Western Australia, where the maximum permitted luminance ranges from 300 to 500 cd/m^2 depending on the surrounding land use. Some jurisdictions also provide additional guidance on other relevant aspects such as veiling luminance and glare.	Many jurisdictions require that advertising areas and device dimensions are aligned with industry standards. It is also required that devices do not imitate the shape of a traffic control device or sign. The majority of jurisdictions provide specific guidance on acceptable dimensions and areas across different types of advertising device.

1 Now Department of Planning, Transport and Infrastructure (DPTI):
2 Now Roads and Maritime Services (RMS).

Table 7.3: Overview of jurisdiction and industry guidance for human factors criteria relating to sign placement (as at July 2010)

Sign placement criteria	Longitudinal placement	Lateral placement	Vertical placement	Orientation/viewing angle	Sight distance/visibility	Speed limit/speed environment	Other
Description	Covers restriction distances in relation to traffic control devices and driver decision and action points, as well as advertising device density constraints.	Covers location relative to edge of carriageway and off-set back from kerb etc.	Covers both maximum height of sign and overhead placement.	Includes requirements for rotation relative to the carriageway geometry and/or passing vehicles.	Covers restrictions in relation to sight distances and visibility of the advertising device as well as for other features of the roadside environment, including official traffic signs and control devices.	Covers restrictions on placement of certain types of advertising signs relative to speed limit or speed environment of road. The speed environment provides an indication of the operating speed of the road and is generally defined as the 85th percentile speed.	Any other relevant criteria, for example, restrictions in relation to surrounding land use and roadway geometry or criteria for vehicle-mounted advertising and double-sided signs.
Refer to section:	6.2.1 and 6.2.2	6.3.1	6.3.2	6.3.1	6.2 and 6.3	6.4	N/A
State guidelines							
Queensland – TMR	✓ An Advertising Device may be considered a traffic hazard if it: ▪ is in an area where there are several devices and the cumulative effect of those devices may be potentially hazardous ▪ it interferes with the effectiveness of a traffic control device (e.g. traffic light, stop or give way sign) ▪ distracts a driver at a critical time (e.g. making a decision at an intersection). Appendix C – specifies Advertising Device restriction distances relative to designated traffic situations for devices located on state-controlled roads and devices beyond the boundary of, but visible from, state-controlled roads. This includes minimum distances between the device and traffic conflict points, official traffic signs and other advertising devices. States that further restrictions may apply where traffic conditions require additional driver attention and decision making, such as sections of road that have a vehicle crash history higher than the system average. Restriction distances for devices located within the boundaries of state-controlled roads (excluding freeways/motorways, only non-rotating, non-illuminated/static illuminated devices permitted) range from 60 m to 140 m depending on the speed environment.	✓ An advertising device may be considered a traffic hazard if it is a dangerous obstruction to road or other infrastructure, traffic, pedestrians, cyclists or other road users. For advertising devices located within the boundaries of state-controlled roads (except where road reserves are very narrow), lateral placement of the device is restricted to locations outside of the Clear Zone (defined in Appendix B of the guidance). The Clear Zone is defined as the total roadside border area, starting at the edge of the travelled way, available for safe use by errant vehicles and for the display of official traffic signs. Queensland has adopted the AASHTO 1996 Roadside Design Guide as the primary reference. Example calculations: Clear Zone for straight roads with flat roadsides is 4.5 m for 60 km/h speed environments, 6 m for 80 km/h speed environments and 9 m for 100 km/h speed environments. Clear Zone requirements do not apply to devices attached to transport infrastructure including passenger transport shelters and seats and pedestrian overbridges. On roads where the overhead transport structure (e.g. road overpass or pedestrian/bicycle bridge) and the road ‘intersect’ at right angles, the advertising	✓ The minimum clearance beneath a device located on an awning within a state-controlled road is 2.5 m Maximum heights: 6 sheet poster = 5 m 12 sheet poster = 9 m supersite = 10 m (except where device is located in a depression). Maximum height of a device located on an awning within a state-controlled road reserve is 1 m (with 2.5 m clearance). The maximum height of a footway sign is 1 m.	✓ Devices containing retro-reflective material shall be rotated approximately 5° away from the normal line of vehicle headlight beams in order to minimise specular reflection.	✓ An advertising device may be considered a traffic hazard if it obscures a driver’s view of a road hazard (e.g. at corners or bends in the road). Devices should not obstruct or distract a driver’s line of sight of official traffic signs, exit ramps, on-ramps, intersections or other decision-making areas. Variable message advertising devices shall only be installed where: ▪ the required sign viewing time does not result in a safety problem for the particular environment; and ▪ there is adequate advance visibility to read the sign. The approach end of a passenger transport shelter shall be either open or transparent to provide waiting passengers with maximum visibility of the approaching passenger transport vehicle.	✓ Devices with changing illumination, variable messages or rotating/changing movement (i.e. Trivision) are not permitted to be located on, or visible from, state-controlled roads with speed limits 80 km/h or above (including motorways/freeways). Advertising devices that change, move or rotate (including Trivision advertising devices) are only permitted on private property and visible from a state-controlled road with a speed limit of less than 80 km/h. VMS advertising devices are only permitted on private property and visible from a state-controlled road with a speed limit of less than 80 km/h. Rotating devices should be permitted only when movement is about a vertical axis and where the speed environment is 80 km/h or less. Non-rotating, static illuminated advertising devices shall only be permitted on bus shelters located in built-up areas with speed environments of 80 km/h or lower. Advertising on bus shelters is not permitted on motorways or freeways.	Official road furniture such as official signs and delineator guide posts shall not be used as the supporting structure of an advertising device without prior written permission. Variable message advertising devices should only be installed where the device is not a moving advertising device. On-vehicle advertising for roadside vending shall be directed only toward oncoming vehicles on the same side of the road as the vendor. An approval for vehicle-mounted advertising for a roadside vending site does not imply that this advertising would be permitted when the vehicle was driven on any road. There are certain areas where advertising may be inappropriate due to the nature of the surrounding area. For example, advertising is generally not permitted within the boundaries of state-controlled roads in national parks or other protected areas.

Sign placement criteria	Longitudinal placement	Lateral placement	Vertical placement	Orientation/viewing angle	Sight distance/visibility	Speed limit/speed environment	Other
Queensland – TMR (cont.)	Restriction distances for devices beyond the boundaries of but visible from state-controlled roads (excluding freeways/motorways) vary between 60 m and 160 m depending on the sign type, characteristics such as size and speed environment. For example, restriction distances for variable message signs are 120 m for signs over 20 m^2 and 80 m for signs under 20 m^2 for locations where the speed limit is less than 80 km/h and with a dwell time of greater than or equal to 8 seconds. Advertising device longitudinal exclusion zones are also detailed for motorways/freeways (in some cases based on the methodology outlined in the Austroads Guide to Traffic Engineering). Exclusion zone relative to official traffic signs = 1.2 V / 2.5 V (where v = speed). Advance/downstream separation distance from motorway exit ramp = 7.5 V / 2.5 V. Advance / downstream separation distance from motorway on-ramp = 5 V / 2.5 V. Longitudinal separation distance from other advertising devices on motorways = 2.5 V / 10V. Maximum of two Advertising Devices (faces) are permitted to be attached to, or form part of, a passenger transport shelter.	device may only be installed directly above the traffic at which the advertising device is directed. In situations where the overhead transport structure of the traversed road is curved or does not 'intersect' at right angles, the position of the installation shall be determined by the Department. Advertising is not permitted in the medians or traffic islands (unless the carriageways diverge significantly as a result of topography or dense vegetation). For Category 4 (miscellaneous including local business / community signs), no portion of an advertising device should project over the carriageway or over any surface used by motor vehicles (taking cross-fall into account).					
South Australia – DTEI[1] *(Note that guidelines generally apply to advertising in incorporated areas only – advertising is not generally permitted in unincorporated areas)*	~ No advertising display shall be allowed to be placed or maintained if the displays which are placed interfere with the effectiveness of, or obscure any official traffic control sign, device or signal. Internally illuminated signs should not be immediately behind or alongside traffic signals in such a way as to diminish the target value of the signals for drivers (see Operational Instruction 2.19).	~ The display shall not infringe upon the recommended clear zone for errant vehicles. [Note: *no definition or method of determining clear zone is provided in the guidance document*].	X	X	~ No advertising display shall be allowed to be placed or maintained if the display obstructs, or interferes, with the drivers vision in approaching, merging or intersecting traffic. No advertising display shall be allowed to be placed or maintained if the displays which are placed interfere with the effectiveness of, or obscure any official traffic control sign, device or signal. An advertising display can be removed under Section 41 of the Highways Act if the advertising display restricts drivers' sight distance, or completely obscures any DTEI sign.	~ Advertising displays placed within the 100–80–60 km/h buffer zones on the approaches to towns should be actively discouraged as drivers may not notice the lower speed signs due to the large number of signs competing for drivers' attention. Advertising signs are generally not allowed on DTEI arterial roads and highways.	The display shall not be placed on the same post as a DTEI traffic control sign. No advertising display shall be allowed to be placed or maintained if visible from the road and which is placed upon trees, or painted or drawn upon rocks or other natural features.

Sign placement criteria	Longitudinal placement	Lateral placement	Vertical placement	Orientation/viewing angle	Sight distance/visibility	Speed limit/speed environment	Other
Tasmania – DIER *(Note criteria apply to temporary event advertising only as other types banned on state roads)*	~ The consenting authority must give consideration to the number of competing signs in the area. The sign should not obstruct or form a confusing background to traffic signs or signals.	✓ Sites for the location of temporary event signs should be chosen so that the sign is no closer than 1 m from the outside edge of the gravel shoulder or 3 m from the sealed road surface, whichever is greater.	X	✓ The sign shall be erected at right angles to the roadway but angled off the direction of the traffic by approximately 5° to reduce headlight glare reflecting back into the motorist's vision.	~ The sign should not obstruct a driver's or pedestrian's view of the road or of other road users. The sign should not obstruct or form a confusing background to traffic signs or signals.	✓ Advertising signs are not permitted on a State or Local Government Road reserve subject to a speed limit in excess of 60 km/h.	
Northern Territory – DCI *(Note that corporate 'product' advertising will not be approved on state road reserves, unless part of a tourist related sign)*	✓ Signs shall not be erected so as to obscure or interfere with any guide sign, information sign, service sign or regulatory sign. No signs may be erected within a radius of 150 m of any intersection of public roads, railway crossing or school. Signs shall not be erected on any section of road for which signs have been erected to warn motorists of potential hazards in such locations so as to detract from the effectiveness of the warning signs, e.g. near sharp curves or narrow bridges.	✓ Reduce likelihood of advertising devices creating obstacles by maintaining adequate lateral clearance between the through traffic lanes and the advertising device, other than portable roadside advertising. 'Adequate lateral clearance' can generally be taken to mean: ▪ more than 1.5 m from the vehicle carriageway on roads with operating speeds of 60 km/h or less ▪ more than 3 m from the vehicle carriageway on roads with operating speeds greater than 60 km/h. Signs may not be erected within 10 m of the edge of the nearest travelled lane of a sealed roadway, nor within 15 m of the centre line of an unsealed roadway.	✓ The overall size of freestanding signs shall not be in excess of 1.8 m high.	✓ Proposed signs shall be orientated at right angles to and facing the oncoming traffic. If the sign face is manufactured partly or wholly with retro-reflective material, a 5° deflection away from the normal is required to eliminate reflection from car headlights.	~ Signs shall not be erected so as to obscure or interfere with any guide sign, information sign, service sign or regulatory sign.	~ Private advertising signs will not be permitted on defined urban roads, and only on rural roads in accordance with the conditions established in the guidelines. Defined urban roads includes roads adjoining urban development in minor urban centres, and on approach roads with designated town speed zones.	Private advertising signs will not be permitted on defined urban roads, and only on rural roads in accordance with the conditions established in the guidelines. Defined urban roads includes roads designated within and adjacent to major urban municipalities: a. Darwin and Palmerston b. Katherine c. Tennant Creek d. Alice Springs Signs to be located clear of vegetation and be clearly visible under headlight illumination. In general, double-sided signs are not permitted. However, consideration will be given to individual cases where double-sided signs may be of significant advantage to the traveling public and/or are proposed in lieu of two separate locations.
Australian Capital Territory Government *(Note that only applies to specific sign types advertising local events, real estate or government agency flags/banners, as other commercial roadside signs are not permitted in road reserves)*	✓ Freestanding signs may be approved on business leases and on sites for recreational, institutional, educational or other similar purposes provided that unnecessary repetition or multiplicity is avoided – one freestanding sign per site permitted. One advertising sign permitted per bus shelter. Real estate roadside signs and community roadside signs must be located further than 20 m from a road intersection. Moveable signs may be placed on unleashed Territory Land subject to them not being placed: ▪ on roundabouts ▪ within 20 m of traffic lights ▪ within 20 m of the apex of the kerb lines at an intersection (real estate directional signs exempt) ▪ traffic lights or street lights.	✓ The placement of moveable signs must be a minimum of 1.2 m back from the the street kerb to allow persons free access when alighting from a vehicle. In commercial areas, pedestrians must have access to a minimum of a 2.5 m wide walkway free of moveable signs or other obstructions, in addition to the 1.2 m back from the top of the street kerb. The walkway should allow pedestrians to walk either in a straight line or in a line which follows the street contour. Generally, devices are not permitted in the median of the road reserve. Moveable signs must not encroach on to or cause an obstruction on pedestrian or bicycle footpaths.	✓ Freestanding signs may be approved on business leases provided maximum height is 4 m (residential neighbourhoods) and 6 m in other locations. Freestanding signs may be approved on sites for recreational, institutional, educational and other similar purposes provided maximum height is 4 m.	X	X	X	Billboards are not permitted on unleased land in the Designated Areas. Many sign types are banned from Main Avenues and Approach Routes. Advertising signs displayed on bus shelters are not permitted in ANZAC Parade or on bus shelters in Commonwealth, Kings and Constitution Avenues or the area bounded by these Avenues. Moveable business signs must not be placed outside of the boundaries of the commercial or industrial centre in which the business is operating.

Sign placement criteria	Longitudinal placement	Lateral placement	Vertical placement	Orientation/viewing angle	Sight distance/visibility	Speed limit/speed environment	Other
Victoria – Dept. of Planning & Community Development/ VicRoads	✓ A sign is a safety hazard if the sign is at a location where particular concentration is required, such as a high pedestrian volume intersection. A sign is a safety hazard if the sign is within 100 m of a rural railway crossing. A sign is a safety hazard if the sign invites drivers to turn where there is fast moving traffic or the sign is so close to the turning point that there is no time to signal and turn safely. In business, office and industrial areas (sign Categories 1 and 2) internally illuminated signs are only permitted if the sign is more than 30 m from a residential zone or pedestrian or traffic lights.	~ A sign is a safety hazard if the sign has insufficient clearance from vehicles on the carriageway.	✓ For Categories 1 and 2 (advertising devices in business areas / office and industrial areas), internally illuminated signs are only permitted without a permit if no part of a sign is above a veranda or, if on veranda, more than 3.7 m above pavement level.	X	✓ A sign is a safety hazard if the sign obstructs a driver's view of a traffic control device, or is likely to create a confusing or dominating background which might reduce the clarity or effectiveness of a traffic control device. A sign is a safety hazard if the sign obstructs a driver's line of sight at an intersection, curve or point of egress from an adjacent property.	✓ Electronic variable advertising messaging signs must not be located near, or be visible from, a freeway environment.	A sign is a safety hazard if the sign requires close study from a moving or stationary vehicle in a location where the vehicle would be unprotected from passing traffic. Major promotion signs are discouraged along forest and tourist roads, scenic routes, landscaped sections of freeways, within open space reserves or corridors and around waterways. Major promotion signs are discouraged where they will form a dominant visual element from residential areas, within a heritage place or where they will obstruct significant viewlines.
Western Australia – MRWA	✓ It is important that drivers are not distracted in the proximity of designated traffic situations, to allow concentration to be focussed on the driving task. A designated traffic situation includes areas in which merging, diverging and weaving traffic manoeuvres take place, 'unsignalised' railway level crossings, road intersections and driver decision areas in the vicinity of an 'important' traffic sign or a traffic control signal. Australian Standard AS 1742.2 - 1994 Manual of Uniform Traffic Control Devices has been adopted as the primary reference for the determination of the longitudinal placement of signs located within the vicinity of a highway or main road. The minimum spacing of at least 1.2 Vm should be applied to the distances from designated traffic situations and a traffic sign or a traffic control signal and to other Advertising Devices, which are specified in this Guide. Device restriction distances for devices located on highways and main roads are outlined in Appendix C. These distances are the absolute minimum and requirements may be greater at locations where longer traffic queues occur, or where the proposed device obstructs sight lines at an intersection or zebra crossing. The minimum distances for devices located on a highway or main road range from 80 m in a 60 km/h speed	✓ Lateral placement controls apply to large freestanding advertising devices within the boundaries of state-controlled roads and are in the form of a Clear Zone. The Clear Zone is the total roadside border, starting at the edge of the travelled way, available for use by errant vehicles and for the display of official traffic signs. Appendix B of the guidance describes the method of determining the width of the Clear Zone. It is based on a concept outlined in the AASHTO 1989 document titled 'Roadside Design Guide', and adapted to align with typical Australian practice. Example calculations: For straight roads with flat roadsides, the Clear Zone is 4.5 m, 6 m, 9 m and 11 m wide for speed environments of 60, 80, 100 and 110 km/h respectively. Clear zone requirements do not apply for devices attached to transport infrastructure such as bus passenger shelters and seats, overhead road bridges and pedestrian overbridges. Advertising devices, other than flags and vertical banners, will not be permitted within medians less than 50 m wide. Where the median is 50 m or greater in width, the carriageways carrying opposing traffic will be considered as separate roads.	✓ The minimum clearance beneath category 1 devices (billboards and trivision signs) is 2.2 m, except where the structure overhangs a footway, in which case a minimum clearance of 2.5 m shall apply. Category 2 devices (static-illuminated devices on street name posts only): (a) The maximum height of the device including all attachments shall be 6.2 m. (b) The minimum clearance beneath the device (including the street name portion of the sign) shall be 2.2 m except where the device is over a footway when the minimum clearance shall be 2. 5m. Category 3 devices (small devices intended for local business and local community advertising): (a) The minimum clearance beneath overhead devices shall be 2.2 m except where the structure overhangs a footway the minimum clearance shall be 2.5 m. (b) No portion of a device shall project over the carriageway or any surface used by road vehicles except that the minimum vertical clearance between a horizontal banner and the roadway below shall be 5.4 m.	✓ Devices containing retro-reflective material shall be rotated approximately 5% away from the normal to the alignment of the vehicle headlight beams in order to eliminate specular reflection.	✓ Sightline assessment procedures have been established to ensure that advertising signs: a) are offset far enough from the driver's sightline to give the driver a clear view of traffic control devices b) do not form a confusing background to traffic control devices c) do not obstruct sightlines of drivers entering or exiting a highway or main road from a side road or driveway. Appendix G describes the sightline assessment procedure to be followed for (a) and (b) above where an advertising device is located near a traffic control device in the following cases: Case 1 – At an intersection Case 2 – Between intersections Case 3 – Near a railway level crossing with boom gates Case 4 – Near a railway level crossing without boom gates. The guidelines also describe the sightline assessment procedure to be followed for (c) above to ensure that an advertising sign which is located at or near an intersection, driveway, median opening or, the exit point of a parking bay, information bay or rest area does not obstruct the sightline of drivers on the side road or driveway to other vehicles travelling on a highway or main road in the following cases: Case 5 – Entering or exiting a highway or main road from a side road or	✓ VMS and moving advertising devices situated in the vicinity of highways and main roads are only permitted when movement within the device is about a vertical axis or axes (i.e. where the Moving Advertising Device is a Rotating Advertising Device) and where the speed environment is 70 km/h or less. Non-Rotating and Static-Illuminated Advertising Devices shall only be permitted on shelters located in built-up areas with speed environments less than or equal to 80 km/h. Category 3 advertising devices (small devices intended for local business and local community advertising) shall not be allowed on freeways and future freeways unless specifically permitted. Devices beyond the boundaries of, but visible from, Kwinana and Mitchell Freeways, Reid, Roe and Tonkin Highways and Great Eastern Highway Bypass and also future freeways and roads of a similar nature are limited to Non-Rotating Static-Illuminated, Non-Rotating Non-Illuminated and Trivision Sign formats only.	Category 1 signs (billboards and trivision signs) can only be placed on declared highways and main roads in accordance with the schedule of permitted roads at Appendix H. Category 3 devices (static illuminated street name signs) shall be permitted at illuminated intersections only. They shall be erected as near as is practical to the intersection. They shall generally only be permitted to be installed on the verge of the road or on medians 40 m or greater in width. Devices shall not be permitted on traffic islands or on roundabouts. Category 3 devices (small local business and community signs) located outside of the Metropolitan region will : a) only be considered within a 5 km radius of rural towns and settlements. Outside the 5 km radius of each rural town, advertising will only be permitted for a local business on a highway or main road adjacent to that local business b) be permitted on a main road or highway if the business is on a road adjoining a main road or a highway, as long as the business is within a 10 km radius of the proposed advertising device c) be permitted within the road reserve if signing attached to property cannot be seen by passing motorists. One sign can also be installed on each approach to the business subject to agreement of both the owner and the lessee of any

