

Guiding principles for developing digital and projected advertising display regulations

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Abstract

Digital and projected advertising displays (DPADs) are a rapidly emerging form of roadside advertising. The brightness of DPADs and their ability to distract drivers by displaying dynamic content are causing concern about their road safety impacts. Most jurisdictions have sign by-laws designed to control the time, place, and manner of static advertising signs. However, many jurisdictions have not updated their by-laws to address the unique characteristics of DPADs. Advertising is a form of expression which is considered a fundamental freedom under the Canadian Charter of Rights and Freedoms. Advertising is also a type of roadside information that is not essential for the driving task and by its nature increases the risk of collision by distracting drivers. Jurisdictions must balance the right to advertise with the potential road safety risks of these advertisements. Therefore, the objective of DPAD regulations is to control the negative road safety effects of DPADs.

This paper presents five principles to guide professionals during the development of DPAD regulations from a road safety perspective as part of a larger study to develop national guidelines for the application and use of digital advertising signs. These principles are safety, consistency, specificity, evidence-based, and pragmatism. These principles help ensure that regulations hold public safety as the primary concern, result in DPADs operating in a manner that emulates static advertising signs, pertain only to issues unique to DPADs and not to issues that are common to all advertising signs, are evidence-based, scientifically supported, and sensitive to local conditions, and are pragmatic and enforceable.

INTRODUCTION

Most drivers are familiar with roadside advertising signs and expect to encounter these signs as they drive. Until recently, roadside advertising has consisted primarily of static signs with or without illumination. Internally lit signs have typically used incandescent or fluorescent bulbs and occasionally used optical illusions such as the phi phenomenon or beta movement (i.e., rapidly turning stationary lights on and off in succession) to give the impression of movement. In many places, roadside advertising signs are part of the fabric of the roadway environment and they are generally not considered as a significant public concern among road authorities in terms of their impact on road safety (the cumulative effects of multiple static advertisements on visual clutter and complexity notwithstanding). Since the early 2000s, light-emitting diode (LED) technology has emerged as an increasingly affordable and attractive replacement to static advertising signs. Referred to as digital and projected advertising displays (DPADs), this technological advancement is challenging the applicability of current sign by-laws, particularly from a road safety perspective. The ability of DPADs to display full-motion video at high illumination levels is introducing a potentially high level of driver distraction which many jurisdictions are struggling to regulate from a road safety perspective.

The objective of this paper is to present and describe five principles to guide professionals during the development of DPAD regulations from a road safety perspective. The development and application of these guiding principles are part of a larger study to develop national guidelines for the application and use of DPADs. The guiding principles are safety, consistency, specificity, evidence-based, and pragmatism.

BACKGROUND

DPADs are defined as any type of stationary advertising display that is visible from the road and is capable of displaying dynamic content or automatically changing content. DPADs can be located on private property or within public right-of-way with content that includes text, images, or both. This content can be displayed statically with multiple advertising messages presented in sequence, dynamically using full motion video, or using scrolling text. These displays can be stand-alone billboards, signs affixed to or advertising projected onto buildings or other structures, or message centres incorporated into ground signs. DPADs are operated for the primary purpose of displaying commercial advertising and occasionally for displaying public service announcements. They exclude portable variable message signs governed by the Manual of Uniform Traffic Control Devices of Canada in Section D3.8, mobile displays such as those affixed to vehicles, and indoor displays.

There are several important aspects and operational characteristics of DPADs that should be regulated as defined here:

Frame duration: the amount of time that a single frame is displayed; sometimes referred to as message duration, message on-time, or exposure time.

Sign spacing and density: spacing is the longitudinal distance between consecutive signs and density is the number of signs within a defined longitudinal distance.

Transition time and effects: the time interval between successive frames and the visual effects between frame transitions.

Message sequencing and text scrolling: the former refers to the use of more than one frame presented on a single sign in succession to convey a single message; the latter involves text continually scrolling across the display (either horizontally, vertically, or diagonally).

