

Memorandum

Date: December 15, 2020

To: Curtis Burnett, Din/Cal 4, Inc.

From: Stephanie Cheng, AICP, Claude Strayer, PE, and Marta Polovin, Fehr & Peers

Subject: Gardena TOD Specific Plan Digital Sign Display and the Potential Effects on Distracted Driving

LB20-0010.00

A literature review was conducted to assess the potential effects on distracted driving as a result of a proposed digital sign display as part of the Gardena Transit Oriented Development (TOD) Specific Plan project in the City of Gardena. This memorandum outlines the key literature findings and considerations to reduce the potential for distracted driving associated with the digital sign display.

Changeable signs that are considered 'active' or 'dynamic' can display multiple messages in sequences. These signs may also be referred to as: changeable message signs, electronic/digital billboards, dynamic/animated signs, or digital reader boards. It should be noted that much of the research to date did not include video-based advertising and research studies have not kept pace with the advances in advertising technology, including animated, emergent video-based, or Light-Emitting Diode (LED) signs. Accordingly, some research factors do not apply to current advanced sign technologies.

Project Description

Din/Cal 4, Inc. proposes an exterior digital LED dynamic, fully animated display for the Gardena TOD Specific Plan project located at 12850 Crenshaw Boulevard, on the southeast quadrant of the intersection of Crenshaw Boulevard and El Segundo Boulevard. The site is located immediately south of an existing gas station. There is another gas station on the northwest corner and retail uses on the northeast and southwest corners of the intersection that all have on-site lighting that remains on at night. Surrounding uses along Crenshaw Boulevard include commercial and industrial uses. The new multi-family residential building will be eight (8) stories tall, including two and a half (2.5) levels of parking and five and a half (5.5) levels of residential units. The proposed sign would be mounted on the north side of the building facade facing El Segundo Boulevard. The dimensions of the proposed sign will be 59.8-feet high by 39.9-feet wide, or an area of 2,386 square



feet of exterior digital display. The sign will have the capability of showing full motion, brilliant colors, and dynamic video content. Display brightness will be adjustable. Hours of operation will be 6:00 AM to 2:00 AM.

Within the immediate vicinity, the sign would generally be visible to drivers on El Segundo Boulevard and Crenshaw Boulevard. When traveling southbound on Crenshaw Boulevard, the sign would be visible when approaching the intersection at El Segundo Boulevard. The sign would not be visible when traveling northbound on Crenshaw Boulevard. Along El Segundo Boulevard, the sign would be visible when traveling eastbound and westbound approaching the intersection at Crenshaw Boulevard.

Literature Review

This review included literature and related references ranging from 1980 to 2019. Many studies were limited in their sample size, conducted along rural or suburban freeways, or did not demonstrate statistically significant causality related to collision patterns. Overall, the potential safety impacts of distracted driving from digital signs remains inconclusive, though the following points were found to be consistent throughout the literature reviewed:

- Additional environmental clutter or distractions can increase crash risk.
- Research regarding the impact of roadside advertising on driving behavior is greatly dependent on study methodology, environmental context, and human factors (e.g., age, driving experience, fatigue) among drivers.¹
- Additional research and data collection are needed.
- The swift evolution of electronic technologies necessitates a reevaluation of previous legislations and regulations.

The literature review includes general academic research as well as research published or sponsored by the outdoor advertising industry. General research references work from academia as well as the transportation industry officials such as the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and the National Highway Traffic Safety Administration (NHTSA). To date, formal guidance to address potential traffic safety effects of digital signs has not been published. Further, the topic has not been addressed by the State CEQA Guidelines or the Los Angeles CEQA Thresholds Guide. FHWA and California Department of Transportation (Caltrans) have evaluated and allow digital billboards along highways, indicating that such signs are in conformance with federal and state regulations.

¹ Oviedo-Trespalacios, O., Truelove, V., Watson, B., & Hinton, J. (2019). "The Impact of Road Advertising Signs on Driver Behaviour and Implications for Road Safety: A Critical Systematic Review," *Transportation Research Part A: Policy and Practice*, Vol. 122.



General Research

The *Highway Safety Manual* describes the interactive effects of human factors, roadway factors, and vehicle factors on vehicle crashes.² The manual describes four distracting situations that could lead to failure to detect slowing or stopping vehicles (or pedestrians in a crosswalk) ahead at intersections. One of the four cited sources of distraction is an object of interest on the roadside, such as a roadside advertising sign.

