

Review of Three CIMA Reports for the City of Toronto Concerning Electronic Advertising Signs

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Document #1 – Current Research Literature Review.

1. In their Introduction, the CIMA authors use the term Static Electronic Signs (SES) to characterize digital signs that “have the ability to automatically change the message shown on the sign at regular intervals. ... some can even display full motion videos.”
 - a. This language is not in keeping with that generally employed or understood in this industry. And I have not seen it used anywhere else. The term coined by FHWA in 1980 “commercial electronic variable message signs” (CEVMS) remains in use today, although some refer to them as digital billboards.
 - b. The authors are incorrect in stating that *some* of these displays can display full motion video. If they are digital, and if they use LED illumination, they *all* can display full motion video.
 - c. The authors use the term “brightness” as a descriptor of these signs. Brightness is a subjective human response to the *luminance* of a sign, and to its contrast against the background in which it is seen. It is incorrect to use the term brightness to describe these signs.
2. The authors begin their review of the literature with a lengthy discussion of a report that I conducted on behalf of NCHRP. Although it is understandable that it is difficult to summarize in 20 pages what I wrote in nearly 200, I am nonetheless concerned that CIMA’s summary, and their conclusions drawn from my report are, in several cases, seriously inadequate and often erroneous. Examples include:
 - a. They state: “Acceptable driver distraction duration varies between 0.75 second, 1.6 second, and 2.0 seconds. Distractions resulting in looking away from the roadway for a longer period than these values are considered to be unsafe.”
 - i. There is nothing in my report to indicate or suggest that distractions below these values are “acceptable.” The CIMA review fails to discuss that these three values represent the work of three different researchers; it is inaccurate for them to

conclude that “looking away from the roadway for a longer period than these values are considered to be unsafe.” This is misunderstanding of the discussion in my report.

- ii. Their statement that “looking away from the roadway ahead for a period longer than two seconds almost doubles the risks of a collision or near collision” is also incorrect. The correct value is a factor of 2.8.
- b. The CIMA authors state: “the concept of ‘spare attentional capacity’ has “been used by the outdoor advertising industry to minimize the impacts of distractions caused by advertising on road safety.” There is nothing in my report to suggest this, and the evidence shows that is clearly untrue. In fact, quite the opposite is the case. Advertisers seek to place their digital billboards adjacent to roadway sections with the highest density of traffic, at the apex of vertical and horizontal curves, and near interchanges – all so that their advertising can be observed by as many drivers as possible. These areas are typically those in which the drivers’ task demands are at their highest.
- c. CIMA summarizes a section of my report as follows: “Studies should not only look at the mean number and duration of distractions. They should also include an analysis of the greatest number of distractions and the longest duration of glances.” This is a mischaracterization of what I wrote. I was discussing the work of Horrey and Wickens who recommended that “the tails of the distribution” (e.g. standard deviations beyond the mean sufficient to accommodate the 15th and 85th percentile driver) should be addressed in such studies.
- d. Their discussion of “information presentation” and its potential effect on distraction was described as being “beyond the scope of the report, and possible, outside the authority of regulators.” As written, this paragraph makes little sense since the CIMA authors do not describe what I meant by information presentation. This discussion in my report specifically addressed characteristics of the display such as letter, number, and character size, font, figure-ground contrast, etc. In other words, information presentation as used in my report meant the manner in which the information to be conveyed on the billboard was visually presented on that billboard. In the U.S., it is possible that action by a government agency to regulate such aspects of a display could tread on issues of freedom of speech. This issue was discussed at length in my report – hence, it was not “beyond the scope of the report,” as CIMA stated, and it can only be understood to be potentially “outside the authority of regulators” for the reasons described herein.
- e. CIMA states: “Roadway authorities may consider granting permits for shorter periods ... and require the permits to be renewed regularly.” Taken out of context as this is makes this statement essentially meaningless. It must be read in the context that the most typical current practice in the U.S. is for local jurisdictions to grant a permit for a billboard with no time restriction, provided that the required fees and/or taxes are paid. In other words, current practice allows, once a billboard has been approved, that it remains in conformance in perpetuity. As a result, any need for the authority to remove or relocate the billboard (due, for example, to road widening or demonstrated safety concerns) results in the authority having to pay the billboard owner huge sums of money. (A recent case in the State of Minnesota required that the