Brightness: the appearance of the sign to the driver. It is a function of sign luminance, distance to the sign, background against which the sign is viewed, driver's age, level of adaptation of the eyes, and atmospheric conditions.

Animation: any motion in the advertisement, including video, special effects within a single frame, and transition, movement, and rotation between successive frames.

There are two broad types of advertising signs: on-premise and off-premise. On-premise are signs whose message relates to a business, profession, product, service, event or other commercial activity sold, offered, or conducted on the same property where the sign is located. They are generally owned and operated by businesses whose primary activity is not advertising or marketing and displaying content specific to the business. On-premise sign owners are usually less sensitive to frame duration, since it is not directly tied to revenue, but are sensitive to DPAD spacing since this can determine how many businesses are eligible to use DPADs. Off-premise are signs directing attention to a specific business, product, service, entertainment event or activity, or other commercial activity that is not sold, produced, manufactured, furnished, or conducted at the property upon which the sign is located. Off-premise signs are generally owned by a company whose primary business is advertising or marketing. Advertising space for off-premise signs is leased to private businesses that are not necessarily situated in proximity to the sign. Off-premise sign owners are usually sensitive to frame duration since, it is directly tied to revenue, and are less sensitive to DPAD spacing.

The primary road safety concern associated with DPADs is their distraction in terms of diverting driver attention from the driving task¹. There are two different components of driver distraction that result when drivers look at DPADs – visual (eyes) and cognitive (mind or attention). Driver attention to DPADs is often measured using visual metrics such as the number of glances (i.e., glance frequency) and the length of glances (i.e., glance duration). Cognitive metrics are difficult to measure and are rarely used for quantifying driver distraction specific to DPADs. Therefore, the challenge for practitioners and road safety professionals is to regulate aspects of DPADs that influence glance frequency and duration such that the change in a driver's visual search does not create an undue increase in collision risk. Critical aspects specific to DPADs that affect glance behaviour and driver distraction are brightness, animation, and location. The guiding principles described in this paper help control these aspects.

The guiding principles are part of a larger national project to develop regulatory and road safety assessment guidelines for DPADs in Canada. These guidelines are intended to assist jurisdictions in developing their own regulations concerning DPADs, evaluating DPAD permit applications, and assessing the potential road safety impact of DPADs. The guideline is currently in development and is expected to be published by the Transportation Association of Canada in 2015. The guiding principles are core elements of the guideline and provide a framework for controlling DPADs without knowing precisely their impact on road safety. Current research concerning the road safety impacts of DPADs is often inconclusive and sometimes contradictory. Despite this limitation, jurisdictions must react and prepare for DPAD permit applications. Given the uncertainty surrounding the road safety impacts of DPADs, it would be reasonable (and in fact preferred from a road safety perspective) for DPADs that are visible from the road to be disallowed until the impacts are better known. However, this approach to

¹ Indirect driver distraction – the reduced ability of drivers to detect something due to an increase in visual clutter – is not addressed in these guidelines as it is a concern that is shared with static advertising displays.

regulating DPADs will be untenable for many road authorities and the guiding principles described in this paper provide direction in the absence of conclusive research surrounding the road safety impacts of DPADs.

DEVELOPING AND APPLYING THE GUIDING PRINCIPLES

Guiding principles are essential components of guidelines. They set the foundation and direction for each recommendation and suggested practice contained within the guideline. In terms of DPAD guidelines, these principles are particularly important for addressing research gaps and allowing recommendations to be made despite scientific uncertainties. The five guiding principles are safety, consistency, specificity, evidence-based, and pragmatism.

Guiding Principle 1: Safety

Since the guidelines are specific to the road safety impacts of DPADs, safety is the first and foremost guiding principle. This principle establishes the type of issues that should be addressed by the guidelines. It states that public safety should be the primary concern of a jurisdiction and road safety professional. Consequently, regulations and by-laws should control the distracting effects of DPADs to limit the increase in collision risk. Further, DPADs should not be permitted unless there is reason to expect that the change in collision risk will be insignificant.