Sign placement criteria	Longitudinal placement	Lateral placement	Vertical placement	Orientation/viewing angle	Sight distance/visibility	Speed limit/speed environment	Other
Western Australia – MRWA (cont.)	environment to 140 m in >100 km/h speed environment. In a 80km/h speed environment, the restriction distance is 100 m. The device restriction distance for devices located in the vicinity of highways and main roads ranges between 80 m and 140 m depending on the device characteristics and speed environment. Large freestanding billboards and trivision signs shall be longitudinally separated from other Advertising Devices within the boundaries of highways and main roads at Main Roads discretion. Typical controls include limitation of the spacing (density) as follows: ▪ Devices > 10 m^2 shall be located so that only one single device is visible at any one time. ▪ Devices having an area of 4.5 to 10 m^2 shall be located no closer than 500 m apart. ▪ Devices must also be clear of locations where drivers have to make decisions such as on and off-ramps, merging areas, where the number of lanes increases or decreases or in lane-changing areas. ▪ Category 1 signs (large freestanding devices and devices attached to bridges are not permitted within 500 m of the start or finish of a merging zone. ▪ Overhead bridges under Main Roads control by a distance of not less than 500 m. ▪ Planned road improvements such as proposed on and off ramps to and from future interchanges. ▪ All adjacent Category 2, 3 and 4 advertising devices and traffic control devices by a distance of at least 2.5 Vm.				driveway. Case 6 – Exiting side road driveways close to intersections on highways and main roads. In general, the advertising sign is acceptable if it is at or beyond the end of the appropriate extended sightline.		business fronting the sign installation, being obtained in writing;

Sign placement criteria	Longitudinal placement	Lateral placement	Vertical placement	Orientation/viewing angle	Sight distance/visibility	Speed limit/speed environment	Other
New South Wales – Dept. of Planning/RTA[2]	✓ Multiple advertisement signs in rural or natural areas or along freeways or tollways adversely impacts on visual amenity and road safety. The overall number of signs placed along a transport corridor should be minimised preferably with only one advertising sign visible in a given view. In assessing advertising proposals, the consent authority is to have regard to: (a) Multiple advertisements on a single block of land, structure or building should be discouraged as they contribute to visual clutter. (b) Where there is advertising clutter, consideration should be given to reducing the overall number of individual advertisements on a site. Replacement of many small signs with a larger single sign is encouraged if the overall advertising display area is not increased. (c) In rural areas, and along freeways and tollways, no more than one advertising structure should be visible along a given sightline. An advertising proposal may be considered a traffic hazard if it interferes with the effectiveness of a traffic control device, or if it distracts the driver at a critical time. According to the Safety Assessment Matrix for signs on RTA infrastructure, (provides a 1-5 risk rating, where 5 is more risk), the grounds for immediate rejection of an advertising proposal are if the sign is located less than 100 m upstream from a decision point (4 risk rating) or if the sign is located at a significant decision/manoeuvre point (5 risk rating). Furthermore, a proposal can be rejected if it may/does reduce the effectiveness of a class #2 or #3 traffic control device.	✓ The advertisement must not create a physical obstruction or hazard to road users or vehicles. The location of a sign on footpaths or nature strips must meet the following criteria to ensure adequate clearance for pedestrian and wheel chair access: ▪ A sign must be positioned so that an absolute minimum envelope of 0.9 m x 2 m of unobstructed clear path of travel is maintained for the entire length of the advertising structure. ▪ Where the sign supports are not frangible (breakable) the sign must be placed outside the clear zone as defined in Section 3.7 of the RTA's Road Design Guide (2011) or behind an RTA-approved crash barrier. Clear Zone is defined as the total roadside border area, starting at the edge of the travelled way, available for use by errant vehicles and the display of traffic control signs. ▪ Where a sign is proposed within the Clear Zone but behind an existing RTA-approved crash barrier, all its structures up to 5.3 m in height (relative to road level) are to comply with lateral clearances as specified by Section 6 of the RTA's Road Design Guide (2011) with respect to dynamic deflection and working width.	✓ The advertisement must not create a physical obstruction or hazard. Where advertising structures hang over the road, the minimum vertical clearance should be the same as other structures in that road environment (i.e. equal or greater clearance than the overpass, tunnel portal or pedestrian bridge). However, in cases where these structures exceed the minimum vertical clearance specified for the particular type of road, the sign may protrude below the bridge or other structure. If the minimum vertical clearance for other surrounding structures is not known then a minimum vertical clearance of 5.3 m is to be used for the sign structure. However, on high performance motorways, the minimum clearance may be 5.8 m or more. Wall advertisement only permitted if, for a building having: (i) an above ground elevation of 200 m^2 or more the advertisement does not exceed 10% of the above ground elevation, and (ii) an above ground elevation of more than 100 m^2 but less than 200 m^2 the advertisement does not exceed 20 m^2 (iii) an above-ground elevation of 100 m^2 or less the advertisement does not exceed 20% of the above-ground elevation.	✓ The advertisement should not distract a driver's attention away from the road environment for an extended length of time. For example: i) The sign should not be located in such a way that the driver's head is required to turn away from the road and the components of the traffic stream in order to view its display and/or message. All drivers should still be able to see the road when viewing the sign, as well as the main components of the traffic stream in the component view. ii) The sign should be orientated in a manner that does not create headlight reflections in the drivers line of sight. As a guideline, angling a sign 5° away from the right angles to the driver's line of sight can minimise headlight reflections. On a curved road alignment, this should be checked for the distance measured back from the sign that a car would travel in 2.5 seconds at the design speed.	✓ An advertisement must not obstruct the driver's view of the road particularly of other vehicles, bicycle riders or pedestrians at crossings. The placement of a sign should not distract a driver at a critical time. In particular, signs should not obstruct a driver's view: i) to a road hazard ii) to an intersection iii) to a traffic control device (signals/stop or give way/ warning signs) iv) to an emergency vehicle access point or Type 2 driveways (wider than 6–9 m) or higher. The advertisement must not distract a driver from or reduce the visibility and effectiveness of directional signs, traffic signals, other traffic control devices, regulatory signs or advisory signs, or obscure information about the road alignment. The advertisement must not interfere with stopping sight distance for the road's design speed or the effectiveness of a traffic control device. A sign should not be located: i) less than the safe sight distance from an intersection, merge point, exit ramp, traffic control signal or sharp curves ii) less than the safe stopping sight distance from a marked foot crossing, pedestrian crossing or refuge, cycle crossing or cycle facility or hazard within road environment iii) so that it is visible from the stem of a T-intersection. The minimum sight distance requirements for the design speed of the road must be met for road hazards (stopping sight distance), emergency vehicle access points and driveways (approach sight distance) and intersections (safe intersection sight distance). See RTA Road Design Guide for sight distances. An advertisement must not obstruct a pedestrian or cyclist's view of the road. Advertisements on bridges should not block significant views for pedestrians or other bridge users (e.g. cyclists) and not create a tunnel effect, impede passive surveillance or in any other way reduce safety for drivers, pedestrians or bridge users.	✓ VMS and moving signs that face the road reserve and are visible to drivers will only be approved if the speed limit of the road is not greater than 70 km/h.	As a guideline, advertising in urban areas should be restricted to rail corridors, freeways, tollways or classified roads: (a) within or adjacent to strategic transport corridors passing through enterprise zones, business development zones, commercial core zones, mixed use zones or industrial zones, or (b) within or adjacent to strategic transport corridors passing through entertainment districts or other urban locations identified by the local council in a relevant strategy as being appropriate for such advertising. The RTA will not allow advertising on guide signs, regulatory signs, warning signs, variable message signs or on structures that already have guide signs attached. In the case of advertising on bridges, no advertising signs will be permitted on bridge approaches that already display RTA guidelines. Only one advertising sign will be permitted on each approach to a bridge. The advertisement should not be located in a position that has the potential to give incorrect information on the alignment of the road (i.e. location/alignment of sign should not give visual clues to the driver suggesting that the road alignment is different to the actual alignment).

Sign placement criteria	Longitudinal placement	Lateral placement	Vertical placement	Orientation/viewing angle	Sight distance/visibility	Speed limit/speed environment	Other
New South Wales – Dept. of Planning/RTA[2]					According to the Safety Assessment Matrix for advertising on RTA infrastructure (which provides a 1–5 risk rating, where 5 is more risk), the grounds for immediate rejection of an advertising proposal are if the advertisement partly obscures a road hazard and provides no warning that a hazard exists (4 risk rating) or completely obscures a serious road hazard (5 risk rating).		
New Zealand – NZTA	✓ Advertising signs should not be located within 100 m and 200 m in urban and rural areas respectively of: ▪ intersections ▪ permanent regulatory or warning signs ▪ curves (with chevron signing) ▪ pedestrian crossings. Advertising signs should not, in the case of a sign inviting motorists to turn, be located so close to the turning point that motorists have insufficient time to read the sign, signal and turn safely. The effectiveness of roadside advertising and also traffic safety will be compromised if there are too many advertising displays on the roadside. In situations where they are permitted, off-site advertising signs visible from roadways should be erected at the maximum spacings possible to ensure that passing motorists have a chance to assimilate such signs if they so desire. Appendix 2.7 provides minimum distances between adjacent advertising signs, based on figures taken from NAASRA. These are the recommended minimum distances between successive traffic warning signs with different messages - desirable minima are based on recommended distances between signs requiring decisions. Recommended minimum spacing ranges from 50 m on roads with operating speed of 60 km/h to 80 m on roads with an operating speed of 115 km/h. Desirable spacings range from 80 m on roads with an operating speed of 60 km/h to 250 m on roads with an operating speed of 115km/h. Wherever possible, billboards should not be placed at an intersection. As a general rule, billboards should be placed at least 50 m from an	✓ Lateral clearance distances are controlled by a number of different factors: ▪ whether the sign is allowed within the road reserve ▪ whether appropriate clear zone requirements are met (refer to Traffic Control Devices Manual Part 1) ▪ whether the sign can be seen within the driver's field of vision. Advertising signs and markings should not be permitted on the vehicle carriageway, on any traffic island or extended kerb line within the vehicle carriageway. Minimum lateral clearance distance between an advertising sign and the edge of the carriageway for roads with a speed limit of 60 km/h or less should be 1.5 m. This minimum distance increases to 3 m for roads with a speed limit greater than 60 km/h. For state highways, the NTZA requires signs to not be located closer than 5 m from the edge of the carriageway. No advertising sign or device, whether temporary or permanent, should be located on or above a footpath or berm closer than 0.5 m to the kerb face or the edge of the vehicle carriageway. Where footpath-mounted advertising is allowed by local authorities the recommended conditions applicable to their use include the sign should not reduce the width of any footpath or other pedestrian way useable by pedestrians to less than 2 m.	✓ In locations where the signs are installed above an area used by pedestrians such as footpaths, the recommended minimum vertical clearance is 2.5 m with an absolute minimum of 2.1 m. Signs or banners over the roadway should have a minimum vertical clearance of 5.5 m (this does not apply to signs mounted on bridges where the absolute minimum clearance is 4.9 m). In general, visibility problems will not be caused by signs or devices which are: ▪ less than 1 m in height, except where they are likely to obscure children ▪ the bottom of the sign is more than 3 m above the level of the roadway.	~ The sign must be at right angles to the state highway and positioned to avoid vehicle headlight reflection. The location, orientation and design of advertising signs in relation to the road should be assessed to ensure advertising signs can be read without a motorist having to slow down or stop their vehicle.	✓ Roadside advertising may create restrictions to sight visibility and create a safety hazard if it obstructs or interferes with: ▪ road users' view of a road hazard, person or oncoming vehicle on the roadway ▪ road users' view of a person or vehicle about to enter the roadway. The sign must not obscure driver visibility at accesses or intersections. Signs should be placed as close as possible to drivers' lines of sight while maintaining the lateral clearances from the roadway. Safe intersection sight distances are defined, ranging from 96 m for 50 km/h roads to 253 m for 100 km/h roads. For 70 km/h roads, the recommended distance is 149 m. The distances relate to the absolute and desirable sight distances along the major road from 5 m (3 m minimum) back from the major road. Corrections should be made where gradient is greater than 2%. The sign must be located so there is an unrestricted view to the motorist for a minimum distance of 180 m where the speed limit is 70 km/h or higher. Some of the more common situations where there is potential for visibility problems include: ▪ vehicle-mounted signs ▪ portable signs placed on footpaths, shoulders or grass berms ▪ signs adjacent to driveways particularly of major traffic generators, e.g. service stations ▪ signs close to intersections or curves in the roadway.	✓ Animated or flashing signs should not be used for roadside advertising if the operating speed of passing traffic is 70 km/h or greater. Billboards must not be placed on or over motorways. To avoid excessive clutter of roadside advertising signs, it is recommended that territorial authorities and road controlling authorities restrict the erection of off-site advertising. Consenting authorities should provide for such situations in areas with speed limits of 70 km/h or more. Animated or flashing signs should not be used as roadside advertising if the operating speed of the passing traffic is 70 km/h or greater.	Where applicable, the sign must be located on the site to which the sign relates and must be placed to ensure there is only one advertising sign located on or adjacent to the property to which it relates. The recommendation of this guideline is that local authorities discourage the use of aerial displays in all forms.

Sign placement criteria	Longitudinal placement	Lateral placement	Vertical placement	Orientation/viewing angle	Sight distance/visibility	Speed limit/speed environment	Other
New Zealand – NZTA (cont.)	intersection; however, this is not always possible in an urban environment.						
OMA Recommendations (See digital billboards only)	✓ 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 sight stopping distances detailed in the 'sight distance/visibility' criterion. In inner city locations where the speed limit is less than 70 km/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.	X	X	X	✓ Sight stopping distance defined as the distance required to stop a vehicle travelling at a certain speed safely: ▪ At 80 km/h, stopping sight distance with 2.5 s reaction time is 114 m. ▪ At 90 km/h, stopping sight distance with 2.5 s reaction time is 140 m. At 100 km, stopping sight distance with 2.5 s reaction time is 170 m.	X	
SUMMARY	All jurisdictions provide qualitative guidelines in relation to this criterion. A number of jurisdictions also specify minimum restriction distances from other features of the road environment, including other advertising devices, official traffic signs or intersections. Minimum restriction distances vary from 50 m to 160 m across jurisdictions, and depending on device type and speed limit or speed environment. Some jurisdictions cite lower values for smaller devices such as local community and business signs. Most jurisdictions also restrict the density of advertising devices by limiting the number of devices permitted at a single location.	All jurisdictions make some reference to lateral placement or associated issues within their guidance. Commonly, jurisdictions require that advertising is not erected within the clear zone (unless on bus shelters). Many jurisdictions provide quantitative guidance, with values ranging from a minimum of approx. 1 m from the carriageway edge to up to 15 m, depending on the device type and speed environment. Generally, the lateral clearance requirements are smaller for smaller devices, such as business signs, and greater for large freestanding billboards. Many jurisdictions also emphasise that advertising should not obstruct road users, including pedestrians/cyclists, nor be located in medians or traffic islands.	Most jurisdictions make at least some reference to maximum heights and minimum clearances for advertising devices. The values provided for height restrictions vary considerably depending on the type of device. A number of jurisdictions do not provide height restrictions for large free-standing devices, including digital billboards. A number of jurisdictions quote values of 2.1 to 2.5 m for clearance under freestanding structures, with the higher value particularly used when referring to structures over pedestrian footpaths. Signs and banners suspended or attached to infrastructure across carriageways are generally required to have a clearance of between 5 and 6 m.	The majority of jurisdictions have some coverage of this criterion within their guidance. Where provided, in general there is consistency across Jurisdictionss with most requiring that the sign is erected at right angles to the carriageway with a 5° deflection.	Most jurisdictions require that advertising devices do not obscure the view of drivers and in some cases also the view of cyclists and pedestrians, to traffic control devices, official traffic signs, intersections or other road users. Three jurisdictions provide more detailed guidance, covering aspects such as sightline assessment procedures and safe stopping sight distances for road hazards. New Zealand provides safe intersection distances ranging from 92 to 253 m depending on the speed limit of the road, and also requires that signs must be located so that the motorist has an unrestricted view for a minimum of 180 m on 70 km/h roads.	Many jurisdictions have introduced restrictions on the erection of advertising devices on higher-speed roads. A few jurisdictions have strict controls on all types of advertisement; for example, Tasmania does not permit advertising devices on state roads with a speed limit above 60 km/h. Other jurisdictions have restrictions for certain types of advertisement. For example, five jurisdictions have banned the use of variable or changeable devices on roads with a speed limit above 70 or 80 km/h (including motorways/freeways). In some cases, this applies to advertising located either within the boundaries of or visible from state-controlled roads.	A number of jurisdictions do not permit advertising devices to be attached to posts for official traffic signs or other purposes (e.g. guide signs). Other restrictions on the placement of advertising devices relate to: ▪ land use ▪ road geometry ▪ specific roads. Jurisdictionss also provide specific guidance in relation to other types of advertising device, such as: ▪ portable devices ▪ aerial devices ▪ double-sided signs.

1 Now Department of Planning, Transport and Infrastructure (DPTI):
2 Now Roads and Maritime Services (RMS).

8 GAP ANALYSIS

While many of the best practice principles identified are covered in at least some of the road authorities' existing guidelines, a number of issues are not yet considered. In particular, the following issues typically are not covered:

- specification of appropriate dwell and transition times relative to road speed limit or speed environment as well as the sight distance to the device
- restrictions in relation to the use of:
  - special effects for transition between messages e.g. 'fade', 'zoom' or 'fly-in' effects
  - message sequencing e.g. the maximum number of sequential messages permitted and/or the minimum and maximum time duration for the entire sequence
  - emotive content – *although this may be covered more comprehensively in general guidelines for advertising content, it is not typically being considered in relation to the impact on road safety*
  - audio, interactive or personalised electronic message displays
- specification of maximum and minimum duration times for display of non-static messages i.e. animated or video displays (if permitted)
- restrictions on quantity of information permitted within an advertising message depending on the road speed limit or speed environment as well as the size of the device e.g. the maximum number of informational elements
- additional specifications regarding luminance, particularly in relation to electronic devices:
  - default display luminance or display settings in event of failure
  - requirements for change in luminance in response to changing light conditions
  - luminance contrast and contrast ratio
  - particularly in relation to changeable devices i.e. digital billboards, specification of:
  - maximum dimensions
  - maximum height
  - minimum spacing between changeable devices
  - specification of maximum required viewing times and minimum sight distances of advertising devices relative to road speed limit or speed environment
  - the fundamental safety profile of the road in question, including restrictions on placement of devices on, or visible from, sections of road classified as black spots or high risk locations.

9 GUIDANCE MODEL/OUTLINE

Based on the considerations discussed above, the following guidance recommendations are provided. These are divided into sign design guidance (Table 9.1) and sign placement guidance (Table 9.2). The recommendations are specifically targeted at digital billboards and their potential for distraction and should be considered to be an addition to existing guidelines relating to conventional billboards.

9.1 Sign Design Guidance

Table 9.1: Sign design guidance recommendations

Sign design criteria	Movement	Flashing lights	Dwell time	Transition time	Message sequencing	Quantity of information	Information presentation	Colour	Information content/meaning	Luminance	Dimensions
Guidance recommendation	Roadside advertising devices should not contain motion, changes in luminance or any effects that create the illusion of movement.	Roadside advertising devices should not contain flashing, blinking, revolving, pulsating or intermittent lights.	This should take account of (1) visibility distance [VD]: the maximum distance from the sign at which the sign face becomes visible to drivers and (2) speed environment [SE]. The goal is to limit the number of message changes that drivers are exposed to. Therefore an advertising device that is visible from 1000 m away on a 60 km/h road needs to have much longer dwell times than an advertising device that is visible only from 100 m away on a 100 km/h road. All drivers will see at least one change if: ▪ dwell time (sec) < VD (m)÷{SE (km/h) x 0.28}. Ideally, the proportion of drivers (PD) who see a change should be much less than 1. Therefore: ▪ dwell time (sec) > VD (m)÷{SE (km/h) x 0.28}. For a desired PD: ▪ dwell time = VD (m)÷{SE (km/h) x 0.28 x PD}.	Message should change instantaneously. That is, no 'fade', 'zoom' or 'fly-in' effects and no blank screen between messages.	Sequencing of messages should be prohibited.	For text, this should be consistent with the number of words that can be read during the approach interval and also the number of words that can be read in a 2 second interval (the 'eyes off the road' interval at which the crash rate doubles). This can be achieved by (1) estimating the legibility distance [LD]: the distance at which the text first becomes legible, (2) taking into account approach speed – the speed environment [SE], (3) estimating the comprehension rate [CR], and (4) ensuring that attention of more than 2 seconds is not required to comprehend the message. Therefore: ▪ number of words < LD (m) ÷{ SE (km/h) x 0.28} x CR (sec). And: ▪ number of words < CR (sec) x 2. In general, a typical comprehension rate would be approximately three words per second, but this will vary for different text sizes, fonts and formats. As a result the CR may need to be tested and demonstrated in the application process.	Not applicable to advertising devices.	Advertising devices should not be coloured like an official traffic sign or traffic signals.	Advertising devices should not imitate traffic control devices or give instructions to traffic to 'stop', 'halt' or other (e.g. give way, turn left or merge). Advertising devices should not contain extreme emotional material, especially content which could be threatening or anxiety provoking.	Luminance levels should not exceed those of static signs in typical ambient light conditions.	Advertising devices should not be shaped like an official traffic control sign/device.