State pay the billboard owner \$4.3 million as a result of its necessary relocation due to a road-widening project). The point made in my report was that certain U.S. jurisdictions have foreseen the potential for such problems and, as a result, have established a system whereby a billboard owner must apply for, and be granted an operating permit for a specified time period. At the end of this period, the billboard owner must reapply or the sign automatically becomes non-conforming. This simple change to the permitting process may save local jurisdictions large sums of money as well as the litigation that typically accompanies it, should there be a need or desire to remove or relocate that billboard in the future.

- f. There are several other examples in which the CIMA authors either misunderstood my report or mischaracterized it, perhaps due to their effort to summarize it briefly.
3. After a discussion of my NCHRP study, the authors discuss their review of several additional studies. With the exception of the Dukic, et al study (discussed in CIMA's Section 3.7), I am insufficiently familiar with some of the other studies discussed to comment on the CIMA review. However, with regard to the Dukic study, the reviewers did not report that the billboards studied in Sweden had been erected as part of a trial, and that, as a result of this study and a companion study performed by the same authors, the Swedish government ended the trial and had the billboards removed.
 4. In their "Conclusions" section, the authors praise the Hawkins, et. al, study. And although I agree that the study was well done methodologically and statistically, there is one serious, overarching flaw in the study that the CIMA authors do not discuss, and another case in which the CIMA team made a statement that is in direct contradiction to the Hawkins study findings. These are serious issues that call into question the thoroughness of the CIMA work.
 - a. First, the Hawkins study was sponsored by the on-premise signage industry, and this organization put the researchers in touch with a number of sign companies. It was these sign companies, not the researchers, who selected the signs to be studied. In fact, the researchers never saw the signs they studied (either in person or via photographs). Why is this important? Because it is not unlikely that the sign companies selected those signs that they knew had the least possible visual or attention-getting impact on the drivers who passed them.
 - b. The CIMA authors state, in their review of the Hawkins study: "... it was found that the following attributes do not have a statistically significant impact on the means of safety indexes: sign colours, sign dimensions, and type of business advertised." This is a disturbing statement given that the Hawkins study did not evaluate any of these sign characteristics, and certainly did not represent that they did or did not have an impact. In fact, in the "Summary and Conclusions" section of the Hawkins study, the authors discuss the need for future research. They state, in part: "... it may be of interest to examine whether or not the index varies as a function of sign characteristics, such as color, size, content, and type of business, or the characteristics of the crash, such as collision type, severity, and age of the driver (especially older drivers) among others."
 5. There are a number of other relevant studies about static and dynamic billboards that have been conducted and reported since 2009 and prior to the issuance of the CIMA report (which is dated

September 13, 2013) that were not addressed in the CIMA review. These studies include:

- a. Backer-Grøndahl, A., & Sagberg, F. (2009). "Relative crash involvement risk associated with different sources of driver distraction." Presented at the First international Conference on Driver Distraction and Inattention. Gothenburg, Sweden: Chalmers University.
- b. Chan, E., Pradhan, AK, Knodler, MA, Jr., Pollatsek, A. & Fisher, DL. (2008). "Empirical Evaluation on a Driving Simulator of the Effect of Distractions Inside and Outside the Vehicle on Drivers' Eye Behaviors," Washington, DC: 87th Annual Meeting of the Transportation Research Board of the National Academies.
- c. Divekar, G., Pradhan, AK, Pollatsek, A., & Fisher, DL. (2013). "External Distractions": Evaluations of their effect on younger novice and experienced drivers' behavior and vehicle control." Transportation Research Record, Journal of the Transportation Research Board No. 2321. Washington, DC: Transportation Research Board of the National Academies.
- d. Edquist, J., Horberry, T., Hosking, S. & Johnston, I. (2011). "Advertising billboards impair change detection in road scenes." Paper presented at the 2011 Australasian Road Safety Research, Education & Policing Conference.
- e. Gitelman, V., Zaidel, D., & Doveh, E. (2012). "Influence of Billboards on Driving Behavior and Road Safety," Presented at: Fifth International Conference on Traffic and Transportation Psychology. Groningen, The Netherlands: University of Groningen.
- f. Horberry, T., Regan, MA, & Edquist, J. (2009). Driver Distraction from Roadside Advertising: The clash of road safety evidence, highway authority guidelines, and commercial advertising pressure. Downloaded from the web at: <https://document.chalmers.se/download?docid=653291678>
- g. Milloy, SL; and Caird, JK. (2011). "External Driver Distractions: The Effects of Video Billboards and Wind Farms on Driver Performance." Published in: *Handbook of Driving Simulation for Engineering, Medicine and Psychology*. Edited by: D.L. Fisher, M. Rizzo, J.K. Caird, & J.D. Lee. Boca Raton: CRC Press.
- h. Roberts, P., Boddington, K., & Rodwell, L. (2013). Impact of Roadside Advertising on Road Safety. Austroads Road Research Report: Publication No. AP-R420-13. City: Australia, ARRB Group.
- i. Young, MS, Mahfoud, JM, Stanton, N. Salmon, PM, Jenkins, DP & Walker, GH. (2009). "Conflicts of Interest: The implications of roadside advertising for driver attention." *Transportation Research Part F: Traffic Psychology and Behaviour, Vol. 12(5)*, 381-388.

It is unfortunate that the CIMA authors did not include these studies in their review. Reviews of these articles may be found in a paper that I prepared for presentation to the American Association of State Highway and Transportation Officials in 2013.¹

It should also be noted that at least two studies have been published on this subject subsequent to the issuance of the CIMA report. These include a well-controlled study performed in Denmark², and a seriously flawed study³ undertaken by the Federal Highway Administration (FHWA) in the U.S. Peer reviews of the latter will be forthcoming within the next several weeks.

Document #2 - Before/After Collision Analysis at Signalized Intersection.

1. Although I have no disagreement with the statistical approach used in this study, I must point out why post-hoc statistical analyses of traffic collisions, particularly collisions that may result, in part, from driver inattention or distraction, are challenging to perform, and why the findings, regardless of methodological approach, are often of questionable value.
 - a. I am not familiar with the traffic collision investigation and reporting process in Canada. I can say, however that in the U.S., the vast majority of traffic collisions are never reported to law enforcement (NHTSA indicates that as many as 80% of crashes are never reported) and hence do not appear in data bases that are used for subsequent analysis. This is particularly true for collisions in which there is no loss of life, severe injuries, or significant property damage. The reasons are straightforward:
 - i. Drivers do not want to incur points on their driver's license, which might be assigned to them if they are found to be at fault.
 - ii. Drivers are fearful of an increase in their automobile insurance rates, or, worse, being dropped from coverage by their insurance company.
 - b. Particularly with regard to collisions involving inattention or distraction, drivers may actually be unaware that they had taken their eyes off the road for a period of time sufficient to contribute to a collision. Conversely, if a driver *is* aware that s/he was distracted, s/he may be unwilling to admit this for fear of adverse consequences.
 - c. Collisions are not only rare events (typically measured in the number of collisions per millions of vehicle miles traveled), but most collisions have multiple causes, the absence of any one of which could have resulted in the collision having been avoided. In the landmark "100 car study" (actually a series of studies) performed by the Virginia Tech Transportation Institute (VTTI) on behalf of the National Highway Traffic Safety

¹ "Compendium of Recent Research Studies on Distraction from Digital Signs," by Jerry Wachtel, The Veridian Group, Inc., June 2013.