A study commissioned for the City of Seattle in 2001 concluded that dynamic signs contribute to driver distraction for longer intervals than static signs.³ This report examined how this may be due to the psychological need to follow a task to its conclusion, which is known as the “Zeigarnik Effect”. The report also described how this effect is influenced by the delivery and content of the message:

- Scrolling messages of particular importance/interest could result in multiple seconds of distraction depending on its length.
- Sequential image or short video clips that tell a story may also result in longer periods of distraction.
- Anticipation of a new message could cause distraction (even if unrelated to the prior image).

The FHWA has conducted a series of studies that evaluate the possible safety impacts of electronic and digital signage. Many studies focus on human factors research and cognitive psychology to help identify the links between driver behavior, environmental factors (such as digital signage) and traffic safety. In 2009, AASHTO sponsored the study *Safety Impacts of the Emerging Digital Display Technology for Outdoor Advertising Signs* prepared by Jerry Wachtel. Despite being over a decade old, it remains one of the most recent and referenced reports available that provides guidance on digital billboards to date. As part of the study, Wachtel et al. reviewed 150 other studies and concluded that it was difficult to perform research that was not affected by small sample sizes, human factors, and generalizations.⁴

The 2009 Wachtel report, academic studies, and numerous professional reports cite *The 100-Car Naturalistic Driving Study* conducted in 2006 by the NHTSA and the Virginia Department of Transportation. The study included over 18 months of data collection tracking the driver behavior of 100 vehicles equipped with video and sensor devices.⁵ The database generated by this study

² AASHTO. (2010). “Highway Safety Manual,” 1st Edition.

³ Beijer, D., Smiley, A. & Eizenman, M. (2004). “Observed Driver Glance Behavior at Roadside Advertising Signs,” *Transportation Research Board (TRB)*.

⁴ Wachtel, J. (2009), “Safety Impacts of the Emerging Digital Display Technology for Outdoor Advertising Signs,” *NCHRP TRB*.

⁵ Wachtel (2009) & Klauer, S.G., Dingus, T., Neale, V., Sudweeks, J., & Ramsey D. (2006). “The Impact of Driver Inattention on Near-Crash/Crash Risk: An Analysis Using the 100-Car Naturalistic Driving Study Data,” *USDOT NHTSA*.



allowed for analysis of factors associated with crashes, near crashes, and critical incidents. The study found that a driver's eyes off-road time due to external distractions or inattention was estimated to cause more than 23% of all crashes and near crashes that occurred.

A follow-up analysis to the initial study found that distractions causing the driver to glance away from the forward roadway for more than two seconds increased the risk of crashing or having a near crash by at least two times over normal driving. However, the study also found that for drivers reporting drowsiness, the presence of a demanding driving environment resulted in lower crash risk compared to flat and less visually demanding environments.⁶ While crash incidence was shown to increase with diverted glances longer than two seconds, correlations based on the type and severity of crashes were not included in the study.

Since the 2009 Wachtel report, several studies that aim to expand understanding of the effects of digital billboards and signage on driver distraction and traffic safety have been published. These peer-reviewed studies often use the two-second rule established by *The 100-Car Naturalistic Driving Study*.⁷ However, the driving environment is often so complex that direct causality between a feature of the external environment and an increase or decrease in the number of traffic collisions remains inconclusive. The 2013 FHWA Study, *Driver Visual Behavior in the Presence of Commercial Electronic Variable Message Signs (CEVMS)*, concluded that typical eye glance duration for digital signs and standard billboards is usually less than 1.4 seconds.⁸ While drivers were found to glance at digital billboards longer than non-digital billboards, the study concluded that overall attention was focused on the task of driving and there were no discernable impacts on overall safety.

Smiley et al. conducted pre- and post- digital billboard installation collision analyses on urban intersections.⁹ The study evaluated three intersections with video billboards within the City of Toronto, measuring crashes approximately three years before sign installation and one year after

⁶ Klauer et al. (2006).

⁷ Edquist, J., Horberry, T., Hosking, S., & Johnston, I. (2011). "Effects of advertising billboards during simulated driving." *Applied Ergonomics*, Volume 42, Issue 4.

Milloy, S. & Caird, J. (2011). "External Distractions: The Effects of Video Billboards and Windfarms on Driving Performance." *Handbook of Driving Simulation for Engineering, Medicine and Psychology*.

Dukic, T., Ahlstrom, C., Patten, C., Kettwich, C., and Kircher, K. (2013). "Effects of electronic billboards on driver distraction." *Traffic Injury Prevention*, Volume 14.