9.2 Sign Placement Guidance

Table 9.2: Sign placement guidance recommendations

Sign placement criteria	Longitudinal placement	Lateral placement	Vertical placement	Orientation/viewing angle	Sight distance/visibility	Speed limit/speed environment	Other
Guidance recommendations	Advertising devices should not be located in such a way that they might interfere with the effectiveness of a traffic control device (e.g. by restricting sightlines or distracting from traffic control devices via proximity or as a background). Advertising devices should not be located so that they are visible at the approach to, or from, an intersection, pedestrian crossing, tram stop or in any location that is likely to be highly demanding of attention. Only one advertising device should be visible to drivers at any time.	Without conflicting with clear zone requirements (e.g. installation of post in a hazardous location), advertising devices should not be placed such that drivers must divert their gaze away from the forward roadway in order to comprehend the sign message.	Advertising devices should not be placed at a height that coincides with the normal 'hazard viewing window' that drivers scan. That is, they should be elevated above the height of vehicles, pedestrians and traffic control devices, but not so high that they draw the gaze away from the forward roadway.	Advertising devices should be oriented to facilitate legibility from the maximum legibility distance and across the full approach distance.	Advertising devices should be placed so that enough time is available on approach for drivers to comprehend the message. That is, the sight distance must correspond to the required legibility distance.	The speed environment on its own is likely to be less important than the overall risk profile of the road and driving demand characteristic of the road section which should be carefully reviewed.	All installations should consider the overall risk profile of the road environment in question and the driver demand of the road section (e.g. crash history, AusRAP ratings, traffic volume, speed, complexity, clutter). In particular: ▪ Black spots and road sections with less than a 3-star rating (AusRAP or equivalent) should be ruled out for advertising device placement. ▪ Highly cluttered road environments should be ruled out for advertising device placement. ▪ The installation should be reviewed at regular intervals and audited against the guidance principles (because crash rates, traffic volume, the built environment etc. will change over time). ▪ Advertising signs should not be placed on the same posts as traffic control devices.

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APPENDIX A LIST OF WORKSHOP ATTENDEES

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INFORMATION RETRIEVAL

Austroads, 2013, **Impact of Roadside Advertising on Road Safety**, Sydney, A4, pp.50. **AP-R420-13**

Keywords:

Roadside advertising, digital billboards, driver distraction, roadside advertising guidelines.

Abstract:

This research project aimed to harmonise the criteria road agencies use to manage roadside advertising devices, and promote improved and consistent good practice by road agencies.

Physical and psychological human characteristics strongly suggest that in some driving situations it is likely that the movement or changes in luminance created by digital displays will involuntarily capture attention, and that particularly salient emotional and engaging material will divert attention, to the detriment of driving performance. This is particularly the case for inexperienced drivers. Where this happens in a driving situation that is also cognitively demanding, the consequences have the potential to be significant.

This report provides guidance principles designed to mitigate the potential for roadside advertising to capture attention, reduce the cognitive capacity available for driving and have a negative impact on driving performance. The principles are divided into sign design and sign placement recommendations and cover movement, dwell time, transition time, message sequencing, quantity of information, information content / meaning, luminance, longitudinal placement, lateral placement, vertical placement, orientation/viewing angle, sight distance/visibility, and speed environment.

Attachment 2

Effects of Outdoor Advertising Displays on Driver Safety

Requested by
Suzy Namba, Caltrans Division of Design

October 11, 2012

The Caltrans Division of Research and Innovation (DRI) receives and evaluates numerous research problem statements for funding every year. DRI conducts Preliminary Investigations on these problem statements to better scope and prioritize the proposed research in light of existing credible work on the topics nationally and internationally. Online and print sources for Preliminary Investigations include the National Cooperative Highway Research Program (NCHRP) and other Transportation Research Board (TRB) programs, the American Association of State Highway and Transportation Officials (AASHTO), the research and practices of other transportation agencies, and related academic and industry research. The views and conclusions in cited works, while generally peer reviewed or published by authoritative sources, may not be accepted without qualification by all experts in the field.

Executive Summary

Background

Digital and other outdoor advertising displays are becoming more common along California's highways, and Caltrans is considering generating income with advertisements on changeable message signs and outdoor advertising displays on state-owned rights of way outside of the operational highway. Local agencies, commercial businesses and private landowners are also looking at digital displays as a way to generate income.

However, the technology for digital displays is relatively new, and there has been little account taken of their effects on driver safety. Further, there are no regulations regarding their font size or complexity. Caltrans needed more data to determine whether digital displays and other forms of outdoor advertising constitute a safety hazard to drivers.

To conduct this investigation, CTC carried out a literature search to:

- Identify existing or in-progress research about the driver safety impacts of static signs, digital billboards and other displays, including the effects of brightness/illumination, font size and visual complexity of the signs.
- Review research on both on-premise and off-premise signage as well as the broader aspects of how guide signs (as given in the California Manual on Uniform Traffic Control Devices) affect safety.
- Investigate how other states are regulating the use of digital displays.

Summary of Findings

We gathered information in three topic areas:

- Federal Guidance on Digital Displays
- Related Research
    - The Wachtel Report and Pre-2009 Literature on Outdoor Advertising Safety
    - Literature on Outdoor Advertising Safety Since the 2009 Wachtel Report
    - Luminance Criteria and Other Human Factors for Sign Design
- State Regulations

Following is a summary of findings by topic area.

Federal Guidance on Digital Displays

A 2007 Federal Highway Administration (FHWA) memo makes recommendations for changeable message sign message duration (8 seconds), transition time (1 to 4 seconds), brightness, spacing and locations.

Related Research

The most thorough review of the literature to date on digital display safety is the 2009 report Safety Impacts of the Emerging Digital Display Technology for Outdoor Advertising Signs by Jerry Wachtel. Wachtel has been the president of The Veridian Group, a California human factors research consulting firm, for 22 years and has published numerous studies on outdoor advertising safety.

We give a summary of this report and include a selection of the references cited for studies in or before 2009. (We found no relevant studies for this period not included in Wachtel's report, which covers both digital and nondigital outdoor advertising.) In a separate section, we discuss literature on outdoor advertising safety that has been published since Wachtel's report.

The Wachtel Report and Pre-2009 Literature on Outdoor Advertising Safety

Based on the literature review, Wachtel concludes that:

- Studies regularly demonstrate that roadside advertising, including digital billboards, contributes to driver distraction at levels that adversely affect safe driving performance.
- There are consistent research recommendations regarding brightness, message duration and change interval, and other factors.

Wachtel also gives a thorough survey of national and international guidelines and regulations for digital billboards, and based on these (along with the literature review) makes recommendations for digital billboard guidelines, including:

- *Message duration:* A minimum display duration of sight distance to the digital billboard (feet)/speed limit (feet/second).
- *Message interval:* An interval between successive displays that is close to instantaneous as possible.
- *Display brightness:* Brightness, luminance and illuminance limits based on the ambient lighting conditions of digital billboards.
- *Digital billboard spacing:* Spacing between digital billboards that does not face a driver with two or more displays within his field of view at the same time.
- *Other:* The prohibition of visual effects, message sequencing, and the placement of digital billboards near traffic control devices and driver decision and action points.

Wachtel concludes that there is growing evidence that digital billboards distract drivers because these signs increase driver glance duration and the driver's gaze is reflexively drawn to objects of different luminance in the visual field.

Findings from the literature support the argument that while there is no definitive research showing increased crashes due to the presence of billboards or digital billboards, there is an increased crash risk based on research on the effects of billboards on driver attention and the effects of driver distraction on safety:

- Billboards can have a significant effect on driver speed, lateral control, mental workload, ability to follow road signs, and eye movements and fixations, with older drivers particularly affected. (*The Effects of Visual Clutter on Driving Performance* and *Driven to Distraction*, *An Evaluation of the Influence of Roadside Advertising on Road Safety*, and *Review of Roadside Advertising Signs*). And visual clutter generally can distract drivers (*Driver Distraction by Advertising*).
- Digital billboards attract more attention than regular billboards, with larger number of glances and longer glances (*Driving Performance and Digital Billboards* and *Observed Driver Glance*

Behavior at Roadside Advertising Signs). Wachtel notes that the implication is that the shorter the message duration, the longer the driver's glance in anticipation of the next message.

- Drivers engaging in visually demanding tasks have a crash risk three times higher than attentive drivers; while brief glances do not increase risk, glances of more than two seconds at least double crash risk (*The Impact of Driver Inattention on Near-Crash/Crash Risk*).
- While studies have not been able to establish a statistical relationship between the presence of billboards and traffic safety, these studies have been flawed in design, and the use of accident data in evaluating the impacts of billboard is ill-advised (*The Impact of Roadside Advertising on Driver Distraction, A Study of the Relationship between Digital Billboards and Traffic Safety in Cuyahoga County, Ohio*, *Driving Performance and Digital Billboards*, and *Driving Performance in the Presence and Absence of Billboards*, *Effects of Roadside Advertisements on Road Safety*).
- More research is needed. A 2009 FHWA study on the effects of commercial electronic variable message signs on driver attention and safety (of which Wachtel is a co-author) proposes a three-stage program of research: an on-road instrumented vehicle study, a naturalistic driving study and an unobtrusive observation study (*The Effects of Commercial Electronic Variable Message Signs (CEVMS) on Driver Attention and Distraction*).

Literature on Outdoor Advertising Safety Since the 2009 Wachtel Report

We found a number of studies on outdoor advertising safety that have been published since the Wachtel report; but only three on digital billboard safety specifically. These studies reaffirm the negative effects of billboards on driver attention, despite the fact that no correlation can be found between the presence of billboards and increased crash rates:

- Advertising billboards affect driver's ability to detect changes in road scenes, especially when the roadway background is more cluttered (*Advertising Billboards Impair Change Detection in Road Scenes*). In general they affect lateral control and mental workload (*Conflicts of Interest*), and change drivers' pattern of visual attention, increasing the amount of time needed for drivers to respond to road signs and increasing driving errors (*Effects of Advertising Billboards during Simulated Driving*). A 2010 study concludes that among distractions external to vehicles, roadside advertisements have the strongest correlation to collision frequency (*Quantifying External Vehicle Distractions and Their Impacts at Signalized Intersections*).
- A 2011 FHWA study scans outdoor advertising control practices in Australia, Europe and Japan (*Outdoor Advertising Control Practices in Australia, Europe, and Japan*).
- A 2010 Transport Research Laboratory study concludes that video billboards draw longer and more frequent glances from drivers than static advertisements, with drivers showing greater variation in lateral lane position, driving more slowly and braking harder (*Investigating Driver Distraction*). A 2011 study shows that video billboards also lead to more rear-end collisions when there is a hard-braking lead vehicle (*External Distractions: The Effects of Video Billboards and Windfarms on Driving Performance*).
- A 2010 study showed no impact on driver performance after the installation of a digital billboard (*The Impact of Sacramento State's Electronic Billboard on Traffic and Safety*), and a 2009 study shows no correlation between hazardous intersection and the presence of digital billboards in Los Angeles (*Digital Billboard Safety amongst Motorists in Los Angeles*).
- Preventing distraction by digital billboards requires controlling lighting at nighttime, lengthening message duration time, simplifying message information and prohibiting message sequencing (*Digital Billboards, Distracted Drivers*).

Luminance Criteria and Other Human Factors for Sign Design

We also include a number of studies on human factors for the design of signs in general (including guide signs). Topics include congruent visual information, legibility, message design for variable message signs and luminance criteria for digital billboards. A 2010 study by Arizona State University (*Digital LED Billboard Luminance Recommendations*) suggests that:

… drivers should be subjected to brightness levels of no greater than 10 to 40 times the brightness level to which their eyes are adapted for the critical driving task. As roadway lighting and automobile headlights provide lighting levels of about one nit, this implies signage should appear no brighter than about 40 nits.

State Regulations

- An undated chart from the Outdoor Advertising Association of America summarizes state regulations on changeable message advertising signs. Generally minimum message duration is between 4 and 10 seconds, with 6 and 8 seconds most common; the maximum interval between messages is 1 to 4 seconds; and spacing is most commonly 500 feet. A review of state practices is also included in Appendices B and C of the 2001 FHWA study, Research Review of Potential Safety Effects of Electronic Billboards on Driver Attention and Distraction in **Related Research**.
- We survey the digital advertising display regulations of 12 states. Of note are Massachusetts and Tennessee, which are currently updating regulations to specifically address digital billboards.

Gaps in Findings

- While there is a significant amount of research on the effects of outdoor advertising on driver distraction, there is little research definitively showing that outdoor advertising affects crash rates, and there are a limited number of studies on digital billboards specifically.
- We found little research justifying common regulations and design recommendations for digital billboards, including brightness/illumination, font size and visual complexity. Recommendations are typically based on common state practices.
- We found little research on the safety effects of signage in general, including guide signs.
- We did not find research in progress for any areas of inquiry.

Next Steps

- Caltrans may be able to gather additional information about current practice and regulations by surveying the other state DOTs.
- Caltrans could consider launching a multi-year research study, either by itself or with other states, aimed at measuring changes in crash rates after installation of digital displays.
- Caltrans could follow up with the Outdoor Advertising Association of America to determine the sources and dates of the data presented in their State Changeable Message Chart; OAAA may also have other unpublished research of interest.

Federal Guidance on Digital Displays

Guidance on Off-Premise Changeable Message Signs, Federal Highway Administration, September 2007.
http://www.fhwa.dot.gov/realestate/offprmsgsnguid.htm
Guidance from this memorandum is as follows:

- Duration of message: Between 4 and 10 seconds; 8 seconds is recommended.
- Transition time between messages: 1 to 4 seconds.
- Brightness: Adjust brightness in response to changes in light levels so that signs are not unreasonably bright for the safety of the motoring public.
- Spacing: Not less than minimum spacing requirements for signs under the federal/state agreement (FSA), or greater if determined appropriate to ensure the safety of the motoring public.
- Locations: As where allowed by the FSA except where such locations are determined to be unsafe.

Related Resources:

Outdoor Advertising Control, Federal Highway Administration, January 3, 2012.
http://www.fhwa.dot.gov/realestate/out_ad.htm
This web page provides a series of links to related topics, including a history and overview of the federal outdoor advertising control program, the possible effects of commercial electronic variable message signs on driving safety, and research about the potential safety effects of electronic billboards on driver attention and distraction.

Related Research

Studies below that are industry sponsored are preceded by an asterisk and include an indication of the sponsor.

The Wachtel Report and Pre-2009 Literature on Outdoor Advertising Safety

Safety Impacts of the Emerging Digital Display Technology for Outdoor Advertising Signs, Jerry Wachtel, NCHRP Project 20-7 (256), Final Report, April 2009.
http://www.azmag.gov/Documents/pdf/cms.resource/NCHRP_Digital_Billboard_Report70216.pdf

Sections 2 and 3 of this report include the most thorough review to date of the literature on the use of digital displays for outdoor advertising signs. Summaries of a selection of the studies referenced in the report are provided on the following pages, along with Wachtel's comments on these studies, where relevant. (In the citations for this section, all references to "Wachtel" are to the 2009 report.)

Summaries of the following sections of the report are also provided:

- Conclusions from the literature.
- Section 4: Human Factors Issues.
- Section 5: Current and Proposed Guidelines and Regulations.
- Section 6: Recommendations for Guidelines.
- Section 7: Digital Billboards On-Premise and on the Right-Of-Way.
- Section 8: New Technology, New Applications, New Challenges.
- Section 9: Summary and Conclusions.

Conclusions from the Literature

This report gives an exhaustive review of the literature (Sections 2 and 3) and concludes broadly (pages 5 and 6 of the report) that:

- Studies regularly demonstrate that the presence of roadside advertising signs such as digital billboards contributes to driver distraction at levels that adversely affect safe driving performance.
- There is consistency in research recommendations regarding brightness, message duration and change interval, and billboard location with regard to official traffic control devices, roadway geometry and vehicle maneuver requirements at interchanges, lane drops, merges and diverges, as well as regarding constraints that should be placed on such signs' placement and operation.

Section 4: Human Factor Issues:

Beginning on page 115 of the report, Wachtel summarizes human factors issues related to digital billboards as follows:

- *Conspicuity:* Billboards with high levels of illumination and frequent changes can reduce the visibility of traffic control devices and other visual signs required for safety (vehicle brake lights, reflectors, etc.).
- *Distraction and inattention:* Inattention involves the failure of a driver to concentrate on the driving task for any reason, or for no known reason at all. It is distinguished from distraction in that it may have no known cause and possibly no remediation.
- *Information processing:* Billboards are often placed in ways that do not adhere to good human factors practice restricting the amount of information conveyed by signs.
- *The Zeigarnik Effect:* Discomfort related to task interruption may lead drivers to continue looking at changing messages on digital billboards to learn what comes next.
- *Brightness and glare:* The majority of public complaints about digital billboards concern their excessive brightness, particularly at night, to the extent that they become the most conspicuous item in the visual field and draw the eye away from other objects that need to be seen.
- *Legibility and readability:* Billboards may not adhere to Manual on Uniform Traffic Control Devices (MUTCD) guidelines on legibility, including font, letter size and color. Often they take more time to read than guidelines prescribe, taking multiple glances to communicate the intended message.
- *Novelty:* Novel stimuli make a greater demand on driver attention, and where drivers get used to static billboards, digital billboards have the ability to present new images to drivers every time the sign is approached.
- *Sign design, coding, redundancy:* Digital billboards lack the consistent design of traffic control devices, which is intended to assist recognition and decrease reaction time.
- *Visual attention:* Digital billboards, more than any previous technology used for roadside advertising, are capable of commanding drivers' attention by employing extremely high luminance levels; bright, rich colors; and a pattern of message display that may appear to flash.
- *Positive Guidance:* Drivers can be given sufficient information about road hazards when and where they need it, and in a form that enables them to avoid error that might result in a crash.
- *The Moth Effect:* Drivers may have the tendency to inadvertently steer in the direction of bright lights, leading to lane departures and crashes.

Section 5: Current and Proposed Guidelines and Regulations

This section reviews national and international guidelines and regulations for digital billboards.

Queensland, Australia

Queensland had the most comprehensive regulations, including flowcharts and tables that enable an inspector to determine exactly what types and operational characteristics of advertising signs are permissible under different road and speed conditions. Page 121 of the report describes different levels of restriction for different road categories:

For advertising devices beyond the right-of-way but visible from "motorways, freeways, or roads of similar standard," only non-illuminated signs or non-rotating static illuminated signs are permitted (p. 6-4). Where an advertising device is permitted on State-controlled roads, the same restrictions apply. Further, "variable message signs and trivision signs are not permitted on State-controlled roads" (p. 6-5). For those advertising devices that are permitted, a clear chart is provided (labeled Figure C6) that provides graphic depictions of the "device restriction area" (p. C-12).

Guidelines also establish maximum average sign luminance for zones with differing ambient street lighting. To limit the distracting potential of electronic billboards, Australia requires that digital billboards outside the boundaries of but visible from state-controlled roads (except motorways) (Category 1) be installed only where:

- There is adequate advanced visibility to read the sign.
- The environment is free from driver distraction points and there is no competition with official signs.
- The speed limit is 80km/h or less.
- The device is not a moving sign (defined elsewhere in the document).

For Category 1 digital billboards that display predominantly graphics:

- Long duration display periods are preferred in order to minimize driver distraction and reduce the amount of perceived movement. Each screen should have a minimum display period of 8 seconds.
- The time taken for consecutive displays to change should be within 0.1 seconds.
- The complete screen display should change instantly.
- Sequential message sets are not permitted.
- The time limits will be reviewed periodically.

For Category 1 digital billboards that display predominantly text:

- The number of sequential messages … may range from one to a maximum of three; in locations with high traffic volume or a high demand on driver concentration, the number of sequential messages should be limited to two.
- Where a display is part of a sequential message set, the display duration should be between 2.5 to 3.5 seconds for a corresponding message length of three to six familiar words.
- The number and complexity of words used … should be consistent with the display duration.
- The time taken for consecutive displays to change should be within 0.1 seconds.
- The complete screen display should change instantaneously.
- In a text-only display, the background color should be uniform and nonconspicuous.