² "Roadside Advertising Affects Driver Attention and Road Safety." *Proceedings of the 3rd International Conference on Driver Distraction and Inattention*, September 2013, Gothenburg, Sweden.

³ "Driver Visual Behavior in the Presence of Commercial Electronic Variable Message Signs (CEVMS), September 2012. U.S. Department of Transportation, Federal Highway Administration. Accessed from the web at: http://www.fhwa.dot.gov/real_estate/practitioners/oac/visual_behavior_report/final/

Administration (NHTSA), the researchers found that it was necessary to include “near misses” within their collision database in order to achieve statistical significance in their findings. The research team found, in addition, that such near misses demonstrated all of the same factors that led to actual collisions, with the single exception that one or more of the drivers managed to take some action at the last moment to avoid the collision. Unfortunately, when performing a statistical analysis of a traffic collision database, near misses are, by definition, excluded, and thus it becomes less likely that statistically significant results will be found. Capturing near miss data, and merging this data set with the collision database would have been enlightening, but was not possible with the research methodology employed.

2. There are a number of aspects of the research methods used that seem puzzling at best, and are potentially of serious concern as they may affect the reported findings.
 - a. The original data used by the CIMA researchers, and provided to them by the City, appears questionable. For example, how is it possible that traffic volume counts for pedestrians and for the major and minor legs of the intersection were identical for all three treatment sites, and identical for all four comparison sites at the Sheppard Ave E and Warden Ave sites. Did the research team question these statistics? They made no attempt to explain them.
 - b. There is no discussion about the studied sign itself, including characteristics such as its luminance or the frequency with which its message changed (known as dwell time). For example, high luminance levels at night might have been associated with greater distraction, as might more frequent message changes. A number of studies have suggested that it is the message change itself (with a concomitant change in sign luminance, color, etc.) that leads to higher levels of distraction. The less often the message on this studied sign changed, the less likely it was that passing drivers experienced the moment of change. What might have been the authors’ conclusion had they found that the increased number of collisions at the treatment sites all occurred during the moment of message change? (Of course, this is merely a hypothetical question, one that cannot be answered with the available data. But it indicates the difficulties faced when trying to undertake a post-hoc statistical analysis of collisions from a broad database that does not provide information about the key parameters being studied).
 - c. There was no discussion about the collisions that were used from the database. Did the authors include *all* collisions, or were certain types excluded? The authors state: “To determine the frequency of collisions that occurred on each approach, two fields from the Motor Vehicle Accident (MVA) reports were used: ‘Apparent Driver Action’ and ‘Initial Direction of Travel.’ If a driver had an attribute different than ‘Driving Properly’ for the collision field ‘Apparent Driver Action,’ it was identified as the at-fault driver and its direction of travel was used.” It is not clear to me what this statement means, or how this affected the data used. Did this address both single vehicle and multi-vehicle crashes? If each of the drivers in any given collision was found to be ‘driving properly,’ does that mean that that particular collision was eliminated from analysis? Isn’t it possible (likely) that a collision occurred in which the police did not assign fault to either driver, or, conversely, assigned fault to both drivers? Without a clear understanding about the

authors' use of the MVA database, I am unable to determine whether their methods of collision assignment and analysis were reasonable. In any event, if any collisions reported in the MVA database were eliminated from analysis for reasons discussed herein, the effect would be to reduce the significance of the findings, and this cannot be discounted.