An insignificant change in collisions is interpreted differently by different jurisdictions. Applying this principle resulted in a range of estimated changes in collisions predicted to occur for various situations (i.e., various number of DPADs within a driver's field of view, frame durations, road types, posted speed limits, and historical crash frequencies). Providing this range allows practitioners and decision-makers to determine what is acceptable in their jurisdiction and move forward with regulations that correspond with the estimated change in collisions.

Guiding Principle 2: Consistency

This guiding principle is the most influential in terms of developing recommendations for the issues applicable to road safety (as specified by Guiding Principle 1). This principle states that DPADs should be regulated such that they emulate static advertising signs. The rationale for this principle is that the road safety impact of static advertisements is generally accepted by jurisdictions while the road safety impacts of DPADs are generally unknown. Therefore, by regulating DPADs such that they are perceived by drivers as static signs, the road safety impacts of DPADs can be approximated to the impacts of static signs. Assimilating DPADs to static signs can be achieved by regulating motion, frame duration, transition time and effects, message sequencing, and brightness. Following this principle still allows advertisers to take advantage of many DPAD features such as remotely changing content, showing multiple advertisements on a single sign, and day-parting (e.g., displaying breakfast advertisements in the morning and dinner advertisements in the evening).

This principle formed the foundation for many critical recommendations that permeated throughout the guideline. One important application of this principle is the maximum number of frame changes that a driver should observe within their field of view. This required balancing driver distraction with the opportunity for businesses to advertise. More DPADs within a driver's field of view increases the ability for businesses to obtain a DPAD permit but will also result in more frame changes. It also required addressing on- and off-premise sign owner needs separately since, in general, on-premise sign owners are more sensitive to sign density than are off-premise sign owners. Applying this principle resulted in a

guideline specifying a maximum density for on-premise DPADs and a minimum spacing between off-premise DPADs.

For on-premise DPADs, a maximum density of three DPADs per driver field of view is recommended. Considering that the field of view (defined as the decision sight distance as described by Guiding Principle 5) is approximately between 150 m and 450 m for various road types and travel speeds, this recommendation supports multiple on-premise DPADs per block. This is consistent with current practice in most jurisdictions and provides opportunities for businesses to obtain a DPAD permit. For off-premise DPADs, a minimum spacing of 300 m (or the equivalent decision sight distance, whichever is greater) is recommended between DPADs. This is consistent with current practice in most jurisdictions.

To help ensure that drivers do not observe more than three frame changes in their field of view and given the different density and spacing limits between on- and off-premise DPADs, the application of this principle produced separate frame duration limits and approaches. For on-premise DPADs an entirely new road safety assessment method was developed to provide parameters around minimum frame duration limits. The description of this method is beyond the scope of this paper; however, the guidelines recommend a 20 s minimum frame duration or higher to limit the change in collision frequency to less than five percent. For off-premise DPADs, the recommended minimum frame duration is 8 s which is similar to many jurisdictions' regulations.

This guiding principle provides the rationale for prohibiting full motion video and animated effects for DPADs. This included recommendations to prohibit transition effects between frames (e.g., fading, dissolving, or spinning messages), message sequencing and scrolling text.

Guiding Principle 3: Specificity

All jurisdictions regulate roadside advertising and follow some type of formal by-law. There are many common aspects between DPADs and static advertising signs for which existing static sign by-laws can apply. This principle states that DPAD guidelines should pertain only to issues unique to DPADs and not issues that are common to all advertising signs. For instance, sign dimension and content are not DPAD specific characteristics and therefore current by-laws pertaining to these aspects should be applied. Applying this principle simplifies the regulation of roadside advertising signs and helps ensure that all advertising signs are regulated consistently.