Australia's regulations do not allow changeable message signs, flashing signs or digital billboards of any type if such devices would be visible by motorists traveling on motorways (Category 2). Where advertising devices are permitted within the boundaries of state-controlled roads (Category 3), such signs must be nonrotating static illuminated and nonrotating, nonilluminated signs. Neither variable message signs nor trivision signs are permitted on state-controlled roads.

South Africa

On page 126 of the report, Wachtel describes South Africa's regulations, which require that no advertisement may:

- Be so placed as to distract, or contain an element that distracts, the attention of drivers of vehicles in a manner likely to lead to unsafe driving conditions.
- Be illuminated to the extent that it causes discomfort to or inhibits the vision of approaching pedestrians or drivers of vehicles.

- Be attached to traffic signs, combined with traffic signs, … obscure traffic signs, create confusion with traffic signs, interfere with the functioning of traffic signs, or create road safety hazards.
- Obscure the view of pedestrians or drivers, or obscure road or rail vehicles and road, railway or sidewalk features such as junctions, bends, and changes in width.
- Be erected in the vicinity of signalized intersections which display the colours red, yellow or green if such colours will constitute a road safety hazard.
- Have light sources that are visible to vehicles traveling in either direction (p. 12).

Regulations provide guidance on advertisement size, colors, number of advertisements in the area, speed limit, quantity of information in the advertisement (measured in bits), illumination level and other factors.

Victoria, Australia
Regulations define the conditions under which an advertisement is a road safety hazard, including position and potential for distraction because of color or illumination. From page 130 of the report, signs must:

- Not display animated or moving images, or flashing or intermittent lights.
- Not be brighter than 0.25 candela per square metre.
- Remain unchanged for a minimum of 30 seconds.
- Not be visible from a freeway.
- Satisfy the ten point checklist.

New South Wales, Australia
Guidelines include recommendations for variable message signs on conventional roads, including message on- and off-time, changeover time, maximum distance to traffic signal, and minimum distances to other advertising devices or to official traffic devices. It also restricts the maximum luminance levels of advertising devices based on levels of ambient off-street lighting.

The Netherlands
The Netherlands has guidelines for visual distracters (including but not limited to billboards) that contain nondriving related information. Recommendations include (from page 132 of the report):

- There should be no information that actively attracts attention; this includes no moving objects, no LCD or LED screens, and no moving or changing pictures or images.
- Non-driving related information should not appear within the driver's central field-of-view (less than 10 deg from straight ahead).
- Signs should contain a maximum of five "items" (letters, numbers, symbols, etc.).
- No distractions should be permitted at merges, exits and entrances, close to road signs or in curves (specific constraints will follow).
- No telephone numbers will be permitted.
- No fluorescent colors are permitted.
- No ambiguity is permitted.
- No controversial information is permitted; examples include sex, violence, religion, nudity.
- No mixture of real and fake words is permitted.
- Commercial signs must be 90 deg to the road to minimize head turning.
- No signs will be permitted that mimic road signs in color or layout.

Brazil
A 1998 study proposes the following regulations (from page 134 of the report):

- Advertising signs should be located at a tangent to approaching drivers.
- Advertising signs should be no closer than 1000 m from one another on the same side of the road, and no closer than 500 m from the nearest advertising sign on the opposite side of the road.
- The display time of each image on a variable message sign should be long enough to appear static to 95% of drivers approaching it at highway speeds.

- The message change interval should not exceed 2 s.
- The displayed image should remain static from the moment it first appears until the moment it is changed.
- No animation, flashing or moving lights should be allowed.
- No message or image that could be mistaken for a traffic control signal should be displayed.
- Messages should be simple and concise.

United States

New York State

Regulations proposed in 2008 include:

- Minimum message duration of 62 seconds, so that no motorist would be able to see more than one message change as he or she approached any particular changeable electronic variable message sign.
- Message transition time should be instantaneous to minimize distraction.
- Minimum spacing between changeable electronic variable message sign is 5,000 feet.
- Maximum changeable electronic variable message sign brightness of 5,000 cd/m^2 in daylight and 280 cd/m^2 at night.
- Prohibited locations:
    - On interstate and controlled access highways: Within 1,100 feet of an interchange, at-grade intersection, toll plaza, signed curve or lane merge/weave area; within 5,000 feet of another changeable electronic variable message sign or official traffic device that has changeable messages.
    - On primary highways: Within 1,100 feet of an entrance or exit from a controlled access highway, a signed curve or a lane/merge area; within 5,000 feet of another changeable electronic variable message sign or official traffic control device with changeable messages.

Revised criteria made these requirements less restrictive, reducing message duration from 62 to 6 seconds and changing spacing requirements and prohibited locations. The requirements for instantaneous message transition and maximum brightness did not change.

San Antonio, TX

Regulations for a trial evaluation of 15 off-premise digital signs included a message duration time of 10 seconds; change intervals of one second or less; brightness less than or equal to 7,000 nits during the day and 2,500 nits at night; and various other regulations. (One nit = one candela per square meter.)

Flowery Branch, GA

Regulations in this community begin on page 138 of the report and include:

- Minimum message duration: to the amount of time that would result in one message per mile at the highest speed limit posted within the 5000 feet approaching the sign for the road from which the sign is to be viewed.
- Transition time: less than one-tenth of a second, with no animated transitions.
- Illumination and brightness: not greater than 12 foot-candles from the nearest point of the road.
- Freezing of the display on malfunction.
- Prohibition of message sequencing.

Oakdale, MN

Brightness is limited to 2,500 nits during the day and 500 nits at night, with adjustments for ambient light conditions and a minimum display duration of 60 seconds.

St. Croix County, WI

From page 140 of the report, signs with "external and uncolored" illumination are permitted. In addition to typical prohibitions against flashing, moving, traveling, or animated signs or sign elements, the following prohibitions apply to all signs with internal illumination:

- No illuminated off-premises sign which changes in color or intensity of artificial light at any time while the sign is illuminated shall be permitted.
- No illuminated on-premise sign which changes in color or intensity of artificial light at any time when the sign is illuminated shall be permitted, except one for which the changes are necessary for the purpose of correcting hour-and-minute, date or temperature information.
- A sign that regularly or automatically ceases illumination for the purpose of causing the color or intensity to have changed when illumination resumes (are prohibited).
- The scope of the ordinance's prohibitions include, but are not limited to, any sign face that includes a video display, LED lights that change in color or intensity, "digital ink," and any other method or technology that causes the sign face to present a series of two or more images or displays.

Outdoor Advertising Industry

The Outdoor Advertising Association of America (OAAA) publication Regulating Digital Billboards suggests that digital billboards:

- Display a message that appears for no less than four seconds.
- Have message transitions of at least one second.
- Have spacing consistent with state requirements.
- Do not include animated, flashing, scrolling, intermittent or video elements.
- Appropriately adjust display brightness as ambient light levels change.

Section 6: Recommendations for Guidelines

Wachtel makes recommendations for guidelines based on the review of literature and international, national, state and local regulations (despite the fact that "there are not yet comprehensive research-based answers to fully inform such guidance and regulation"):

- Minimum message display duration: The FHWA recommends 6 seconds, the OAAA recommends 4 seconds, and the OAAA reports that 41 states have set display minimums ranging from 4 seconds to 10 seconds. Wachtel is not aware of any research on this issue to support such guidelines, and notes that "good human factors practice would suggest that minimum display duration should differ with sight distance, prevailing speeds, and other factors." The author recommends the following formula to minimize the chance that a motorist will see more than two successive messages:

  Sight distance to the digital billboards (ft) / Speed limit (ft/sec) = Minimum display duration (sec)

- Interval between successive displays: This interval should be as close to instantaneous as possible so that a driver cannot perceive any blanking of the display screen.
- Visual effects between successive displays: Visual effects should be prohibited.
- Message sequencing: Sequencing should be prohibited.
- Amount of information displayed: To the author's knowledge, no U.S. jurisdiction places restrictions on the amount of information that may be presented on billboards, including digital billboards (although some agencies outside the United States do). There is not enough research to make recommendations, although a good starting point are guidelines for South Africa and the Netherlands (which limit information based on how much a driver can read at a given speed and while the sign is visible).
- Information presentation: Considerable guidance is available to advertisers and digital billboard owners from sources inside the outdoor advertising industry as well as human factors and traffic

safety experts, and the MUTCD itself. Digital billboards should facilitate rapid, error-free reading of roadside advertisements with lower levels of driver attentional demand and distraction. Typeface, font, color and contrast of figure and background, character size, etc., all play a role in the legibility and readability of a display.

- Digital billboard size: Recommendations for size limitations are beyond the scope of the report. The most common size for billboards of any kind is 14 feet high by 48 feet wide.
- Brightness, luminance and illuminance: Since perceived brightness can change depending on ambient light conditions, it is necessary to establish objective, measurable limits on the amount of light that such billboards actually emit, and set different upper bounds for different environmental and ambient conditions.
- Display luminance in the event of failure: Roadway authorities should incorporate into their guidelines verifiable requirements that, in the event of any failure or combination of failures that affect DBB luminance, the display will default to an output level no higher than that which has been independently determined to be the acceptable maximum under normal operation.
- Longitudinal spacing between billboards: An approaching driver should not be faced with two or more digital billboard displays within his field of view at the same time.
- Digital billboard placement with relation to traffic control devices and driver decision and action points: Prohibitions against the placement of distracting irrelevant stimuli in roadway settings where drivers must make decisions and take actions should be imposed. The guidance for Queensland, Australia, might serve as a model.
- Annual operating permits: Government agencies and roadway operating authorities might consider the practice adopted in Oakdale, MN, where owners of digital billboards are granted a permit to operate a sign for a year and must renew the permit annually.

Section 7: Digital Billboards On-Premise and on the Right-Of-Way

On-Premise Signs
From page 161 of the report:

> … On-premise sign regulation is typically accomplished through local zoning codes, and may, in general, be far more variable and likely less stringent with regard to the means of the display, display characteristics, or the size of the sign than comparable controls on billboards. Many such codes have changed little in recent years, despite the growth of digital technology for on-premise displays.
>
> From the traffic safety perspective, it is possible that the risk of driver inattention and distraction is higher for some on-premise signs than for some [digital billboards], because on-premise signs may be larger and closer to the road, mounted at elevations closer to the approaching driver's eye level, and placed at angles that may require excessive head movements, In addition, many such signs may display animation, full motion video, sound, and other stimuli.
>
> … Agencies might want to consider restrictions for on-premise sign operations at least as rigorous as those for billboards, as well as restrictions on size, height, proximity to the right-of-way, and angular placement with regard to the oncoming driver's line of sight. Of all of the guidelines proposed in this report for [digital billboards], there may well be an equal or greater need to consider similar controls for on-premise signs. In addition, consideration must also be given to such signs' capacity for animation, flashing lights or other special effects, and full motion video.

Digital Billboards within the Right-of-Way
The FHWA opposes advertising of any kind within the right of way (despite proposals for public-private partnerships in California and Nevada).

Wachtel concludes that permitting California to study its proposed exceptions to the requirements of the MUTCD and existing federal law would bring about several adverse consequences, including undermining decades of human factors research, setting a dangerous precedent and opening to challenge the entire basis of the MUTCD.

Section 8: New Technology, New Applications, New Challenges
The potential for driver distraction displaying billboards (electronic and otherwise) on moving vehicles is high, as it is for personalized and interactive billboards.

Section 9: Summary and Conclusions
From page 179 of the report:

> In short, the issue of the role of [digital billboards (DBBs)] in traffic safety is extremely complex, and there is no single research study approach that can provide answers to all of the many questions that must be raised in looking at this issue. … A small number of important research studies, all published (or to be published) within the past several years, may have opened the door to a solution to the long-standing question of whether unsafe levels of driver distraction can occur from roadside billboards. … [One study found] that a driver's eyes-off-road time due to external-to-the-vehicle distraction or inattention was estimated to cause more than 23% of all crashes and near crashes that occurred. … [Another study shows] significantly longer average glance durations to roadside digital signs than to "baseline" sites and to traditional (fixed) billboards, and the researchers suggest, *all* measures of visual glances indicative of driver distraction would prove to be significantly worse in the presence of digital signs if a full study was to be conducted at night. … [T]here is growing evidence that billboards can attract and hold a driver's attention for the extended periods of time that we now know to be unsafe.
>
> … [A]n on-road study (Lee, et al., 2007) using an instrumented vehicle found many more such long glances made to DBBs and similar "comparison sites" consisting of (among other things) on-premise digital signs, than there were to sites containing traditional, static billboards, or sites with no obvious visual elements. … From the same study, we have evidence expressed by the researchers that if we were to conduct our research at night we would find that *all* measures of eye glance behavior would demonstrate significantly greater amounts of distraction to digital advertisements than to fixed billboards or to the natural roadside environment, and that driver vehicle control behaviors such as lane-keeping and speed maintenance would also suffer in the presence of these digital signs.
>
> … When we add the results of these recent, applied research studies, to the earlier theoretical work by Theeuwes and his colleagues (1998, 1999), in which they demonstrated that our attention and our eye gaze is reflexively drawn to an object of different luminance in the visual field, that this occurs even when we are engaged in a primary task, and regardless of whether we have any interest in this irrelevant stimulus, and that we may have no recollection of having been attracted to it, we have a growing, and consistent picture of the adverse impact of irrelevant, outside-the-vehicle distracters such as DBBs on driver performance.

Note: In the citations that follow, all references to "Wachtel" are from the 2009 report citation given on page 4 of this report.

The Effects of Commercial Electronic Variable Message Signs (CEVMS) on Driver Attention and Distraction: An Update, Federal Highway Administration, Report No. FHWA-HRT-09-018, February 2009.
http://www.fhwa.dot.gov/realestate/cevms.pdf
From the abstract: The present report reviews research concerning the possible effects of Commercial Electronic Variable Message Signs (CEVMS) used for outdoor advertising on driver safety. Such CEVMS displays are alternatively known as Electronic Billboards (EBB) and Digital Billboards (DBB). The report consists of an update of earlier published work, a review of applicable research methods and techniques, recommendations for future research, and an extensive bibliography. The literature review update covers recent post-hoc crash studies, field investigations, laboratory investigations, previous literature reviews, and reviews of practice. The present report also examines the key factors or independent variables that might affect a driver's response to CEVMS, as well as the key measures or dependent variables which may serve as indicators of driver safety, especially those that might reflect attention or distraction. These key factors and measures were selected, combined, and integrated into a set of alternative research strategies. Based on these strategies, as well as on the review of the literature, a proposed three stage program of research has been developed to address the problem. The present report also addresses CEVMS programmatic and research study approaches. In terms of an initial research study, three candidate methodologies are discussed and compared. These are: (1) an on-road instrumented vehicle study, (2) a naturalistic driving study, and (3) an unobtrusive observation study. An analysis of the relative advantages and disadvantages of each study approach indicated that the on-road instrumented vehicle approach was the best choice for answering the research question at the first stage.

Wachtel notes:

> It should be noted that this project was performed essentially in parallel with the present study. Although both looked at the recent literature that addressed driver behavior and performance in the presence of DBBs, the two studies had different goals and took different approaches. The study by Molino and his colleagues was intended to identify gaps in our current knowledge and design a research strategy to begin to fill those gaps, with the ultimate goal of providing the FHWA Office of Real Estate Services with a sufficient empirical basis from which to develop or revise, if appropriate, guidance and/or regulation for the use of DBBs along the Federal Aid Highway System. These goals differed considerably from the present study, whose purpose was to review, not only the recent research literature, but also existing guidelines and/or regulations that have been developed in the U.S. and abroad to address DBBs. Finally, the ultimate goal of the present study was to take what is known from the research, combine this knowledge with what has worked for regulatory authorities, and recommend new guidelines and/or regulations that could be enacted by State and local governments, and private and toll road authorities, without the need or the ability to wait for the completion of additional research. The FHWA study had no such objective.

The Effects of Visual Clutter on Driving Performance, Jessica Edquist, Accident Research Centre, Monash University, February 24, 2009.
http://www.tml.org/legal_pdf/Billboard-study-article.pdf
From the abstract: Driving a motor vehicle is a complex activity, and errors in performing the driving task can result in crashes which cause property damage, injuries, and sometimes death. It is important that the road environment supports drivers in safe performance of the driving task. At present, increasing amounts of visual information from sources such as roadside advertising create visual clutter in the road environment. There has been little research on the effect of this visual clutter on driving performance, particularly for vulnerable groups such as novice and older drivers. The present work aims to fill this gap. Literature from a variety of relevant disciplines was surveyed and integrated, and a model of the mechanisms by which visual clutter could affect performance of the driving task was developed. To determine potential sources of clutter, focus groups with drivers were held and two studies involving subjective ratings of visual clutter in photographs and video clips of road environments were carried out. This resulted in a taxonomy of visual clutter in the road environment: "situational clutter", including

vehicles and other road users with whom drivers interact; "designed clutter", including road signs, signals, and markings used by traffic authorities to communicate with users; and "built clutter", including roadside development and any signage not originating from a road authority. The taxonomy of visual clutter was tested using the change detection paradigm. Drivers were slower to detect changes in photographs of road scenes with high levels of visual clutter than with low levels, and slower for road scenes including advertising billboards than road scenes without billboards. Finally, the effects of billboard presence and lead vehicles on vehicle control, eye movements and responses to traffic signs and signals were tested using a driving simulator. The number of vehicles included appeared to be insufficient to create situational clutter. However billboards had significant effects on driver speed (slower), ability to follow directions on road signs (slower with more errors), and eye movements (increased amount of time fixating on roadsides at the expense of scanning the road ahead). Older drivers were particularly affected by visual clutter in both the change detection and simulated driving tasks. Results are discussed in terms of implications for future research and for road safety practitioners. Visual clutter can affect driver workload as well as purely visual aspects of the driving task (such as hazard perception and search for road signs). When driver workload is increased past a certain point other driving tasks will also be performed less well (such as speed maintenance). Advertising billboards in particular cause visual distraction, and should be considered at a similar level of potential danger as visual distraction from in-vehicle devices. The consequences of roadside visual clutter are more severe for the growing demographic of older drivers. Currently, road environments do not support drivers (particularly older drivers) as well as they could. Based on the results, guidance is given for road authorities to improve this status when designing and location road signage and approving roadside advertising.

The Impact of Roadside Advertising on Driver Distraction: Final Report, WSP Development and Transportation, June 2008.
http://www.highways.gov.uk/knowledge_compendium/assets/documents/Portfolio/The%20impact%20of%20roadside%20advertising%20on%20the%20travelling%20public%20-%20Report%20-%201103.pdf
This report argues against the use of accident data in evaluating the impacts of billboards. Wachtel summarizes these arguments as follows:

- There could be other unknown variables that could have led to the reported accidents.
- There are many opportunities for error or omission in data entry in police accident reporting forms.
- In minor accidents, the involved vehicles may move away from the point of rest (POR) to clear traffic lanes, thus further degrading the potential accuracy of identifying the true location. The POR of the involved vehicle(s) (which is what is commonly identified in police reports) may have little relationship to the point of distraction that was the proximal cause of the crash.
- Accidents, particularly minor accidents, are underreported.
- Accident data considers only those incidents that result in an actual collision. But there are likely many more incidences of distraction that result in driver error (such as late braking, lane exceedances) without consequence, and others that result in "near misses" that might have resulted in a crash but for the evasive actions of another driver. "As no data on 'near misses' is available, it is not possible to quantify the full effect of distraction" (p. 35).

Wachtel also summarizes the reports broad conclusions as follows:

- Although it is accepted that drivers are responsible for attending to the driving task, "visual clutter is liable to overload or distract drivers" (p. 63).
- The stakeholders could not provide statistical evidence to demonstrate the presence or absence of a correlation between roadside advertising and accidents.
- There is no desire for an outright ban on roadside advertising, but there is general agreement about the need for more guidance or regulation to control the type, location and content of such advertising.
- There is a need for additional governmental powers to remove unauthorized advertising, and there is a need to make enforcement a greater priority.

***A Study of the Relationship between Digital Billboards and Traffic Safety in Cuyahoga County, Ohio**, Tantala Associates, sponsored by the OAAA, July 2007.
Citation at http://trid.trb.org/view/2007/M/1154756
This study sponsored by the Outdoor Advertising Association of America uses police reports to examine the statistical relationship between certain digital billboards and traffic safety for seven locations in Cuyahoga County. Results show no statistical relationship between the presence of digital billboards and accidents.

Wachtel notes:

> The authors performed a post-hoc accident analysis study in which they reviewed statistical summaries of traffic collision reports, the originals of which had been prepared by investigating police officers. There are serious, inherent weaknesses in the use of this technique; such weaknesses have been understood and well documented for many years (see, for example, Wachtel and Netherton, 1980; Klauer, et al., 2006b; Speirs, et al., 2008). The use of this approach to relate crashes to driver distraction from DBBs, however, raises additional concerns.