- d. The authors include a puzzling statement in their discussion of the treatment and comparison sites. They state: "A review of collisions on the mid-block sections of each approach of each intersection was undertaken to determine if any were related to the signalized intersection or the scrolling signs and, therefore, need to be included in the analysis." This statement is confusing for several reasons. First, how did the researchers attempt to relate these mid-block collisions to the intersections, and what were the results? Second, were these midblock collisions treated as a separate data set? Third, and of most concern is their potential relationship to "the scrolling signs." The obvious question is – What scrolling signs? There is no mention of any such scrolling signs anywhere else in this report. How many such signs were there? Where were they located? Were they considered to be part of the comparison sites? This confusing statement, completely out of context with the rest of the report, raises additional questions about the adequacy of the research methodology, and about the true difference between treatment and control sites. Depending upon what is really meant by this statement, the potential exists for an inappropriate reduction in the number of collisions observed at the comparison sites, and a concomitant artificial loss of statistical significance.
3. Given the above caveats, it is not surprising that statistically significant results were not obtained. Nonetheless, it is interesting to observe that all three of the treatment sites experienced an increase in collisions after the digital sign was erected (by 17%, 20%, and 7%), whereas the single comparison site at the same location experienced a decrease in collisions by 17%.
 4. Before the city accepts the results of this study as valid, these apparent discrepancies should be clarified and, if necessary, the analysis redone.

Document #3 – Before/After Collision Analysis at Mid-Block Locations.

1. Unfortunately, time did not permit more than a cursory review of this report. Accordingly, my review is limited to raising a few questions about the approach employed.
2. As stated above, there are a number of limitations that apply to post-hoc reviews of collision data that form the basis for studies of this type. A thorough discussion of such limitations is provided in my 2009 NCHRP report, to which the CIMA reviewers refer in their Technical Memorandum #1.
3. There seems to be no discussion of how the comparison sites were selected, or the characteristics of these sites. Since the collision rates in the treatment sections were compared to those in the comparison sections, such a description is warranted. For example, one presumes that the comparison sections were matched to the treatment sections for characteristics such as road geometry, traffic volumes, number of lanes, posted speed limit, prevailing speeds, traffic enforcement, etc., but this is insufficient. To truly serve as a comparison section, one must know the basis of this comparison. That is, were comparison sections devoid of all signs, or might there have been on-premise (sometimes called first-person) signs present? Is it possible that

some of the comparison sections included illuminated, or even digital on-premise signs? (In a study often praised by outdoor advertising proponents in the U.S., but heavily criticized by independent peer reviewers, a group of researchers at VTTI⁴ identified comparison sites as: “areas with visual elements other than billboards. Examples include on-premise signs, logo placards, interesting landmark buildings, large wall murals, and variable message signs. Several had digital components.” Although Lee and her colleagues deserve praise for the thoroughness with which they described such sites, they were hardly justified in using them as a basis of comparison to digital billboards, since they may have appeared quite similar to the naïve driver, and contributed to comparable distraction).

4. Apparently, ten digital signs were considered in this analysis. According to Table 1, seven of these ten signs had two sign faces; i.e. they faced motorists traveling in two different directions. Yet, in their characterization of a sign’s “influence zone,” (Figure 5), the researchers only accounted for a driver’s view of a sign in a single direction. Were the views in the opposite direction addressed in any way – i.e. were they included, treated as comparison sites, or simply ignored?
5. Typically, when conducting research studies, the researchers begin with a hypothesis (or multiple hypotheses) and then set out to disprove them. That does not appear to have been the case in this study; had it been so, the research team would have been expected to explain, or at least postulate, about why their results seemed to show something other than what was expected.
6. Although it is useful that the CIMA team performed an analysis under both daylight and dark conditions, this analysis is not terribly useful without the measurement of luminance values of the overall scene, and especially the studied digital signs, under each condition. The same measurements should have been made for the comparison sites.

Respectfully submitted,

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⁴ “Driving Performance and Digital Billboards - Final Report.” Prepared for Foundation for Outdoor Advertising Research and Education, 2007. By Suzanne E. Lee, Melinda J. McElheny, and Ronald Gibbons.