Roberts, P. (2013). "Designing evidence-based guidelines for the safe use of digital billboard installations: Experience and results from Australia." *Proceedings of the 16th International Conference Road Safety on Four Continents; Beijing, China*.

Divekar, G., Pradhan, A., Pollatsek, A., & Fisher, D. (2012). "Effect of External Distractions: Behavior and Vehicle Control of Novice and Experienced Drivers Evaluated." *Transportation Research Record*, Volume 2321.

⁸ Perez, W., Bertola, M., Kennedy, J.; & Molino, J. (2013). "Driver Visual Behavior in the Presence of Commercial Electronic Variable Message Signs (CEVMS)," *FHWA*.

⁹ Smiley, A., Persaud, B., Bahar, G., Mollett, C., Lyon, C., Smahel, T., and Kelman, W.L. (2005). "Traffic Safety Evaluation of Video Advertising Signs," *Transportation Research Record*, Volume 1937.



sign installation. Two intersections demonstrated increases in both total and rear-end crashes; the third intersection showed no significant increase in crashes. Due to the small sample size, the results were inconclusive with regards to the overall relationship between the potential for traffic safety impacts due to distracted driving and digital billboards.

Driver distraction and associated risks vary depending on the roadway classification and land use setting or context. Numerous studies states that simple driving-related tasks consume relatively little information processing; however, when additional conditions such as traffic congestion, weather, or complicated roadway geometries exist, the additional distraction of a dynamic sign could lead to driving errors. On urban arterials, in contrast to freeways or rural highways, drivers are exposed to a more complex environment and encounter vulnerable road users such as pedestrians and bicyclists.¹⁰ Perez et al. found that drivers on urban arterials were more likely to look at digital billboard displays for longer durations than drivers on freeways, likely attributed to slower travel speeds. However, long “dwell times” (referring to the length of time a driver’s eyes remain on the billboard) on digital billboards were not observed or recorded on urban arterials.¹¹

Human factors relate to all elements that explain driver behavior. The diversity of published literature acknowledges the role of human factors in the research. Driver characteristics significantly affect the risk of distraction or inattention. Distraction can be caused by internal factors (such as fatigue and medication), factors external to the driver but internal to the vehicle (such as cell phones and navigation systems), and factors external to the vehicle (such as pedestrians and signs). Results from a survey given to all participating drivers as part of *The 100-Car Naturalistic Driving Study* indicated that driver age, experience, self-reported traffic violations and accidents, daytime sleepiness rating, and personality result in substantially different levels of involvement in inattention-related crashes and near crashes.¹²

Industry-Sponsored Research

Four key studies have been published with support from the advertising industry, largely demonstrating no adverse effects from digital billboards.¹³ These studies range from more naturalistic experiments with real drivers on real roadways to simulator studies in a laboratory.

¹⁰ Smiley et al. (2005).

¹¹ Perez et al. (2013).

¹² Klauer et al. (2006) & Belyusar, D., Reimer, B., Mehler, B., Coughlin, J. (2015). “A field study on the effects of digital billboards on glance behavior during highway driving,” *Accident Analysis and Prevention*, Volume 88.

¹³ Lee, S. (2007). “Driving Performance and Digital Billboards.” *Virginia Tech Transportation Institute & Foundation for Outdoor Advertising Research and Education*.

Tantala, M. & Tantala, A. (2009). “An Update of a Study of the Relationship between Digital Billboards and Traffic Safety in Cuyahoga County, Ohio,” *Tantala Associates, Foundation for Outdoor Advertising Research and Education*.

Hawkins, K., Kuo, P. and Lord, D. (2012). “Statistical Analysis of the Relationship between On-Premise Digital Signage and Traffic Safety.” *Texas A&M & The Signage Foundation, Inc.*



Industry reports provide summaries and interpretations of the academic research related to digital signage and driver distraction. A 2004 report states that despite the conservative approach to safety concerns, the ensuing 20 years of “inevitable” technology proliferation in billboards has shown there to be no observable spike in traffic safety concerns related to billboards. The report also points out that many cities permit or encourage engaging signage, frequently digital, in the urban core to help cultivate a feeling of excitement and engagement.¹⁴

Design & Operation Considerations

The following summarizes design and operational considerations obtained from the literature that will minimize the potential for driver distraction associated with the proposed sign. The potential impacts of the proposed sign are addressed in *italics*.