Wachtel goes on to give an extensive critique of this study (pages 89 to 101), reprising his criticisms in the following review:

> **A Critical, Comprehensive Review of Two Studies Recently Released by the Outdoor Advertising Association of America**, Jerry Wachtel, The Veridian Group, October 18, 2007.
> http://www.scenic.org/storage/documents/Wachtel_Maryland_review.pdf
> *From the report:* In July 2007, the Outdoor Advertising Association of America (OAAA) announced on its website the issuance of two "ground-breaking studies" that addressed the human factors and driver performance issues associated with real-world digital (or electronic) billboards (EBBs), and the impact of such billboards on traffic accidents (Outdoor Advertising Association of America, 2007). … As a result of the issuance of these two studies and the claims made for them, and because of the need to address this technology by Government agencies nationwide, the Maryland State Highway Administration (MDSHA) asked this reviewer to perform an independent peer review of each of the two studies. This report represents the results of that review. … Having completed this peer review, it is our opinion that acceptance of these reports as valid is inappropriate and unsupported by scientific data, and that ordinance or code changes based on their findings is ill advised.

***Driving Performance and Digital Billboards**, Suzanne E. Lee, Melinda J. McElheny, Ronald Gibbons, Center for Automotive Safety Research, Virginia Tech Transportation Institute, sponsored by the OAAA, March 22, 2007.
http://www.oaaa.org/UserFiles/File/Legislative/Digital/6.3.9b%20Driver%20Behavior%20Research.pdf
From the abstract: Thirty-six drivers drove an instrumented vehicle on a 50-mile loop route in the daytime along some of the interstates and surface streets in Cleveland [OH]. … The overall conclusion, supported by both the eyeglance results and the questionnaire results, is that the digital billboards seem to attract more attention than the conventional billboards and baseline sites. Because of the lack of crash causation data, no conclusions can be drawn regarding the ultimate safety of digital billboards. Although there are measurable changes in driver performance in the presence of digital billboards, in many cases these differences are on a par with those associated with everyday driving, such as the on-premises signs located at businesses.

Driven to Distraction: Determining the Effects of Roadside Advertising on Driver Attention, Mark S. Young, Janina M. Mahfoud, Brunel University, 2007.
http://bura.brunel.ac.uk/bitstream/2438/2229/1/Roadside%20distractions%20final%20report%20%28Brunel%29.pdf
From the abstract: There is growing concern that roadside advertising presents a real risk to driving safety, with conservative estimates putting external distractors responsible for up to 10% of all accidents. In this report, we present a simulator study quantifying the effects of billboards on driver attention, mental workload and performance in Urban, Motorway and Rural environments. The results demonstrate that roadside advertising has a clear detrimental effect on lateral control, increases mental workload and eye fixations, and on some roads can draw attention away from more relevant road signage. Detailed analysis of the data suggests that the effects of billboards may in fact be more consequential in scenarios which are monotonous or of lower workload. Nevertheless, the overriding conclusion is that prudence should be exercised when authorising or placing roadside advertising. The findings are discussed with respect to governmental policy and guidelines.

Wachtel gives an extensive critique of the methodology for this industry-sponsored study (pages 101 to 114).

The Impact of Driver Inattention on Near-Crash/Crash Risk: An Analysis Using the 100-Car Naturalistic Driving Study Data, S.G. Klauer, T.A. Dingus, V.L. Neale, J.D. Sudweeks, D.J. Ramsey, Virginia Tech Transportation Institute, April 2006.
http://www.nhtsa.gov/DOT/NHTSA/NRD/Multimedia/PDFs/Crash%20Avoidance/2006/DriverInattention.pdf
From the abstract: The purpose of this report was to conduct in-depth analyses of driver inattention using the driving data collected in the 100-Car Naturalistic Driving Study. An additional database of baseline epochs was reduced from the raw data and used in conjunction with the crash and near-crash data identified as part of the original 100-Car Study to account for exposure and establish near-crash/crash risk. The analyses presented in this report are able to establish direct relationships between driving behavior and crash and near-crash involvement. Risk was calculated (odds ratios) using both crash and near-crash data as well as normal baseline driving data for various sources of inattention. The corresponding population attributable risk percentages were also calculated to estimate the percentage of crashes and near-crashes occurring in the population resulting from inattention. Additional analyses involved: driver willingness to engage in distracting tasks or driving while drowsy; analyses with survey and test battery responses; and the impact of driver's eyes being off of the forward roadway. The results indicated that driving while drowsy results in a four- to six-times higher near-crash/crash risk relative to alert drivers. Drivers engaging in visually and/or manually complex tasks have a three-times higher near-crash/crash risk than drivers who are attentive. There are specific environmental conditions in which engaging in secondary tasks or driving while drowsy is more dangerous, including intersections, wet roadways, and areas of high traffic density. Short, brief glances away from the forward roadway for the purpose of scanning the driving environment are safe and actually decrease near-crash/crash risk. Even in the cases of secondary task engagement, if the task is simple and requires a single short glance, the risk is elevated only slightly, if at all. However, glances totaling more than 2 seconds for any purpose increase near-crash/crash risk by at least two times that of normal, baseline driving.

Driving Performance in the Presence and Absence of Billboards, Suzanne E. Lee, Erik C.B. Olsen, Maryanne C. DeHart, Virginia Polytechnic Institute and State University, February 29, 2004.
Citation at http://trid.trb.org/view/2004/M/811075
From the abstract: The current project was undertaken to determine whether there is any change in driving behavior in the presence or absence of billboards. Several measures of eyeglance location were used as primary measures of driver visual performance. Additional measures were included to provide further insight into driving performance—these included speed variation and lane deviation. The overall conclusion from this study is that there is no measurable evidence that billboards cause changes in driver

behavior, in terms of visual behavior, speed maintenance, and lane keeping. A rigorous examination of individual billboards that could be considered to be the most visually attention-getting demonstrated no measurable relationship between glance location and billboard location. Driving performance measures in the presence of these specific billboards generally showed less speed variation and lane deviation. Thus, even in the presence of the most visually attention-getting billboards, neither visual performance nor driving performance changes measurably. Participants in this study drove a vehicle equipped with cameras in order to capture the forward view and two views of the driver's face and eyes. The vehicle was also equipped with a data collection system that would capture vehicle information such as speed, lane deviation, GPS location, and other measures of driving performance. Thirty-six drivers participated in the study, driving a 35-mile loop route in Charlotte, North Carolina. A total of 30 billboard sites along the route were selected, along with six comparison sites and six baseline sites. Several measures were used to examine driving performance during the 7-seconds preceding the billboard or other type of site. These included measures of driver visual performance (forward, left, and right glances) and measures of driving performance (lane deviation and speed variation). With 36 participants and 42 sites, there were 1,512 events available for analysis. A small amount of data was lost due to sensor outages, sun angle, and lane changes, leaving 1,481 events for eyeglance analysis and 1,394 events for speed and lane position analysis. Altogether, 103,670 video frames were analyzed and 10,895 glances were identified. There were 97,580 data points in the speed and lane position data set. The visual performance results indicate that billboards do not differ measurably from comparison sites such as logo boards, on-premises advertisements, and other roadside items. No measurable differences were found for visual behavior in terms of side of road, age, or familiarity, while there was one difference for gender. Not surprisingly, there were significant differences for road type, with surface streets showing a more active glance pattern than interstates. There were also no measurable differences in speed variability or lane deviation in the presence of billboards as compared to baseline or comparison sites. An analysis of specific, high attention-getting billboards showed that some sites show a more active glance pattern than other sites, but the glance locations did not necessarily correspond to the side of the road where the billboards were situated. The active glance patterns are probably due more to the road type than to the billboard itself. One major finding was that significantly more time was spent with the eyes looking forward (eyes on road) for billboard and comparison sites as compared to baseline sites, providing a clue that billboards may actually improve driver visual behavior. Taken as a whole, these analyses support the overall conclusion that driving performance does not change measurably in the presence or absence of billboards.

Effects of Roadside Advertisements on Road Safety, Finnish Road Administration, 2004.
http://alk.tiehallinto.fi/julkaisut/pdf/4000423e-veffectsofroadside.pdf
From the abstract: The effects of roadside advertisements on road safety have been studied using various methods. The topic was studied in Finland especially in the 1970s and 1980s. The results of those studies can be summarised thusly:

- In general, the number of accidents occurring near roadside advertisements has not been observed to be higher than at reference sites.
- The negative effects of advertisements are, however, visible in accident statistics if they are focused on limited conditions (junctions).
- The effects of advertisements are apparent in driver behaviour, but the effects measured in normal traffic are small.
- Advertisements along main roads distract the detection of traffic signs and possibly also other objects relevant to the driver's task.

"Observed Driver Glance Behavior at Roadside Advertising Signs," *Transportation Research Record 1899*, 2004: 96-103.
Citation at http://trid.trb.org/view/2004/C/749677
From the abstract: This study focused on the glance behavior of 25 drivers at various advertising signs along an expressway in Toronto, Ontario, Canada. The average duration of the glances for the subjects was 0.57 s [standard deviation (SD) = 0.41], and in total there was an average of 35.6 glances per subject (SD = 26.4). Active signs that contained movable displays or components made up 51% of the signs and received significantly more glances (69% of all glances and 78% of long glances). The number of glances was significantly lower for passive signs (0.64 glances per subject per sign) than for active signs (greater than 1.31 glances per subject per sign). The number of long glances was also greater for active signs than for passive signs. Sign placement in the visual field may be critical to a sign being noticed or not. Empirical information is provided to assist regulatory agencies in setting policy on commercial signing.

Wachtel notes:

> The implication for digital signs is that the shorter the period of time for which a given message is presented, and thus the more likely it is that a given approaching driver will see one or more message changes, the more likely it is that a driver will glance at such a sign for a longer period in anticipation of the next message to be displayed. Further, digital billboards display some characteristics of both fixed, traditional billboards and the types of active signs examined here. For example, a digital billboard may display a fixed image to any particular approaching driver, but depending upon its message cycle time, a driver may see one or more different displays. In this way, it is not unlike the roller signs discussed in this study, and, depending upon the display duration and change interval, digital signs may attract the same kind of attention expressed by some of the respondents in this study. Finally, a digital billboard is likely to possess image brightness, color, contrast, and image fidelity far higher than that achieved by any of the four sign types examined by the authors in this study. While the implications of these technological advances suggest that digital billboards would be more effective at capturing attention, this remains an empirical question.

"Driver Distraction by Advertising: Genuine Risk or Urban Myth?" Brendan Wallace, *Proceedings of the Institution of Civil Engineers*, *Municipal Engineer*, Vol. 156, Issue 3, September 2003: 185-190.
Citation at http://trid.trb.org/view/2003/C/688088
From the abstract: Drivers operate in an increasingly complex visual environment, and yet there has been little recent research on the effects this might have on driving ability and accident rates. This paper is based on research carried out for the Scottish Executive's Central Research Unit on the subject of external-to-vehicle driver distraction. A literature review/meta-analysis was carried out with a view to answering the following questions: is there a serious risk to safe driving caused by features in the external environment, and if there is, what can be done about it? Review of the existing literature suggests that, although the subject is under-researched, there is evidence that in some cases overcomplex visual fields can distract drivers and that it is unlikely that existing guidelines and legislation adequately regulate this. Theoretical explanations for the phenomenon are offered and areas for future research highlighted.

Wachtel summarizes the major conclusions as follows:

- The adverse effect of billboards is real, but situation specific.
- Too much visual clutter at or near intersections can interfere with drivers' visual search and lead to accidents.
- It is "probable" that isolated, illuminated billboards in an otherwise boring section of highway can create distraction through phototaxis.

Research Review of Potential Safety Effects of Electronic Billboards on Driver Attention and Distraction, Federal Highway Administration, September 11, 2001.
http://www.fhwa.dot.gov////realestate/elecbbrd/elecbbrd.pdf
This report reviews the literature on electronic billboards (with a focus on implications for safety) from 1980 to 2001. Based on the literature review, it identifies knowledge gaps and potential research questions categorized by roadway characteristics such as curves, interchanges and work zones; electronic billboard characteristics such as exposure time, motion and legibility; and driver characteristics such as familiarity and age. Related research findings on the legibility of changeable message signs are also included.

Wachtel gives the following overview of the report's conclusions:

> A number of the conclusions reached, while highly relevant, might be seen even more strongly in light of the observations made by other researchers. For example, the authors appropriately suggest that there may be lessons from studies into the legibility and conspicuity of official changeable message signs that could be applied to [digital billboards (DBBs)]. They further discuss the fact that low levels of illumination on official signs could lead to reduced conspicuity and, hence, reduced legibility. This difficulty might be exacerbated because DBBs typically have very high luminance levels, often leading to complaints by the traveling public as well as regulators. These high luminance levels may increase the conspicuity of the DBBs at the expense of official signs. Similarly, the authors discuss differences in response to signs by familiar vs. unfamiliar drivers, since it is understood that motorists who pass the same signs regularly become acclimated to their presence and may ignore them. Of course, one of the defining characteristics of DBBs is their ability to display a new message every few seconds, thus, in effect, presenting displays that are always new and therefore unfamiliar to all drivers.

The report also gives an overview of state regulations and practices as of 2001 (pages 5-9 and Appendices B and C) of 42 states:

- Thirty-six states had prohibitions on signs with red, flashing, intermittent or moving lights.
- Twenty-nine states prohibited signs that were so illuminated as to obscure or interfere with traffic control devices.
- Twenty-nine states prohibited signs located on Interstate or primary highway outside of the zoning authority of incorporated cities within 500 feet of an interchange or intersection at grade or safety roadside area.

"An Evaluation of the Influence of Roadside Advertising on Road Safety in the Greater Montreal Region," J. Bergeron, *Proceedings of the 1997 Conference of the Northeast Association of State Transportation Officials*, 1997: 527.
Citation at http://trid.trb.org/view/1997/C/539081
Wachtel summarizes this report's conclusions as follows:

- Attentional resources needed for the driving task are diverted by the irrelevant information presented on advertising signs. This is an impact attributable to the "nature of the information" that is conveyed on such signs. This distraction leads to degradation in oculomotor performance that adversely affects reaction time and vehicle control capability.
- When the driving task imposes substantial attentional demands such as might occur on a heavily traveled, high speed urban freeway, billboards can create an attentional overload that can have an impact on micro- and macro-performance requirements of the driving task. In other words, the impact of the distraction varies according to the complexity of the driving task. The greater the driving task demands, the more obvious are the adverse effects of the distraction on driving performance.
- The difficulty of the driving task can vary in several ways. Those that relate to the physical environment (e.g., weather, roadway geometry, road conditions) are unavoidable, and drivers must adjust to them (unless they take an alternate route or wait for better conditions). Necessary

sensory information adds to the workload of the driving task, but is, of course, needed to perform safely. In addition, road signs and signals that communicate complex but necessary information contribute to the overall workload of driving. In this case, however, years of study have been directed toward making this information as clear and as easily accessible as possible.

- To some extent, the level of mental workload that impacts driving occurs at a pre-processing level. Bergeron cites, as an example, a complex or cluttered visual environment. In this case, the attentional effort that drivers expend in searching for target objects (e.g., signs and signals) will be more laborious, demand more resources, and lead to declines in performance levels.
- The presence of a billboard increases the confusion of the visual (back)ground and may lead to conflict with road signs and signals.
- Situational factors that are likely to create a heavy mental workload include: complex geometry, heavy traffic, high speeds, areas of merging and diverging traffic, areas with road signs where drivers must make decisions, roadways in poor repair, areas of reduced visibility, and adverse weather conditions.
- The very characteristics of billboards that their designers employ to enable them to draw attention are those that have the greatest impact on what Bergeron calls attentional diversion.
- Drivers must constantly carry out the work of recognizing stimuli that may not be immediately meaningful to them. This task requires time and mental resources, both of which are in limited supply.
- Attention directs perception, and vice versa. In other words, when we are looking for something, our sensory system places itself at the service of our attention. But it is also possible for a sensation to attract the attention of drivers because it may represent something that is of potential importance. For example, authorities put flashing lights on emergency vehicles because they want drivers to attend to them.

Review of Roadside Advertising Signs, Transportation Environment Consultants, Roads and Traffic Authority, August 1989.
Citation at http://trid.trb.org/view.aspx?id=350317
From the abstract: Some of the main findings are: 1) The review study did not identify any factor or experience which would substantiate, on safety grounds, the long standing policy of prohibiting the erection of advertising signs within the road reserves of declared roads, including freeways. In fact, the literature survey, embracing over 40 publications including a comprehensive safety survey as recently as 1985, did not identify any evidence to say that, in general, advertising signs are causing traffic accidents. 2) Human factors research confirms the principle of the limited processor capacity of the driver. Management of stimuli to the driver, both inherent to the driving task and from external (distractions) sources, requires scrutiny as driving performance deteriorates when high levels of attention and decision making are involved. 3) Motorists information needs systems comprise a 'navigational' and a 'services information' component. There is a strong correlation between these needs and the adequacy of display of such information by traditional forms of advertising. 4) Changing values of aesthetics and amenity have resulted from community concerns with the disorder and clutter of traditional roadside advertising; 5) Subject to specified control conditions, advertising signs may be permitted within the road reserve of declared roads, including freeways. Desirably such signs should provide directional, tourist, services and locational information.

Wachtel summarizes the report's conclusions as follows:

- Research confirms the limited processor capacity of a driver.
- It is important that management of stimuli to the driver, both inherent to the primary task of driving and external to it (distraction) must clearly aim not to exceed the optimum rate for safe and efficient driver performance.
- When these external stimuli fall significantly below optimum, driver performance may decrease (boredom), and additional external stimuli could benefit driver response.

- Additional attentional loading by advertising signs may impair driving performance when high levels of attention and decision making are required.
- Advertisements not associated with navigational and services information needs can, subject to relevant safety controls, be permitted at roadside locations where the driving task does not heavily load the attentional capacity of the driver.

Interestingly, they reported from their interview with a Dr. S. Jenkins of the ARRB, his recommendation that "changeable message signs could be used in roadside advertisements providing each message is 'static for about 5 minutes' (i.e., the message on-time) and the changeover period between messages 'does not exceed about 2 seconds'" (p. 39).

In a later chapter of the report, the authors provide a series of "definitions and technology" (p. 49) to describe the different types of advertising signs that might be considered, and how they might be used. In a section on "internally illuminated signs" the authors provide a table showing what they consider to be the maximum luminance levels of advertising signs of different sizes which may be located in different driving environments. These data are based on recommendations from the Public Lighting Engineers in the U.K. With regard to "electronic variable-message signs" the authors devote several pages to defining terminology and identifying "factors" that should be taken into account when considering their impact (pp. 56-60). This discussion is taken directly from the Wachtel and Netherton (1980) report (pp. 68-74), and need not be repeated here.

Literature on Outdoor Advertising Safety Since the 2009 Wachtel Report

"Advertising Billboards Impair Change Detection in Road Scenes," J. Edquist, T. Horberry, S. Hosking, I. Johnston, *Proceedings of the Australasian Road Safety Research, Policing and Education Conference*, November 6-9, 2011.
http://casr.adelaide.edu.au/rsr/RSR2011/4CPaper%20166%20Edquist.pdf
From the abstract: The present experiment used the 'change detection' paradigm to examine how billboards affect visual search and situation awareness in road scenes. In a controlled experiment, inexperienced, older, and comparison drivers searched for changes to road signs and vehicle locations in static photographs of road scenes. On average, participants took longer to detect changes in road scenes that contained advertising billboards. This finding was especially true when the roadway background was more cluttered, when the change was to a road sign, and for older drivers. The results are consistent with the small yet growing body of evidence suggesting that roadside advertising billboards impair aspects of driving performance such as visual search and the detection of hazards, and therefore should be more precisely regulated in order to ensure a safe road system.

"Are Roadside Electronic Static Displays a Threat to Safety?" Rena Friswell, Elia Vecellio, Raphael Grzebieta, Julie Hatfield, Lori Mooren, Murray Cleaver, Michael De Roos, *Proceedings of the Australasian Road Safety Research, Policing and Education Conference*, November 6-9, 2011.
http://casr.adelaide.edu.au/rsr/RSR2011/4CPaper%20172%20Friswell.pdf
This study reviews the literature from 2001 to 2010 on the effects of electronic static displays (ESDs) on driver distraction, driving performance and safety, and discusses the implications of the findings for research and policy. Researchers found only 11 studies that bear directly on ESDs, and created two tables summarizing them (pages 5-8). Over half of the studies were conducted by Tantala and Tantala and were commissioned by the U.S. Outdoor Advertising Association of America, and most examined crash data before and after installation of ESDs. Five of the eight crash data studies reported no adverse effect of ESD installation on crashes, but both of the studies that compared post-installation crashes with the rates predicted by the trend in pre-installation crashes found statistically significant evidence of increased crashes following installation. Studies using measures other than crashes reported mixed findings. Gaze was directed toward the sign stimuli in the simulator and on-road studies, dual task reaction time was slowed in the presence of the sign stimuli in the laboratory experiment, and lane keeping was impaired in

the simulator study but reductions in lane keeping only approached significance on-road and there was no evidence of speed disruption on-road. Researchers conclude that while the research designs for these studies are weak, there does seem to be evidence that ESDs can have a negative impact on attention, driving performance and safety.