Applying this principle helped put perspective into the logic for defining DPAD restriction areas around traffic control devices and decision-making points on the road. For example, if existing regulations permitted the use of static advertising signs in proximity to various traffic control devices and decision-making points, there needed to be an argument that the LED technology or the ability of DPADs to change frames was different enough from static signs to warrant the development of a separate restriction area. If this argument could not be made, the guidelines recommended that static sign by-laws should also be applied to DPADs. One example of where a separate DPAD restriction area was defined was around traffic signals. The rationale was that signalized intersections are typically at higher risk for collisions compared to other parts of the road, the increasing use of LEDs for traffic signals could be confused with the LEDs used in a DPAD, and the moving display of traffic signals could also be confused with the moving display of DPADs.

Guiding Principle 4: Evidence-based

Although current research does not provide conclusive and substantive evidence about the road safety impact of certain aspects of DPADs, there is a body of knowledge and best practices that can be used to inform the guidelines. This principle recognizes the availability of this research and states that guidelines

should be evidence-based, scientifically supported, and sensitive to local conditions as much as possible. This principle helps jurisdictions defend their policies, encourages jurisdictions to follow best practices, and recognizes that a rigid, one-size-fits-all approach to regulating DPADs is unlikely to be effective.

More than 70 research documents and studies were used to develop the guidelines. Three important research findings that are used in the guidelines relate to the collision risk of driver distraction, mean glance duration (MGD) of drivers towards DPADs, and the relationship between traffic conflicts and crashes. The 100-car naturalistic driving study, cosponsored by the U.S. National Highway Traffic Safety Administration and the Virginia Transportation Research Council, provided one of the most extensive human factors databases concerning driver distraction and road safety. Among the many statistics produced using these data was the increase in collision risk as a function of driver glance behaviour away from the road. According to this research, collision risk increases by a factor of 1.4 when one or two glances are made away from the road and by a factor of 2.3 when more than two glances are made away from the roadway [1]. It is important to note that these collision risks are not specific to DPADs but to glances away from the roadway in general.

Three recent and high quality research studies analyzed the behaviour of driver glance duration towards DPADs [2] [3] [4]. These three research studies estimate mean glance duration of drivers towards DPADs as 0.354 s, 0.379 s, and 0.5 s. According to this collection of research, the mean glance duration of drivers towards DPADs is therefore estimated to be about 0.4 s.

The U.S. Federal Highway Administration (FHWA) conducted research to define a mathematical relationship between traffic conflicts and crashes [5]. According to this research, the following exponential relationship was developed:

$$Crashes = 0.119 \times (Conflicts)^{1.419}$$

This research and relationship helped convert the estimated change in collision risk due to a DPAD (as supported by the 100-car naturalistic driving study) to an estimated change in crash frequency.

The combination of these three research findings (i.e., collision risk relationship to glance behaviour, glance behaviour to DPADs, and crash frequency relationship to traffic conflicts) formed the foundation for the method to estimate the change in crash frequency due to on-premise DPADs provided in the guidelines. The guidelines develop a method for estimating the number of glances drivers will make towards DPADs for different road types, travel speeds, and traffic volumes using a MGD of 0.4 s. Using this information, the increase in crash risk is estimated using the 100-car naturalistic driving study results. The change in crash risk is converted into a change in crash frequency using the FHWA equation. This method was critical for recommending minimum frame duration limits for on-premise DPADs.

Guiding Principle 5: Pragmatism

This principle states that DPAD regulations should be pragmatic and enforceable. The scientific research concerning DPADs can be complex and detailed. Some of this research includes complicated equations for determining appropriate DPAD characteristics for different situations. Detailed regulations could be developed which scrutinize every aspect of a DPAD and its location according to the scientific research; however, jurisdictions may not have the resources to conduct detailed analyses for each application or to enforce the regulations. Developing and applying commonly accepted heuristics or lookup tables as approximations for regulating certain DPAD features may be an effective way to control DPADs within available resources without compromising road safety.

Applying this principle directly impacted each guideline and recommendation, particularly those relating to brightness, sight distance to DPADs, DPAD spacing and density, and the treatment of on- and off-premise DPADs. There are two main metrics for regulating sign brightness: luminance and illuminance. Luminance refers to light that is emitted from a surface while illuminance is the amount of light falling upon a surface. The guidelines recommend regulating illuminance for several reasons, one of them being enforcement and the ability to measure brightness. Illuminance is typically easier to measure from the field and therefore is easier to enforce. Further, illuminance is more reflective of how a driver may perceive brightness and also accounts for ambient light conditions, including the relative brightness of the surrounding environment.