Animation & Movement

Any animation should avoid “flashing, strobing, or racing effects” as such types of movement are more distracting than other types of animation.¹⁵ Additionally, animation that may resemble “red or blinking intermittent light” or may resemble traffic control devices should be prohibited.¹⁶

The proposed sign content is anticipated to comply with the considerations above.

Placement

Lateral placement should reduce the driver’s need to turn their head by minimizing the angle away from the forward view. Signage should not be placed in spaces that are highly demanding for drivers based on roadway geometry or placed in spaces that are visually cluttered.¹⁷

The roadway segment alignments at the proposed project location are generally straight and the sign will be primarily visible to drivers on Crenshaw Boulevard traveling in a southbound direction. Drivers traveling eastbound and westbound on El Segundo Boulevard may be inclined to turn their head towards the proposed sign. However, the proposed placement is not atypical and the inclination for drivers to turn their heads would be considered comparable to other urban elements in the area.

Spacing

No more than two digital billboards should be located within driver’s field of view at the same time.¹⁸

¹⁴ US Sign Council, “Electronic Sign Zoning Information,” (2004).

¹⁵ Morris, Marya, John Baker and Daniel Mandelker. (2009). “Regulating Digital Signs and Billboards (S606).” APA National Conference, presented April 28, 2009.

¹⁶ Outdoor Advertising Act (Article 7, Section 5403 of the California Code of Regulation).

¹⁷ Roberts (2013).

¹⁸ Wachtel et al. (2009).



The proposed sign would be the first digital billboard at the intersection. The nearest digital sign is located on Crenshaw Boulevard approximately 600' north of El Segundo Boulevard in the City of Hawthorne, which is not expected to conflict with the placement of the proposed sign.

Illuminance and Luminance

Illuminance refers to the light energy landing on a surface at a distance from a sign, while luminance refers to the light energy at the sign surface itself. The FHWA recommends adjusting luminance in response to ambient illuminance to ensure signage is not “unreasonably bright for the safety of the motoring public”¹⁹. For areas of medium to high ambient illuminance, academic literature recommends digital signs should not exceed 0.8 foot candles and that digital signs should be equipped with auto-dimming technology.²⁰

The proposed sign content is anticipated to comply with the recommendations above and will provide timed dimmers. A formal lighting study is also underway that will be submitted to the City for review prior to project approval.

Operations

The timeframe during which a sign is operational can be regulated if the standards pass the “time, place, manner” test.²¹ The standards must be content-neutral, but may require all digital or internally-lit signage to turn off or dim after a certain time of night, for example. The FHWA recommends requiring a default designed to freeze the image in the event of a malfunction²². These types of regulations can ameliorate community concerns about light pollution or about exacerbating the dangers of impaired drivers past a certain time of night.

The proposed sign content is anticipated to comply with the recommendations above. The proposed sign operation would function from a content server with a backup server system. The backup server system would respond in the event of a malfunction in the content server.

¹⁹ FHWA (2007).

²⁰ Gottwald, R. (2011). “Recommended Night-time Brightness Levels for On-Premise Electronic Message Centers (EMC’s),” *International Signage Association*.

²¹ Mandelker, D. and Baker, J. (2014). “Bettman Symposium: Reading the Signs (S656).” *APA National Conference*.

²² FHWA (2007).



Conclusion

The most recent research on the topic concludes that:

Based on the available evidence, it is not possible to conclude that there is a direct relationship between the driving behavior changes that can be attributed to roadside advertising and subsequent road crashes. Most of the results in this respect remain inconclusive. However, there is an emerging trend in the literature suggesting that roadside advertising, particularly those signs with changeable messages, can increase crash risk. It is important to bear in mind that most of the empirical studies undertaken to date feature strong methodological limitations. Finally, roadside advertising technology is continually evolving, so there is a need for further research to ensure the recent technological advancements are addressed.²³

The impact of installing a dynamic sign in an urban location is much different than a sign installed in a rural context or a highway. Therefore, the recommendations of the research cannot be applied universally. The distracting environment along an urban arterial demands a constant level of attention, particularly at intersections. Higher ambient lighting along urban arterials may neutralize some concerns regarding the effects of dynamic signs that otherwise exist on rural or suburban roads, where highway users can become lulled in inattention and then surprised by unexpected events.

Based on the literature review, design and operational characteristics of the digital sign were identified to minimize driver distraction and the potential for traffic safety hazards. The project is expected to be designed and operated to meet these characteristics to the extent feasible and therefore reduce the potential for traffic safety hazards associated with driver distraction.

²³ Oviedo-Trespalacios et al. (2019).