Outdoor Advertising Control Practices in Australia, Europe, and Japan, Federal Highway Administration, May 2011.
http://ntl.bts.gov/lib/42000/42200/42240/FHWA-PL-11-023.pdf
This study scanned practices in Australia, Sweden, the Netherlands and the United Kingdom to learn how they regulate outdoor advertising both inside and outside the roadway right of way, and also includes a desk scan of outdoor advertising practices in Japan.

General similarities between practices in the countries visited and those of the United States include (pages 1-2):

- Inconsistent enforcement and mixed success in developing more objective criteria for decision makers.
- Interest in growing commercial advertising in transportation corridors.
- Interest in generating revenue inside the right of way and removing some of the restrictions to commercial use of the right of way.
- Common interest in regulating new technologies to minimize driver distraction, such as use of and rules to govern commercial electronic variable message signs (CEVMS). The major focus is reducing crashes and fatalities.
- Prohibitions of signs that resemble official signs.
- Interest in reliable research on the safety impacts of outdoor advertising and CEVMS.

Differences (from pages 2-3 of the report) include:

- Where outdoor advertising is allowed in the countries visited, state and federal responsibility is limited to high-level and national routes.
- For permitting purposes, on-premise and off-premise signs are regulated.
- The national/federal government has a lesser role in the state's administration and program compliance.
- Sign businesses, site owners, and sign owners can incur penalties for noncompliance.
- Agencies in the countries visited rely more on safety factors and the relationship between the sign and the road environment for permitting decisions than agencies in the United States.
- Agencies have some control over message formatting, such as specifying font size and prohibiting phone numbers and e-mail addresses, to reduce driver distraction and reading time.
- Local planning authorities had more regulatory involvement in and control of sign permits in all countries visited because all areas were under some control, designation, or zoning. There were few unzoned areas because of more rigorous, comprehensive local planning and land use management.
- Use of the right- of- way for commercial billboards is limited, but more prevalent in locally controlled urban jurisdictions. One Australian state generated AU$15 million with advertising inside the right- of- way, but most countries visited are waiting until more conclusive research is done on driver distraction. Sweden is beginning a pilot.
- Signs may be removed after permitted if safety is a concern.
- In all of the countries visited, traffic and public safety play a more critical role in the permitting process than in the United States.
- All of the countries have developed criteria to identify unacceptable signs, such as those that resemble traffic control devices, could direct traffic, or could distract or confuse drivers.
- The safety evaluation process is more comprehensive, both in the documentation and burden of proof applicants must provide that a sign will not create a safety hazard and the review process after an application is submitted.

Based on this scan, researchers suggest the following steps to enhance safety (from page 4 of the report):

- Develop criteria to evaluate permit applications to identify signs that are unacceptable from a safety perspective because they resemble traffic control devices or could distract or confuse drivers.
- Update the assessment criteria used to review permit applications to reflect design, planning, environmental, and public and traffic safety criteria used by several countries visited.
- Update permitting requirements to include an analysis of the technical feasibility, benefits, safety impacts, and other effects of a proposed outdoor advertising installation.
- Conduct research on the safety impacts of outdoor advertising, and possibly require applicants to conduct a safety analysis to demonstrate the design and safety feasibility of proposed installations. Assess whether existing traffic data from intelligent transportation systems or traffic control centers could be used to track traffic patterns and establish the potential impacts of commercial electronic variable message signs on traffic flow.
- Study the effects of full-motion video on driver attention.

"Effects of Advertising Billboards During Simulated Driving," Jessica Edquist, Tim Horberry, Simon Hosking, Ian Johnston *Applied Ergonomics*, Vol. 42, Issue 4, May 2011: 619-626.
Citation at http://trid.trb.org/view/2011/C/1100574
From the abstract: The driving simulator experiment presented here examines the effects of billboards on drivers, including older and inexperienced drivers who may be more vulnerable to distractions. The presence of billboards changed drivers' patterns of visual attention, increased the amount of time needed for drivers to respond to road signs, and increased the number of errors in this driving task.

"Digital Billboards, Distracted Drivers," Jerry Wachtel, *Planning*, Vol. 77, Issue 3, March 2011: 25-27.
Citation at http://trid.trb.org/view/2011/C/1106533
From the abstract: This article discusses the negative consequences of billboards, especially those that employ digital technology. … An industry study has shown that drivers take their eyes off the road for two seconds or longer twice as often when they are looking at digital advertising signs than when they are looking at traditional billboards. … The author has identified four factors that could reduce the distraction caused by digital billboards: control the lighting at nighttime; lengthen the dwell time of messages; simplify the message by limiting the number and types of words and symbols; and prohibit message sequencing (i.e., the digital equivalent of Burma Shave-type signs).

"External Distractions: The Effects of Video Billboards and Windfarms on Driving Performance," *Handbook of Driving Simulation for Engineering, Medicine and Psychology*, CRC Press, 2011: 16-1 – 16-14.
Citation at http://trid.trb.org/view/2011/C/1114742
This study used a driving simulator to study driver reactions to the braking of a lead vehicle in the presence of wind turbines and digital video billboard. While perception response time was not affected by the presence of wind turbines, significantly more rear-end collisions occurred to the hard lead-vehicle braking event in the presence of video billboards than conventional billboard and control conditions.

***"An Examination of the Relationship between Digital Billboards and Traffic Safety in Reading, Pennsylvania, Using Empirical Bayes Analyses,"** *Moving Toward Zero: 2011 ITE Technical Conference and Exhibit*, sponsored by the Institute of Transportation Engineers, 2011.
Citation at http://trid.trb.org/view/2011/C/1103869
From the abstract: This paper examines the statistical relationship between advertising digital billboards and traffic safety using Empirical Bayes Method analyses. Specifically, this paper analyzes traffic and accident data near 26 existing, non-accessory, advertising digital billboards along routes with periods of comparison as long as 8 years in the greater Reading area, Berks County, Pennsylvania. These studied digital billboards are one type of commercial electronic variable message signs (CEVMS) which display

static messages, include no animation, flashing lights, scrolling, or full-motion video, and have duration times of 6, 8, or 10 seconds. Temporal (when and how frequently) and spatial (where and how far) statistics are summarized within multiple vicinity ranges as large as one mile near billboards. The study uses the Empirical Bayes (EB) method to predict the "expected" range of accidents at locations assuming that no digital billboard technology was introduced. The method analyzes data near 26 billboard locations, incorporates data using 51 non-digital comparison sites, and establishes a multivariate Crash Estimation Model (CEM) with a negative binomial distribution to estimate expected numbers of crashes near locations. Predictive methods in the AASHTO Highway Safety Manual are used with the Pennsylvania Department of Transportation (PennDOT) highway, geometric, and crash data.

Investigating Driver Distraction: The Effects of Video and Static Advertising, TRL Published Project Report, Transport Research Laboratory, 2010.
Citation at http://trid.trb.org/view/2010/M/919620
From the abstract: Roadside advertising is a common sight on urban roads. Previous research suggests the presence of advertising increases mental workload and changes the profile of eye fixations, drawing attention away from the driving task. This study was conducted using a driving simulator and integrated eye-tracking system to compare driving behaviour across a number of experimental advertising conditions. Forty eight participants took part in this trial, with three factors examined; Advert type, position of adverts and exposure duration to adverts. The results indicated that when passing advert positions, drivers: spent longer looking at video adverts; glanced at video adverts more frequently; tended to show greater variation in lateral lane position with video adverts; braked harder on approach to video adverts; drove more slowly past video adverts. The findings indicate that video adverts caused significantly greater impairment to driving performance when compared to static adverts. Questionnaire results support the findings of the data recorded in the driving simulator, with participants being aware their driving was more impaired by the presence of video adverts. Through analysis of the experimental data, this study has provided the most detailed insight yet into the effects of roadside billboard advertising on driver behaviour.

***"Quantifying External Vehicle Distractions and Their Impacts at Signalized Intersections,"** Raheem Dilgir, Cory Wilson, *ITE 2010 Annual Meeting and Exhibit*, sponsored by the Institute of Transportation Engineers, 2010.
http://www.ite.org/annualmeeting/compendium10/pdf/AB10H3702.pdf
This study investigated the safety impacts of visual distractions for vehicles at 28 signalized intersections in greater Vancouver, British Columbia, and Calgary, Alberta. Site visits were conducted to assess each intersection, and three years of collision data and traffic volumes were provided by road agencies. The results indicated a positive relationship between distraction score and collision rate as well as between distraction score and collision frequency. Analysis of individual distraction criteria revealed that the strongest correlation exists between roadside advertising and safety. No other specific element was significantly more influential than another regarding safety performance, suggesting that the combined effect of various distraction features is correlated to safety performance.

The Impact of Sacramento State's Electronic Billboard on Traffic and Safety, Mahesh Pandey, California State University, Sacramento, Summer 2010.
http://csus-dspace.calstate.edu/bitstream/handle/10211.9/282/Project%20Report10a.pdf?sequence=1
This student project evaluated the traffic and safety impact of a new electronic billboard near Sacramento State adjacent to Highway 50 by analyzing traffic flow parameters on upstream portions of electronic billboards on both directions of the highway before and after the installation. Data came from the California Freeway Performance Measurement System (PeMS) database for changes in common traffic flow parameters (speed, flow rate and lane occupancy) over a two-month period before and after the installation of the electronic billboard. This project also analyzed crash and collision data from PeMS for changes in noninjury, injury and fatal crashes over a one-year period before and a one-year period after the installation of the electronic billboard.

Results showed that the presence of the electronic billboard near Sacramento State does not appear to have a significant negative impact in traffic performance (flow, speed and lane occupancy) or incidents in the study section of the freeway. Because many of the road users at this segment are probably commuters, they may be familiar with the electronic billboard, and it does not appear to affect their driving. Even though electronic billboards are capable of displaying multiple messages/commercials at different times, the advertisements do not appear to be a major distraction to drivers at this location. No changes in measurable impact on road safety after the installation of the electronic billboard were observed. At the same time, a public opinion survey indicated that more than two-thirds of self-identified drivers through the study area who were surveyed believed that this electronic billboard does not pose a safety risk to traffic.

"Conflicts of Interest: The Implications of Roadside Advertising for Driver Attention," *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 12, Issue 5, September 2009: 381-388.
Citation at http://trid.trb.org/view/2009/C/902985
From the abstract: There is growing concern that roadside advertising presents a real risk to driving safety, with conservative estimates putting external distractors responsible for up to 10% of all road traffic accidents. In this report, we present a simulator study quantifying the effects of billboards on driver attention, mental workload and performance in urban, motorway and rural environments. The results demonstrate that roadside advertising has clear adverse effects on lateral control and driver attention, in terms of mental workload. Whilst the methodological limitations of the study are acknowledged, the overriding conclusion is that prudence should be exercised when authorizing or placing roadside advertising. The findings are discussed with respect to governmental policy and guidelines.

Digital Billboard Safety Amongst Motorists in Los Angeles, Steven Clark Henson, California State University Northridge, Spring 2009.
http://www.csun.edu/~sch60990/Geog_490_PAPER.pdf
The paper discusses the impact of digital billboards and driver safety in Los Angeles via a review of literature, driver behavior surveys and a spatial analysis of high traffic collision intersections and digital billboard locations. Of 76 intersections with digital billboards, only three (4 percent) were hazardous intersections (as defined by The 2008 California 5 Percent Report and driver surveys). However, 80 percent of drivers surveyed said they were more likely to glance at a digital billboard as opposed to a standard billboard, 42.8 percent said that digital billboards inhibited the ability of motorists to concentrate on the road, and all but two respondents said their glances are longer than two seconds.

Luminance Criteria and Other Human Factors for Sign Design

In the following studies, "luminance" refers to luminous intensity per unity area, measured in candela per square meter (cd/m^2, or "nit"). Luminance differs from brightness, which measures the subjective perception caused by an object's luminance, and can differ in various contexts for an object of the same luminance.

"Congruent Visual Information Improves Traffic Signage," *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 15, Issue 4, 2012: 438-444.
Abstract at: http://trid.trb.org/view/2012/C/1141270
From the abstract: This study investigated the interference effect produced by the position of the sign elements in traffic signage on response accuracy and reaction time. Sixteen drivers performed a flanker interference reaction time task. Incongruent graphical/space solutions, actually used for the airport stack-type sign, [led] to increased reaction time and a reduction in the proportion of correct answers. These results suggest that incongruent visual information should be avoided, as this might impair drivers' performance. These findings provide important information for the specification of future signage design guidelines and for improving road safety.

"A Study on Guide Sign Validity in Driving Simulator," Wei Zhonghua, Gong Ming, Guo Ruili, Rong Jian, *Transportation Research Board 91st Annual Meeting Compendium of Papers DVD*, Paper #12-1983, sponsored by Transportation Research Board, 2012.
Citation at http://trid.trb.org/view/2012/C/1129560
This project used a driving simulator to study guide sign legibility distance. Results indicated that legibility distance was inversely related to speed and positively related to the text height of the guide sign. When the speed is 20km/h, 30km/h or 40km/h, the magnifying power of text height is 4.3, 4.1 or 3.8, respectively.

"Luminance Criteria and Measurement Considerations for Light-Emitting Diode Billboards," John Bullough, Nicholas Skinner, *Transportation Research Board 90th Annual Meeting Compendium of Papers DVD*, Paper #11-0659, sponsored by Transportation Research Board, 2011.
ftp://ftp.hsrc.unc.edu/pub/TRB2011/data/papers/11-0659.pdf
From the abstract: The present paper summarizes luminance measurements and calculations for advertising billboard signs located adjacent to highways. The primary purpose of the present information is to provide preliminary estimates of conventional externally-illuminated billboard panel luminances in the driving environment. These estimates could form a partial basis for maximum luminance requirements for electronic billboards adjacent to highways using self-luminous light sources such as light-emitting diodes. Also discussed are considerations when making luminance measurements of billboard signs in the field.

Table 1 on page 3 has a summary of luminance measurements:

TABLE 1 Summary of Billboard Sign Characteristics and Luminance Measurements

Sign location, type and color	Direction of travel facing sign	Distance of sign from roadway edge (ft)	Measurement location (and distance)	Daytime luminance (cd/m²)	Nighttime luminance (cd/m²)
I-787 conventional (white)	northbound	125 (from southbound side)	I-787 southbound (n/a)	23,100	not measured
I-787 conventional	southbound	280	Erie Boulevard (340 ft away)	1230	4
I-90 conventional (beige)	westbound	70	Erie Boulevard (70 ft away)	2880	160
I-90 conventional (purple)	westbound	25 (from eastbound side)	Erie Boulevard (70 ft away)	540	8
I-90 conventional (white)	westbound	60	Anderson Drive (310 ft away)	3300	180
I-90 conventional (white)	eastbound	180	Watervliet Avenue (80 ft away)	13,100	240
I-90 conventional (yellow)	eastbound	75	Westgate Plaza (150 ft away)	3950	150
I-90 LED (yellow)	westbound	75	Anderson Drive (290 ft away)	3810	200
			I-90 westbound (n/a)	not measured	160
I-90 LED (light green)	eastbound	75 (from westbound side)	Anderson Drive (300 ft away)	4170	320
			I-90 eastbound (n/a)	not measured	220

Digital LED Billboard Luminance Recommendations: How Bright is Bright Enough? Christian B. Luginbuhl, Howard Israel, Paul Scowen, Jennifer and Tom Polakis, Arizona State University, November 9, 2010.
http://www.illinoislighting.org/resources/DigitalBillboardLuminanceRecommendation_ver7.pdf
From the abstract: Careful and sensible control of the nighttime brightness of digital LED signage is critical. Unlike previous technologies, these signs are designed to produce brightness levels that are visible during the daytime; should too large a fraction of this brightness be used at night serious consequences for driver visibility and safety are possible. A review of the lighting professional literature indicates that drivers should be subjected to brightness levels of no greater than 10 to 40 times the

brightness level to which their eyes are adapted for the critical driving task. As roadway lighting and automobile headlights provide lighting levels of about one nit, this implies signage should appear no brighter than about 40 nits. Standard industry practice with previous technologies for floodlit billboards averages less than 60 nits, and rarely exceeds 100 nits. It is recommended that the new technologies should not exceed 100 nits.

"Effect of Luminance and Text Size on Information Acquisition Time from Traffic Signs (With Discussion and Closure)," *Transportation Research Record 2122*, 2009: 52-62.
Citation at http://trid.trb.org/view/2009/C/881884
From the abstract: This study investigated the effect of (legend) luminance and letter size on the information acquisition time and transfer accuracy from simulated traffic signs. Luminances ranged from 3.2 cd/m² to 80 cd/m² on positive-contrast textual traffic sign stimuli with contrast ratios of 6:1 and 10:1, positioned at 33 ft/in. and 40 ft/in. legibility indices, and viewed under conditions simulating a nighttime driving environment. The findings suggest that increasing the sign luminance significantly reduces the time to acquire information. Similarly, increasing the sign size (or reducing the legibility index) also reduces the information acquisition time. These findings suggest that larger and brighter signs are more efficient in transferring their message to the driver by reducing information acquisition time, or alternatively, by increasing the transfer accuracy. In return, reduced sign viewing durations and increased reading accuracy are likely to improve roadway safety.

Note: the "legibility index" is:

> ... a numerical value representing the distance in feet at which a sign may be read for every inch of capital letter height. For example, a sign with a Legibility Index of 30 means that it should be legible at 30 feet with one inch capital letters, or legible at 300 feet with ten inch capital letters. (See http://www.usscfoundation.org/USSCSignLegiRulesThumb.pdf)

Driver Comprehension of Diagrammatic Freeway Guide Signs, Susan T. Chrysler, Alicia A. Williams, Dillon S. Funkhouser, Andrew J. Holick, Marcus A. Brewer, Texas Transportation Institute, February 2007.
http://tti.tamu.edu/documents/0-5147-1.pdf
From the abstract: This report contains the results of a three-phase human factors study which tested driver comprehension of diagrammatic freeway guide signs and their text alternatives. Four different interchange types were tested: left optional exit, left lane drop, freeway to freeway split with optional center lane, and two lane right exits with optional lanes. Three phases of the project tested comprehension by using digitally edited photographs of advance guide signs in freeway scenes. Participants viewed a computer slideshow in which slides were shown for only three seconds to simulate a single driver eye glance at a sign. All signs were mounted overhead in the photographs. Participants were provided a route number and city name as a destination that could be reached either by the through route or the exit route. They indicated which lane or lanes they would choose to reach the given destination. The fourth phase of the study used a fixed-base driving simulator which presented full sign sequences consisting of two advance guides and one exit direction sign. Performance measures were distance from the gore at which required lane changes were made and number of unnecessary lane changes made. Results showed that for the left exits the standard text-only signs performed equal to or better than the diagrammatic signs. This performance was true for left lane drops also. For the right exit with optional lane, the standard text signs did well, as did the diagrammatic signs. For freeway-to-freeway splits, standard text signs with two arrows over the optional lane performed better than either style of diagrammatic sign. This report also contains an extensive literature review of previous work in the area, a discussion of testing methodology, and suggestions for future research.

Enhancing Driving Safety through Proper Message Design on Variable Message Signs, Jyh-Hone Wang, Charles E. Collyer, Chun-Ming Yang, University of Rhode Island, Kingston, September 2005. Citation at http://trid.trb.org/view/2005/M/793262

From the abstract: This report presents a study that assessed drivers' responses to and comprehension of variable message sign (VMS) messages displayed in different ways with the intent to help enhance message display on VMSs. Firstly, a review of literatures and current practices regarding the design and display of VMS messages is presented. Secondly, the study incorporates three approaches in the assessment. Questionnaire surveys were designed to investigate the preferences of highway drivers in regards to six message display settings, they were: number of message frames, flashing effect, color, color combinations, wording, and use of abbreviations. Lab experiments were developed to assess drivers' responses to a variety of VMS messages in a simulated driving environment. Two groups of factors, within-subject and between-subject factors, were considered in the design of experiment. Within-subject factors included message flashing and color combination. Between-subject factors were age and gender. To help validate results found from lab experiments, field studies were set up to study drivers' response to VMS in real driving environment. Thirty-six subjects, from three age populations (20-40, 40-60, above 60 years old) with balanced genders, were recruited to participate in both questionnaire surveys and lab experiments while eighteen of them participated in field studies on a voluntarily basis. The study findings suggest a specific set of VMS features that might help traffic engineers and highway management design VMS signs that could be noticed, understood and responded to in a more timely fashion. Safer and more proactive driving experiences could be achieved by adopting these suggested VMS features.