Sight distance can be calculated using engineering or human factors methods. The human factors method calculates sight distance as a function of reading time and sign legibility. It is more scientific than the engineering method and explicitly considers a driver's interaction with a DPAD. Using human factors methods for estimating sight distance can be difficult to calculate and can vary significantly based on season (e.g., tree foliage in the summer can reduce sight distance compared to winter) and sign content (e.g., a single DPAD may have several messages, each with a different sight distance). The engineering method uses stopping sight distance (SSD) or decision sight distance (DSD) as a proxy for determining the sight distance to a DPAD. The guidelines recommend using DSD as a surrogate for a driver's sight distance to a DPAD as a pragmatic approach that is simpler to calculate and can be applied consistently. DSD is recommended over SSD since an advertising sign sometimes requests drivers to make a decision and perform a specific action (e.g., turn left at the next intersection).

Applying this principle also affects the recommendations for on-premise DPAD density. Rather than recommending minimum spacing requirements between on-premise DPADs, the guidelines recommend maximum density limits. This mitigates the complexity and difficulty of taking measurements between signs and provides flexibility in the regulations to better accommodate the variable distances between businesses. Further, this principle also underlies the approach to treat on- and off-premise DPADs differently in terms of regulating sign spacing/density and frame duration. Applying the same sign spacing and frame duration limits to both types of DPADs would likely result in one or both types of sign owners challenging the regulations. By following a pragmatic approach that recognizes the differences between these signs, a set of regulations can be developed that mitigates road safety concerns while satisfying business needs.

CONCLUSION

This paper describes the development and application of five guiding principles as part of the Transportation Association of Canada's Regulatory and Road Safety Assessment Guidelines. The five guiding principles are safety, consistency, specificity, evidence-based, and pragmatism. The paper demonstrates that these guiding principles were fundamental in establishing recommendations, particularly given the lack of conclusive research regarding the safety impacts of DPADs. Without these principles, the guideline would not have been able to guide the development of policies and regulations for many aspects of DPADs.

Guiding Principle 1: This principle states that public safety is the foremost concern of the guidelines and associated regulatory recommendations. A significant impact of applying this principle is the exclusion of recommendations pertaining to aesthetic, political, and economic issues related to DPADs. Guiding Principle 2: Consistency is one of the most important principles and states that DPADs should be regulated in such a manner as to emulate static advertising signs. A significant impact of this principle is the prohibition of DPAD animation and the establishment of DPAD spacing and density limits. Guiding Principle 3: Specificity ensures that the guidelines are specific only to DPAD characteristics that are

different from static advertising signs and recommends adopting existing static sign by-laws for DPADs for common characteristics. A significant impact of this principle is the exclusion of recommendations concerning DPAD colour, content, and defining certain DPAD restriction areas. Guiding Principle 4: Evidence-based states that guidelines should be scientifically-supported by research and sensitive to local conditions as much as possible. A significant impact of this principle is the use of three important research findings relating to the collision risk of driver distraction, mean glance duration (MGD) of drivers towards DPADs, and the relationship between traffic conflicts and crashes. Guiding Principle 5: Pragmatism recognizes that practical and enforceable guidelines are necessary for jurisdictions to be able to adopt, adapt, and apply the recommended policies and regulations. This principle impacted the recommendations for DPAD brightness, sight distance to DPADs, spacing and density limits, and the separate treatment of on- and off-premise DPADs regarding frame duration, spacing, and density.

The five principles are an integral part of the guidelines. They inform each recommendation and support suggested policies and regulations for governing the use of DPADs. Although these principles are foundational to the guidelines, they are also useful for jurisdictions wishing to develop DPAD policies and regulations that may differ from those recommended in the guideline.

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