State Regulations

State and Local Regulation Summaries

State Changeable Message Chart, Outdoor Advertising Association of America, undated. http://www.superliciousdesign.com/ledmedia/State_Changeable_Message.pdf (or see Appendix A). This chart summarizes changeable message advertising sign regulations for 46 states:

- Three states (New Hampshire, North Dakota and Wyoming) do not allow these signs.
- Five states (Maryland, Massachusetts, Oregon, Texas and Washington) allow tri-action signs only.
- Thirty-eight states allow changeable message signs. Of these, 19 states (California, Colorado, Connecticut, Delaware, Florida, Georgia, Indiana, Kansas, Michigan, Minnesota, Missouri, New Jersey, New York, Ohio, Oklahoma, Tennessee, Utah, Virginia and Wisconsin) have statutes; 10 states (Arkansas, Idaho, Illinois, Iowa, Louisiana, Nebraska, Nevada, North Carolina, South Carolina and West Virginia) have regulations; seven states (Alaska, Arizona, Kentucky, Montana, New Mexico, Rhode Island and South Dakota) have interpretations of the federal/state agreement; and two states (Mississippi and Pennsylvania) have policy memoranda.

The document categorizes each of these states by regulations for minimum message duration ("dwell time"—generally from 4 to 10 seconds, with 6 or 8 seconds most common); maximum interval between messages (typically from 1 to 4 seconds), and spacing (500 feet is most common). It is unclear how up-to-date these regulations are; we were unable to determine the date for this chart or obtain the latest information from the OAAA, which requires paid registration for access.

The Regulation of Signage: Guidelines for Local Regulation of Digital On-Premise Signs, Menelaos Triantafillou, Alan C. Weinstein, National Signage Research and Education Conference, 2010. http://www.thesignagefoundation.org/LinkClick.aspx?fileticket=3inv%2fFyrpFk%3d&tabid=59&mid=468

From the report: Based on a recent survey of numerous jurisdictions by one of the authors, the most common regulatory provisions applicable to digital on-premise signs appear below:

- Require that the sign display remain static for a minimum of 5-8 seconds and require "instantaneous" change of the display; i.e., no "fading" in/out of the message.
- Prohibit scrolling and animation outside of unique—and mostly pedestrian-oriented—locations.
- Limit brightness to 5,000 nits during daylight and 500 nits at night.
- Require automatic brightness control keyed to ambient light levels.
- Require display to go dark if there is a malfunction.
- Specify distancing requirements from areas zoned for residential use and/or prohibit orientation of s sign face towards an area zoned for residential use.

See also Appendices B and C in Research Review of Potential Safety Effects of Electronic Billboards on Driver Attention and Distraction in **Related Research** for an overview of state regulations and practices as of 2001.

Survey of Current State Regulations

We found digital display regulations for 12 states. These regulations are summarized in the following table and then detailed by state.

State	Duration ≥	Inter-val ≤	Brightness/ Illumination	Font Size	Visual Effects	Sequencing	Spacing	Locations	Billboard Size
DE	10s	1s	Must appropriately adjust display brightness as ambient light levels change.	Size not specified. A sign that attempts or appears to attempt to direct the movement of traffic or which contains wording, color, shapes, or likenesses of official traffic control devices is prohibited.	May not contain or display any lights, effects, or messages that flash, move, appear to be animated or to move, scroll, or change in intensity during the fixed display period	Prohibited.	>2,500ft from another VMS >500ft from a static sign	Permitted within 660ft of the edge of the right-of-way of any interstate or federal-aid primary highway. > 1,000ft from an interchange, interstate junction of merging or diverging traffic, or an at-grade intersection. May not be placed along designated Delaware byways.	Not specified.
FL	6s	2s	Lighting which causes glare or impairs the vision of the driver of any motor vehicle, or which otherwise interferes with any driver's operation of a motor vehicle is prohibited. A sign may not be illuminated so that it interferes with the effectiveness of, or obscures, an official traffic sign, signal or device. Lighting may not be added to or increased on a nonconforming sign.	Not specified.	Flashing, intermittent, rotating, or moving lights are prohibited. Instantaneous transition for entire sign face required.	Not specified.	Not specified.	Not specified.	Not specified.

State	Duration ≥	Inter-val ≤	Brightness/ Illumination	Font Size	Visual Effects	Sequencing	Spacing	Locations	Billboard Size
GA	10s	3s	Must be effectively shielded so as to prevent beams or rays of light from being directed at any portion of the traveled way, which beams or rays are of such intensity or brilliance as to cause glare or to impair the vision of the driver of any motor vehicle or which otherwise interfere with the operation of a motor vehicle. Must not obscure or interfere with the effectiveness of an official traffic sign, device, or signal.	Not specified.	May not contain flashing, intermittent, or moving light or lights except those giving public service information such as time, date, temperature, weather.	Not specified.	>5,000ft from another multiple message sign.	Not specified.	Not specified.
IA	8s	1s	The intensity of the illumination may not cause glare or impair the vision of the driver of any motor vehicle or otherwise interferes with any driver's operation of a motor vehicle.	Not specified.	No traveling messages (e.g., moving messages, animated messages, full-motion video, or scrolling text messages) or segmented messages are allowed.	No segmented messages allowed.	>500ft from another LED display facing the same way in cities. >1000ft in rural areas.	Not specified.	Not specified.
KS	8s	2s	Must be effectively shielded so as to prevent beams or rays of light from being directed at any portion	Not specified.	Cannot contain or display flashing, intermittent or moving lights, including	Not specified.	>1000ft from another CMS.	Not specified.	Not specified.

State	Duration ≥	Inter-val ≤	Brightness/ Illumination	Font Size	Visual Effects	Sequencing	Spacing	Locations	Billboard Size
			of the traveled way of any interstate or primary highway and are of such intensity or brilliance as to cause glare or to impair the vision of the driver of any motor vehicle or to otherwise interfere with any driver's operation of a motor vehicle. Must not be so illuminated that they obscure any official traffic sign, device or signal, or imitate or may be confused with any official traffic sign, device or signal.		animated or scrolling advertising.				
MA	10s	0s	Must automatically adjust the intensity of its display according to natural ambient light conditions. May not cause beams or rays of light from being directed at any portion of the traveled way, which beams or rays are of such intensity or brilliance as to cause glare or to impair the vision of the driver of any motor vehicle or otherwise interfere with the operation of a motor	Not specified.	May not contain flashing, intermittent, or moving lights; or display animated, moving video, scrolling advertising; or consist of a static image projected upon a stationary object. May not display illumination that moves, appears to move or changes in intensity during	Not specified.	>500ft from any sign. >2000ft from another off premise electronic sign on the same side of the highway. >1000ft from another off premise electronic sign on the opposite side of the	Not specified.	Not specified.

State	Duration ≥	Inter-val ≤	Brightness/ Illumination	Font Size	Visual Effects	Sequencing	Spacing	Locations	Billboard Size
			vehicle. May not obscure or interfere with the effectiveness of an official traffic sign, device or signal, or cause an undue distraction to the traveling public		the static display period. This does not include changes to a display for time, date and temperature.		highway.		
NY	6s	3s	Not specified.	Not specified.	Not specified.	Not specified.	Not specified.	Not specified.	Not specified.
OH	8s	3s	Not specified.	Not specified.	A multiple message or variable message advertising device shall not be illuminated by flashing, intermittent, or moving lights. No multiple message or variable message advertising device may include any illumination which is flashing, intermittent, or moving when the sign face is in a fixed position.	Not specified.	>1000ft from another MMS.	Not specified.	Not specified.
OR	8s	2s	Must operate at an intensity level of not more than 0.3 foot-candles over ambient light as measured by the distance to the sign	Not specified.	No flashing or varying intensity light; cannot create the appearance of movement.	Not specified.	Not specified.	Not specified.	Not specified.

State	Duration ≥	Inter-val ≤	Brightness/ Illumination	Font Size	Visual Effects	Sequencing	Spacing	Locations	Billboard Size
			depending upon its size (150 feet if the display surface of the sign is 12 feet by 25 feet, 200 feet if the display surface is 10.5 by 36 feet, and 250 feet if the display surface is 14 by 48 feet).						
TN	8s	2s	Not specified.	Not specified.	Video, animation, and continuous scrolling messages are prohibited.	Not specified.	>2000ft from another CMS.	Not specified.	Not specified.
WS	A single message or a message segment must have a static display time of at least two seconds after moving onto the signboard, with all segments of the total message to be displayed within ten seconds.	4s	No electronic sign lamp may be illuminated to a degree of brightness that is greater than necessary for adequate visibility. In no case may the brightness exceed 8,000 nits or equivalent candelas during daylight hours, or 1,000 nits or equivalent candelas between dusk and dawn. Signs found to be too bright shall be adjusted as directed by the department.	Not specified.	Displays may travel horizontally or scroll vertically onto electronic signboards, but must hold in a static position for two seconds after completing the travel or scroll. Displays shall not appear to flash, undulate, or pulse, or portray explosions, fireworks, flashes of light, or blinking or chasing lights. Displays shall not appear to move toward or away from the viewer,	Not specified.	Not specified.	Not specified.	Not specified.

State	Duration ≥	Inter-val ≤	Brightness/ Illumination	Font Size	Visual Effects	Sequencing	Spacing	Locations	Billboard Size
	A one-segment message may remain static on the signboard with no duration limit.				expand or contract, bounce, rotate, spin, twist, or otherwise portray graphics or animation as it moves onto, is displayed on, or leaves the signboard.				
WI	6s	1s	No variable message sign lamp may be illuminated to a degree of brightness that is greater than necessary for adequate visibility.	Not specified.	No flashing, intermittent or moving light. Traveling messages prohibited.	Not specified.	Not specified.	Not specified.	Not specified.

Delaware

§ 1110. Delaware Byways Program, Chapter 11: Regulation of Outdoor Advertising, Title 17: Highways, Delaware Code, State of Delaware, 2012.
http://delcode.delaware.gov/title17/c011/sc01/index.shtml#1110
From the code:

(3) Lighting. -- Signs may be illuminated, subject to the following restrictions.

a. Signs which contain, include, or are illuminated by any flashing, intermittent, or moving light or lights are prohibited, except those giving public service information such as time, date, temperature, weather, or traffic conditions, or as defined in paragraph (3)e. of this section.

e. Notwithstanding the provisions of paragraphs (b)(3)a. through d. of this section, signs commonly known as variable message signs may be changed at intervals by electronic or mechanical process or remote control, and are permitted within 660 feet of the edge of the right-of-way of any interstate or federal-aid primary highway so designated as of June 1, 1991, and of the National Highway System. These variable message signs are permitted, except as prohibited by local ordinance or zoning regulation or by the Delaware federal-state outdoor advertising agreement of May 1, 1968, and are not considered to be in violation of flashing, intermittent, or moving lights criteria provided that:

1. Each message remains fixed for a minimum of at least 10 seconds.

2. When the message is changed, it must be accomplished in 1 second or less, with all moving parts or illumination changing simultaneously and in unison.

3. A variable message sign along the same roadway and facing in the same direction of travel may not be placed, as measured along the centerline of the roadway, within 2,500 feet of another variable message sign, or within 500 feet of a static billboard sign regulated by this section, or within 1,000 feet of an interchange, interstate junction of merging or diverging traffic, or an at-grade intersection.

4. A variable message sign must contain a default design that will freeze the sign in 1 position if a malfunction occurs or, in the alternative, that will shut down.

5. A variable message sign may not contain or display any lights, effects, or messages that flash, move, appear to be animated or to move, scroll, or change in intensity during the fixed display period. A variable message sign must appropriately adjust display brightness as ambient light levels change.

6. A sign that attempts or appears to attempt to direct the movement of traffic or which contains wording, color, shapes, or likenesses of official traffic control devices is prohibited.

7. A sign may not be placed along designated Delaware byways.

Florida

Outdoor Advertising Sign Regulation and Highway Beautification Program, Florida Administrative Weekly & Florida Administrative Code, Florida Department of Transportation, October 3, 2010.
https://www.flrules.org/gateway/chapterhome.asp?chapter=14-10
From the code:

14-10.004 Permit.

(3) Changeable messages – A permit shall be granted for an automatic changeable facing provided:
(a) The static display time for each message is at least six seconds;

(b) The time to completely change from one message to the next is a maximum of two seconds;
(c) The change of message occurs simultaneously for the entire sign face; and
(d) The application meets all other permitting requirements.
(e) All signs with changeable messages shall contain a default design that will ensure no flashing, intermittent message, or any other apparent movement is displayed should a malfunction occur.

Guide to Outdoor Advertising, Florida Department of Transportation, 2012.
http://www.dot.state.fl.us/rightofway/documents/GuidetoODA.pdf
From page 15 of the guide:

Multiple messages: Your sign may display multiple messages, provided you do not have more than two sign faces for each direction the sign is facing. Mechanically changeable and digital display panels are allowed on conforming signs, provided the static display time is at least 6 seconds, and the time to change from one message to another is no great than 2 seconds. Scrolling or animated images are prohibited.

1. Flashing, intermittent, rotating, or moving lights are prohibited.
2. Lighting which causes glare or impairs the vision of the driver of any motor vehicle, or which otherwise interferes with any driver's operation of a motor vehicle is prohibited.
3. A sign may not be illuminated so that it interferes with the effectiveness of, or obscures, an official traffic sign, signal or device.
4. Lighting may not be added to or increased on a nonconforming sign.

Georgia

Article 3. Control of Signs and Signals, Chapter 6: Regulation of Maintenance and Use of Public Roads Generally, Title 32: Highways, Bridges, and Ferries, *Georgia Code*, State of Georgia, 2008.
http://oaag.net/guidelines/documents/32-6OutdoorAdvertisingStateLaw.pdf
From page 7 of the report:

32-6-75. Restrictions on outdoor advertising authorized by Code Sections 32-6-72 and 32-6-73; multiple message signs on interstate system, primary highways, and other highways.

(a) No sign authorized by paragraphs (4) through (6) of Code Section 32-6-72 and paragraph (4) of Code Section 32-6-73 shall be erected or maintained which:

(8) If illuminated, contains, includes, or is illuminated by any flashing, intermittent, or moving light or lights except those giving public service information such as time, date, temperature, weather, or other similar information except as expressly permitted under subsection (c) of this Code section. The illumination of mechanical multiple message signs is not illumination by flashing, intermittent, or moving light or lights, except that no multiple message sign may include any illumination which is flashing, intermittent, or moving when the sign is in a fixed position;

(9) If illuminated, is not effectively shielded so as to prevent beams or rays of light from being directed at any portion of the traveled way, which beams or rays are of such intensity or brilliance as to cause glare or to impair the vision of the driver of any motor vehicle or which otherwise interfere with the operation of a motor vehicle;

(10) If illuminated, is illuminated so that it obscures or interferes with the effectiveness of an official traffic sign, device, or signal;

(c) (1) Multiple message signs shall be permitted on the interstate system, primary highways, and other highways under the following conditions:

(A) Each multiple message sign shall remain fixed for at least ten seconds;

(B) When a message is changed mechanically, it shall be accomplished in three seconds or less;

(C) No such multiple message sign shall be placed within 5,000 feet of another mechanical multiple message sign on the same side of the highway;

(D) Any such sign shall contain a default design that will freeze the sign in one position if a malfunction occurs;

(E) Any maximum size limitations shall apply independently to each side of a multiple message sign; and

(F) Nonmechanical electronic multiple message signs that are otherwise in compliance with this subsection and are illuminated entirely by the use of light emitting diodes, back lighting, or any other light source shall be permitted under the following circumstances: (i) Each transitional change occurs within two seconds; (ii) If the department finds an electronic sign or any display or effect thereon to cause glare or to impair the vision of the driver of any motor vehicle or to otherwise interfere with the safe operation of a motor vehicle, then, upon the department's request, the owner of the sign shall promptly and within not more than 48 hours reduce the intensity of the sign to a level acceptable to the department; and (iii) The owner of any existing or nonconforming electronic sign shall have until October 31, 2006, to bring the electronic sign in compliance with this subparagraph and to request a permit from the department.

Iowa

Guide to Iowa Outdoor Advertising Regulations for Interstate Highways, Iowa Department of Transportation, April 2009.
http://www.iowadot.gov/iowaroadsigns/Guide_to_Outdoor_Advertising_for_Interstates.pdf
From page 7 of the guide:
Light emitting diode (LED) displays
LED displays are permitted under the following conditions:

- Adding this type of technology for an existing billboard constitutes a billboard "modification" under Iowa law. Therefore, a new permit application is required.
- Each change of message must be accomplished in one second or less.
- Each message must remain in a fixed position for at least eight seconds.
- No traveling messages (e.g., moving messages, animated messages, full-motion video, or scrolling text messages) or segmented messages are presented.
- The intensity of the illumination does not cause glare or impair the vision of the driver of any motor vehicle or otherwise interferes with any driver's operation of a motor vehicle.
- LED displays must be located a minimum of 500 feet from any other LED display facing the same direction within cities. LED displays must be located a minimum of 1000 feet from any other LED display facing the same direction in rural areas.

Kansas

Section 68-2234. Highway Advertising Control; Sign Standards; Zoning Requirements, Article 22, Highway Beautification Highway Advertising Control Act of 1972 – Revised 2006, Kansas Department of Transportation, 2006.
http://www.ksdot.org/burrow/beaut/KHACARev6.pdf
From page 5 of the report:

(d) Lighting.

(1) Signs shall not be erected which contain, include or are illuminated by any flashing, intermittent, revolving or moving light, except those giving public service information such as, but not limited to, time, date, temperature, weather or news; steadily burning lights in configuration of letters or pictures are not prohibited;

(2) signs shall not be erected or maintained which are not effectively shielded so as to prevent beams or rays of light from being directed at any portion of the traveled way of any interstate or primary highway and are of such intensity or brilliance as to cause glare or to impair the vision of the driver of any motor vehicle or to otherwise interfere with any driver's operation of a motor vehicle; and

(3) signs shall not be erected or maintained which are so illuminated that they obscure any official traffic sign, device or signal, or imitate or may be confused with any official traffic sign, device or signal.

(e) Automatic changeable facing signs.

(1) Automatic changeable facing signs shall be permitted within adjacent or controlled areas under the following conditions:

(A) The sign does not contain or display flashing, intermittent or moving lights, including animated or scrolling advertising;

(B) the changeable facing remains in a fixed position for at least eight seconds;

(C) if a message is changed electronically, it must be accomplished within an interval of two seconds or less;

(D) the sign is not placed within 1,000 feet of another automatic changeable facing sign on the same side of the highway, with the distance being measured along the nearest edge of the pavement and between points directly opposite the signs along each side of the highway;

(E) if the sign is a legal conforming structure it may be modified to an automatic changeable facing sign upon compliance with these standards and approval by the department. A nonconforming structure shall not be modified to create an automatic changeable facing sign;

(F) if the sign contains a default design that will freeze the sign in one position if a malfunction occurs; and

(G) if the sign application meets all other permitting requirements.

(2) The outdoor advertising license shall be revoked for failure to comply with any provision in this subsection.

Massachusetts

Outdoor Advertising, Office of Outdoor Advertising, Highway Division, Massachusetts Department of Transportation, 2012.
http://www.massdot.state.ma.us/highway/Departments/OutdoorAdvertising.aspx
On June 5, 2012, the Massachusetts Department of Transportation conducted a public hearing for proposed regulation changes that include provisions for electronic billboards.

3.17: Requirements for Electronic Sign Permits

(1) Permits for Electronic Signs require the prior approval of the municipality wherein the proposed sign will be located unless otherwise exempted by State law.

(2) Except as otherwise prohibited by Federal or Massachusetts law and regulations, or local ordinances or zoning regulations, permits for Electronic Signs may be issued provided such sign complies with all of the following:

(a) Has a static display lasting at least 10 seconds.
(b) Achieves an instant message change.
(c) Does not display illumination that moves, appears to move or changes in intensity during the static display period. This does not include changes to a display for time, date and temperature.
(d) Automatically adjusts the intensity of its display according to natural ambient light conditions.

(3) A permit issued pursuant to this section shall indicate that it is for an Electronic Sign. Any such permit is determined to not be prohibited by any agreement between the Department and the Secretary of Transportation of the United States. All regulations provided by 700 CMR 3.00 et. seq. are applicable to Electronic Signs. In the event a provision of this section conflicts with another section of 700 CMR, this section controls.

(4) A legally conforming sign or site may be modified to an Electronic Sign if a new permit for the Electronic Sign is obtained by the Department.

(5) Electronic Signs shall not:

(a) Emit or utilize in any manner any sound capable of being detected on a main traveled way by a person with normal hearing;
(b) Cause beams or rays of light from being directed at any portion of the traveled way, which beams or rays are of such intensity or brilliance as to cause glare or to impair the vision of the driver of any motor vehicle or otherwise interfere with the operation of a motor vehicle;
(c) Obscure or interfere with the effectiveness of an official traffic sign, device or signal, or cause an undue distraction to the traveling public;
(d) Contain more than one face visible from the same direction on the traveled way;
(e) Be located so as to obscure or otherwise interfere with a motor vehicle operator's view of approaching, merging or intersecting traffic;
(f) Be within 500 feet of any type of permitted sign;
(g) Be within 2000 feet of another off premise permitted Electronic Sign on the same side of the traveled way;
(h) Be within 1000 feet of another off premise permitted Electronic Sign on the opposite side of the traveled way;
(i) Face more than one direction of travel;
(j) Contain flashing, intermittent, or moving lights; or display animated, moving video, scrolling advertising; or consist of a static image projected upon a stationary object.

(6) Any such sign shall contain a default design that will freeze the sign in one position if a malfunction occurs.

(7) If the Department finds an Electronic Sign or any display or effect thereon to cause glare or to impair the vision of the driver of any motor vehicle or to otherwise interfere with the safe operation of a motor vehicle, upon request, the permit holder shall promptly and within not more than 24 hours reduce the intensity of the sign to a level acceptable to the Department.

(8) In addition to any municipal requirement the Department may impose any restriction as to the hours of operation for each Electronic Sign.

(9) The permit holder of an Electronic Sign shall coordinate with governmental authorities, through the Department's Division of Highways, to display, when appropriate, emergency information important to the traveling public, such as Amber Alerts or alerts concerning terrorist attacks, or natural disasters. Emergency information messages shall remain in the advertising rotation according to the protocols of the agency that issues the information, or protocols established by the Department's Division of Highways.

(10) The permit holder shall provide the Director with contact information for a person who is available 24 hours a day, 7 days a week to turn off the Electronic Sign promptly if a malfunction occurs. The sign shall contain a default mechanism that freezes the sign in one display in the event of a sign malfunction.

(11) The permit holder shall designate a minimum of 25 hours per month of total advertisement time per permit to the Department for Public Service Announcement (PSA) purposes. Said time shall be equally distributed throughout the hours of operation of the Electronic Sign. The permit holder shall submit a detailed proof of play report each month to the Director to verify that PSA's are being displayed. The Director shall determine the total number of PSA's to be aired each month and will coordinate with the permit holder for their sign. Detailed Proof of Play (POP) Reports are due by the 5th day of each month for the prior month of play. Failure to submit a POP report or failure to adhere to the minimum PSA requirement may result in a fine or revocation of permit/s.

Criticism
These regulations have been criticized for not being strong enough:

> **New Rules Would Mean More Billboard Blight for Massachusetts**, Scenic America, 2012.
> http://www.scenic.org/blog/144-new-rules-would-mean-more-billboard-blight-for-massachusetts
> *From the web site:* A proposed set of new regulations on outdoor advertising would see Massachusetts go from having some of the strongest billboard controls in the country to some of the weakest, and result in a proliferation of signs all over the state.
>
> **Massachusetts: Coming Billboard Regulations = Complete Deregulation**, Daily Kos Network, May 30, 2012.
> http://www.dailykos.com/story/2012/05/30/1096048/-Massachusetts-Coming-Billboard-Regulations-Complete-Deregulation
> *From the web site:* The strong Massachusetts billboard regulation legacy will come to a swift end if proposed new regulations by the Massachusetts Department of Transportation's Office of Outdoor Advertising (the "OOA", not to be confused with the OAAA, the Outdoor Advertising Association of America, the billboard industry lobby) are enacted.

New York

N.Y. HAY. LAW § 88: NY Code - Section 88: Control of Outdoor Advertising, FindLaw, 2012.
http://codes.lp.findlaw.com/nycode/HAY/4/88
From the web site:

> Provided that, nothing in this section shall be construed to prohibit the erection or maintenance of outdoor advertising signs, displays and devices which include the steady illumination of sign faces, panels or slats that rotate or change to different messages in a fixed position, commonly known and referred to as changeable or multiple message signs, provided the change of one sign face to another is not more frequent than once every six seconds and the actual change process is accomplished in three seconds or less, when such signs, displays and devices are permitted or authorized pursuant to this section and by the agreement ratified and approved by this section.

Ohio

"Chapter 5501:2-2 – Ohio Administrative Code (OAC)," Ohio Revised Code and Administrative Code for Advertising Device Control, Ohio Department of Transportation, November 2011.
http://www.dot.state.oh.us/Divisions/ContractAdmin/Contracts/ADC/ADC_RegBook.pdf
From the report:

> **5501:2-2-02 General provisions for the erection and control of outdoor advertising.**
> (A) (4) (b) A multiple message or variable message advertising device shall not be illuminated by flashing, intermittent, or moving lights. No multiple message or variable message advertising device may include any illumination which is flashing, intermittent, or moving when the sign face is in a fixed position.
>
> (B) Multiple message and variable message advertising devices: such advertising devices may be permitted on the interstate system or the primary system under the following conditions: (1) Each message or copy shall remain fixed for at least eight seconds; (2) When a message or copy changes by remote control or electronic process, it shall be accomplished in three seconds or less; (3) No such advertising device shall be placed within one thousand feet of another multiple message or variable message advertising device on the same side of the highway visible in the same direction of travel;(4) Such advertising devices shall contain a default design that will freeze the device in one position if a malfunction occurs; (5) Any maximum size limitations shall apply independently to each face of a multiple message or variable message advertising device; and (6) Only one multiple message advertising device shall be permitted at a single location facing the same direction.

Oregon

Chapter 377—Highway Beautification; Motorist Information Signs, Oregon Revised Statutes, 2011 edition.
http://www.leg.state.or.us/ors/377.html
From the web site:

> **377.753 Permits for outdoor advertising signs; rules.** (1) Notwithstanding the provisions of ORS 377.715, 377.725 and 377.770, the Department of Transportation may issue permits for outdoor advertising signs placed on benches or shelters erected or maintained for use by customers of a mass transit district, a transportation district or other public transportation agency.
>
> (2) The department shall determine by rule the fees and criteria for the number, size, and location of such signs but the department may not issue a permit for a sign that is visible from an interstate highway. [2007 c.199 §3]

Division 60: Signs, Department of Transportation, Highway Division, Oregon Administrative Rules, July 13, 2012.
http://arcweb.sos.state.or.us/pages/rules/oars_700/oar_734/734_060.html
From the web site:

Digital Billboard Procedures

(1) This rule describes the process for applying for a permit for a digital billboard.

(2) Definitions for the purposes of this rule:

(a) "Sign" means the sign structure, the display surfaces of the sign, and all other component parts of the sign.

(b) "Retire" means to use a relocation credit such that it no longer exists or to remove an existing sign.

(c) "Bulletin" means an outdoor advertising sign with a display surface that is 14 feet by 48 feet.

(d) "Poster" means an outdoor advertising sign with a display surface that is 12 feet by 25 feet.

(e) "Digital Billboard" means an outdoor advertising sign that is static and changes messages by any electronic process or remote control, provided that the change from one message to another message is no more frequent than once every eight seconds and the actual change process is accomplished in two seconds or less.

(3) Qualifications for receiving a digital billboard state sign permit:

(a) The proposed site and digital billboard must meet all requirements of the OMIA including, but not limited to, the following:

(A) the digital billboard is not illuminated by a flashing or varying intensity light.

(B) the display surface of the digital billboard does not create the appearance of movement.

(C) the digital billboard must operate at an intensity level of not more than 0.3 foot-candles over ambient light as measured by the distance to the sign depending upon its size.

(D) The distance measurement for ambient light is: 150 feet if the display surface of the sign is 12 feet by 25 feet, 200 feet if the display surface is 10.5 by 36 feet, and 250 feet if the display surface is 14 by 48 feet.

(b) Applicant must submit a completed application for a digital billboard state sign permit using the approved form that may be obtained by one of the following methods:

(A) Requesting from Sign Program Staff by phone at 503-986-3656;

(B) Email: OutdoorAdvertising@odot.state.or.us;

(C) Website http://www.oregon.gov/ODOT/HWY/SIGNPROGRAM/contact_us.shtml

(c) The Department shall confirm that any existing permitted Outdoor Advertising Sign or relocation credit being retired for the purpose of receiving a new digital billboard state sign permit has been removed within the 180 days allowed to construct the new permitted sign. The Department will not charge a Banking Permit Fee for the cancellation of state sign permits retired for the purpose of receiving a new digital billboard permit.

(4) This section sets forth the criteria for determining the required relocation credits or existing permitted signs that an applicant shall retire to receive one new digital billboard state sign permit:

(a) Applicants who own 10% or less of all active relocation credits at the time the application is submitted shall either remove one existing state permitted outdoor advertising sign with a display area of at least 250 square feet or provide one active relocation credit of at least 250 square feet and retire that permit. Applicants meeting these criteria are not limited to either "Bulletin" or "Poster" billboards.

(b) Applicants who own more than 10% of all active relocations credits shall apply for a new digital billboard state sign permit as follows:

(A) For a digital billboard that is intended to be a bulletin, the applicant has three options:

(i) Remove two existing bulletins, retire the permits for those signs, and retire three relocation credits; or

(ii) Remove one existing bulletin and two existing posters, retire those permits and retire three active relocation credits; or

(iii) Remove four existing posters, retire the permits for those signs, and retire three relocation credits.

(B) For a digital billboard that is intended to be a poster, the applicant has two options:

(i) Remove two existing posters, retire the permits for those signs, and retire three relocation credits;

(ii) Remove one existing bulletin, retire the permit for that sign, and retire three relocation credits.

(c) For an active relocation credit to be eligible it must be at least 250 square feet. All permits and relocation credits submitted under these procedures will be permanently cancelled and are not eligible for renewal.

(d) Any state sign permits submitted for retirement must include the written statement notifying the Department that the "lease has been lost or cancelled."

(5) The Department will determine the percentage of relocation credits owned by an applicant by dividing the total number of unused relocation credits by the total number of unused relocation credits owned by the applicant on the day the application is received.

(6) Two digital billboard state sign permits are required for any back to back or V-type digital sign. A separate application is required for each digital sign face.

(7) The first time a digital billboard is permitted it is not subject to the 100-mile rule in ORS 377.767(4). The site of the newly permitted billboard will become the established location for future reference.

(8) Relocation of permitted digital billboards. The Department will issue one digital relocation credit for each permitted digital sign that is removed. The digital relocation credit issued will be for the same square footage as the permitted digital sign that was removed. A digital relocation credit can only be used to relocate a digital billboard. A permitted digital sign can only be reconstructed as a digital billboard.

(9) Use of renewable energy resource. The applicant must provide a statement with the application that clarifies what, if any, renewable energy resources are available at the site and are being utilized. If none, then a notarized statement to that effect must be included with the application.

(10) All permitted digital billboards must have the capacity to either freeze in a static position or display a black screen in the event of a malfunction.

(a) The applicant must provide emergency contact information that has the ability and authority to make modifications to the display and lighting levels in the event of emergencies or a malfunction.

(b) The Department will notify the sign owner of a malfunction that has been confirmed by ODOT in the following instances:

(A) The light impairs the vision of a driver of any motor vehicle; or

(B) The message is in violation of ORS 377.710(6) or 377.720(3)(d).

(11) All digital billboard signs must comply with the light intensity and sensor requirements of ORS 377.720(3)(d).

(a) The Department will take measurements of the permitted digital billboard when notified that the sign has been constructed and the permit plate has been installed.

(b) The Department will use an approved luminance meter designed for use in measuring the amount of light emitted from digital billboards using the industry standard for size and distance as follows:

(A) 150 feet for 12'x 25.'

(B) 200 feet for 10.5'x 36'.
(C) 250 feet for 14'x 48'.

Tennessee

Control of Outdoor Advertising, Chapter 1680-2-3, Rules of Tennessee Department of Transportation Maintenance Division, Tennessee Department of Transportation, February 2003.

Current regulations do not include electronic billboards:
http://www.tdot.state.tn.us/environment/beautification/pdf/1680-02-03.pdf.

However, proposed revisions are under review that include guidance on digital displays:
http://www.tdot.state.tn.us/environment/beautification/docs/Revised-ODA-Rules-Redline.pdf.
From the web site:

1680-10-01-.03 CRITERIA FOR THE CONTROL OF OUTDOOR ADVERTISING DEVICES.

4. Spacing

(i) (IV) The minimum spacing for changeable message signs with a digital display is two thousand (2,000) feet, except as follows:

I. An outdoor advertising device that uses a digital display which does not exceed one hundred (100) square feet in total area to give public information such as time, date, temperature, or weather, or to provide the price of a product, the amount of a lottery prize or similar numerical information supplementing the content of a message otherwise displayed on the sign face shall not be subject to the two thousand (2,000) feet minimum spacing requirement in this item (IV).

5. Changeable Message Signs

Changeable message signs are permissible, subject to the following restrictions: (i) The message display time shall remain static for a minimum of eight (8) seconds with a maximum change time of two (2) seconds. (ii) Video, animation, and continuous scrolling messages are prohibited. (iii) Non-conforming devices shall not be converted to a changeable message sign. (iv) The changeable message sign shall contain a default design that will freeze the sign face to one position if a malfunction occurs. (v) The structure for a changeable message sign may contain sign faces that are in a double-faced, back-to-back, or V-type configuration. (vi) The minimum spacing for changeable message signs with a digital display is as provided in Rule 1680-10-.03(1)(a)4.(i)(IV).

Washington

Highway Advertising Control, M22-95, Washington State Department of Transportation, March 2011.
http://www.wsdot.wa.gov/publications/manuals/fulltext/M22-95/HighwayAdvertisingControl.pdf
From the report:

468-66-050 Sign classifications and specific provisions

(3) Type 3 – On-premise signs.

(b) Type 3(b) – Business complex on-premise sign. A Type 3(b) business complex on-premise sign may display the name of a shopping center, mall, or business combination.

(i) Where a business complex erects a Type 3(b) on-premise sign, the sign structure may display additional individual business signs identifying each of the businesses conducted on the premises. A Type 3(b) on-premise sign structure may also have attached a display area, such as a manually changeable copy panel, reader board, or electronically changeable message center, for advertising on-premise activities and/or presenting public service information.

(g) Electronic signs may be used only as Type 3 on-premise signs and/or to present public service information, as follows:

(i) Advertising messages on electronic signboards may contain words, phrases, sentences, symbols, trademarks, and logos. A single message or a message segment must have a static display time of at least two seconds after moving onto the signboard, with all segments of the total message to be displayed within ten seconds. A one-segment message may remain static on the signboard with no duration limit.

(ii) Displays may travel horizontally or scroll vertically onto electronic signboards, but must hold in a static position for two seconds after completing the travel or scroll.

(iii) Displays shall not appear to flash, undulate, or pulse, or portray explosions, fireworks, flashes of light, or blinking or chasing lights. Displays shall not appear to move toward or away from the viewer, expand or contract, bounce, rotate, spin, twist, or otherwise portray graphics or animation as it moves onto, is displayed on, or leaves the signboard.

(iv) Electronic signs requiring more than four seconds to change from one single message display to another shall be turned off during the change interval.

(v) No electronic sign lamp may be illuminated to a degree of brightness that is greater than necessary for adequate visibility. In no case may the brightness exceed 8,000 nits or equivalent candelas during daylight hours, or 1,000 nits or equivalent candelas between dusk and dawn. Signs found to be too bright shall be adjusted as directed by the department.

(h) The act does not regulate Type 3(a), 3(b), 3(c), and 3(d) on-premise signs located along primary system highways inside an incorporated city or town or a commercial or industrial area.

Wisconsin

Control of Outdoor Advertising Along and Visible from Highways on the Interstate and Federal-Aid Primary Systems, Chapter Trans 201, Wisconsin Administrative Code, February 2005.
http://docs.legis.wisconsin.gov/code/admin_code/trans/201.pdf
From the web site:

Trans 201.15 – Electronic signs

(3) Variable Message Signs.

(c) No message may be displayed for less than one-half second.

(d) No message may be repeated at intervals of less than 2 seconds.

(e) No segmented message may last longer than 10 seconds.

(f) No traveling message may travel at a rate slower than 16 light columns per second or faster than 32 columns per second.

(g) No variable message sign lamp may be illuminated to a degree of brightness that is greater than necessary for adequate visibility.

(4) Multiple Message Signs.

(a) The louver rotation time to change a message shall be one second or less.

(b) The time a message remains in a fixed position shall be 6 seconds or more.

84.30 Regulation of Outdoor Advertising, Wisconsin Legislative Documents, 2012.
http://docs.legis.wisconsin.gov/statutes/statutes/84/30
From the web site:

(3)(c)(1) Signs that contain, include or are illuminated by any flashing, intermittent or moving light or lights are prohibited, except electronic signs permitted by rule of the department.

(4)(bm) Signs may contain multiple or variable messages, including messages on louvers that are rotated and messages formed solely by use of lights or other electronic or digital displays, that may be changed by any electronic process, subject to all of the following restrictions:

1. Each change of message shall be accomplished in one second or less.
2. Each message shall remain in a fixed position for at least 6 seconds.
3. The use of traveling messages or segmented messages is prohibited.
4. The department, by rule, may prohibit or establish restrictions on the illumination of messages to a degree of brightness that is greater than necessary for adequate visibility.

APPENDIX A

State Changeable Message Chart
(Source: OAAA State Statute Matrix)

No changeable message signs allowed:	**Tri- action Only**	**Changeable Message /Digital Technology**
(3 STATES) ND, NH, WY	(5 STATES) MD, MA, OR, TX, WA,	(38 STATES) AL, AR, AZ, CA, CO, CT DE, FL, GA, ID, IL, IA, IN, KS, KY, LA, MI, MN, MO, MS, MT, NE, NV, NJ, NM, NY, NC, OH, OK, PA, RI, SC, SD, TN, UT, VA, WV, WI

State-by-state breakdown of the 38 states allowing Changeable Message/Digital technology

- States which have statutes (19):

CA, CO, CT, DE, FL
GA, IN, KS, MI, MO
MN, NJ, NY, OH
OK, UT, TN, VA, WI

- Regulations (10):

AR, ID, IL, IA*, LA, NE,
NV, NC, SC, WV

- States with interpretations of the federal/state agreement (7):

AL, AZ, KY, MT,
NM, RI, SD

- Policy memoranda (2):

MS approved a policy DOT memorandum
PA approved the technology through an internal PENNDOT memorandum (2002)
IA* regulations are undergoing a comment period

OAAA Changeable Message Criteria
Dwell Time Sequence – By State

Dwell Time (Static Message)	State
4 seconds	**CA, CO, IA, VA**
5 seconds	**NM, PA**
6 seconds	**AL, AZ, CT, FL, GA, IA, MI, MN, NV, NY, SD, WI, RI (average)**
8 seconds	**AR, ID, IN, KS, LA, MO, MS, NJ, NC, OH, OK, OR, SC, TN, UT, WV, WA**
10 seconds	**DE, IL, NE, MD, TX**
Other/State-Company Discretion	**KY, MA, MT**

Dwell and Twirl Times for message changes and spacing criteria

States Allowing Changeable Message/Digital Technology

State	Dwell time	Twirl time	Spacing *traditional 500 ft
AL	6 seconds		
AR	8 seconds or more	2 seconds or less	1500 feet
AZ	6 seconds	1 second	*
CA	4 seconds	4 seconds	1000 feet
CO	4 seconds	1 second	1000 feet
CT	6 seconds	3 seconds	*
DE	10 seconds	1 second	2500 feet
FL	6 seconds	2 seconds	1000 to 1500 feet
GA	10 seconds	2 seconds	5000 feet

Dwell and Twirl Times for message changes and spacing criteria (cont'd)

States Allowing Changeable Message Including Electronics

State	Dwell time	Twirl time	Spacing
ID	8 seconds	2 seconds	*
IL	10 seconds	3 seconds	*
IN	8 seconds	2 seconds	*
IA	6 seconds	1 second	*
KS	8 seconds	2 seconds	1000 feet
KY At discretion of state DOT			
LA	8 seconds	4 seconds	*
MI	6 seconds	1 second	*
MN	6 seconds	none	*
MS	8 seconds	instantaneous	*
MO	8 seconds	2 seconds	1400 feet
MT At discretion of state DOT			
NE	10 seconds	2 seconds	5000 feet
NV	6 seconds	3 seconds	*
***NJ** (regulatory change pending	8 seconds	1 second	3000 feet
NM Company discretion	5 seconds	1-2 seconds	*
NY	6 seconds	3 seconds	*
NC	8 seconds	2 seconds	1000 feet
OH	8 seconds	3 seconds	1000 feet
OK	8 seconds	4 seconds	*

Dwell and Twirl Times for message changes and spacing criteria (cont'd)

States Allowing Changeable Message Including Electronics

State	Dwell time	Twirl time	Spacing
PA	5 seconds	1 second	*
RI	5-7 seconds	2-3 seconds	*
Company discretion			
SD	6 seconds	none	*
SC	8 seconds	2-3 seconds	*
TN	8 seconds	2 seconds	2000 feet
UT	8 seconds	3 seconds	*
VA	4 seconds	none	*
WV	8 seconds	2 seconds	1500 feet
WI	6 seconds	1 second	*

States Allowing Changeable Message Including Electronics

Tri-action Only

State	Dwell time	Twirl time	Spacing
MD	10 seconds	4 seconds	*
MA	none	none	*
OR	8 seconds	4 seconds	1000 feet
TX	10 seconds	2 seconds	*
Rural Roads Only			
WA	8 seconds	4 seconds	*