Measuring the effect of brighter markings: The "hands on" approach.

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Abstract

This report outlines current research measuring a set of 'intermediate outcomes' to assess the benefits of improved road markings using a before/after design which involves upgrading a 3-4km section of state highway. A suitable site has been identified on SH 1, north of Kaitoke. Observations will be taken of vehicle speed, lane position, headway, and hand positions to build a risk profile for drivers in four conditions: Day/Night, Wet/Dry. The technical difficulties of measuring driver hand position in car travelling 100kph in wet/night conditions have been overcome using active infra-red floodlighting and passive infra-red light-enhancement optics fitted to a high-speed digital camera. Our ability to examine a wider range of intermediate outcomes now allows us the opportunity to determine the level of risk a driver perceives as they pass through a roading environment and the effect improved delineation has on that level of perceived risk.

Introduction

Observable behaviours that are associated with accident rates, often referred to as "intermediate outcomes", can be used to measure the impact of a change in the road environment on driver behaviour, and from this infer likely improvements in road safety.

Road safety research has used naturalistic observation techniques to assess a number of driving behaviours, such as seat-belt use (Hunter, Stewart, Stutts & Rodgman, 1993), infant restraint (Eby, and Kostyniuk 1999), handheld cell phone use (McCartt, Braver, Geary 2003) and seating position (Parkin, Mackey and Cooper, 1995). Typical intermediate outcome measures include 'head-way' (distance between vehicles) (French, West, Elander and Wilding (1993), gap acceptance (Reason, Manstead, Stradling Baxter and Campbell 1990, Wasielewski & Evans, 1985), speed, (Smeed, 1972, Evans & Wasielewski, 1982) and lane positioning (Elliott, McColl & Kennedy 2003, Straughton and Storie 1977). These intermediate measures replace direct measures for research purposes due to Poisson-distributed nature of rare events like actual accidents. Walton and Thomas (2005) and Thomas & Walton (2007) have expanded intermediate measures to include 'hand positions' because these vary with actual risk and directly monitor a behaviour that is not influenced by other drivers (vis-à-vis speed and headway).

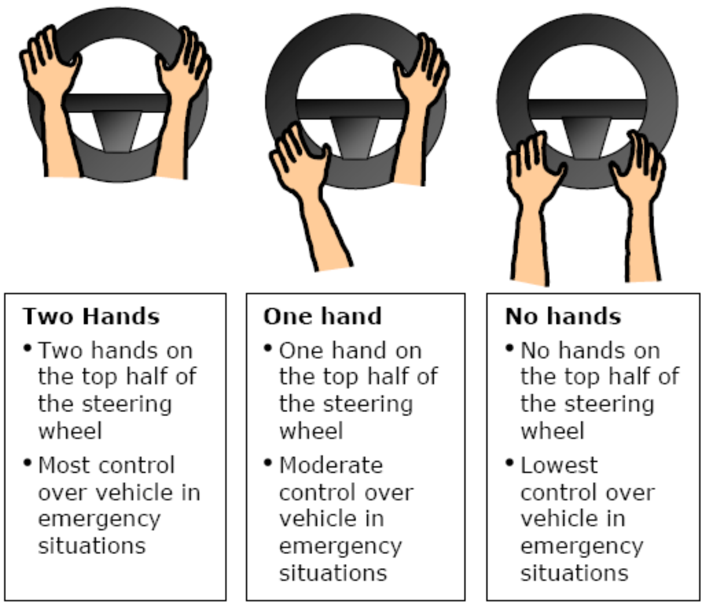
Purpose of the Proposed Research

New Zealand has the benefit of the most useful data about the road environment being centralised in the RAMM database and collected by high-speed monitoring on an annual basis. However, not having a significant population of accidents undermines epidemiological analyses that attempt to establish the benefits of corridor treatments (Dravitzki, Wilkie and Lester, 2005). Before-and-after crash data take too long to monitor before new improvements are introduced. The current technique of before-and-after crash studies is found to be difficult to apply to determine the benefits of delineation. Data must be collected over a very long period of time to be statistically robust. The effect of individual components of an improved roading context (such as improved signage, better delineation, or improved sightlines) is normally subsumed by broader analysis of area-wide improvements and changes in behaviour, enforcement, and administration over this long period.

Three New Zealand studies have each sought to identify the benefits of brighter markings, the use of cats-eyes, or brighter edge-marker posts using "before and after" crash analysis. These three studies have been inconclusive. A different approach is needed.

In previous studies addressing issues of 'mental workload', road context has had a significant influence on a workload index and this is related to behavioural adjustments such as, speed, smoking and conversing (Zeitlin, 1998). The new method measures 'driver's self-perceived risk' by monitoring driving posture—this is a particularly useful measure in before/after evaluations as any change in hand pattern configurations has an explanation based on risk perception.

Figure1. An illustration of the ordinal scale of hand positions (Walton & Thomas 2005).



On any given road, normally around 50% of people drive with only one hand on the top section of a steering wheel, less than 25% are observed to drive with two hands in the recommended '10 and 2' position (see figure 1). Variation in the pattern of hand positions observed across a large sample (typically N >2500 observations) reveals that configurations alter with increased objective risk, as inferred from the context (different speed zones, and multi-lane environments) and is acknowledged in self-reports (Thomas and Walton, 2007). Repeated observations of the same drivers indicate the pattern of hand positions is not a function of fatigue or habit, and hand positions alter continuously throughout a journey (Walton and Thomas, 2005). Hand positions alter with vehicle type, as SUV drivers are more likely to drive with a reduced risk perception profile compared to drivers of ordinary vehicles (Thomas and Walton, 2007). Current work has indicated that there is no significant multi-colinearity with other intermediate measures such as speed and headway, and that the so-called

‘Hands-on’ measure varies across gender (Fourie and Walton, 2007). As a consequence, a change in the road context that has a concomitant change in hand position configurations, observed in a large number of drivers, requires an explanation related to the change in context. In addition to this, standardised individual measures of each vehicle can be indexed into a risk profile which can then be aggregated to form a single measure of perceived risk associated with a particular stretch of the highway network.

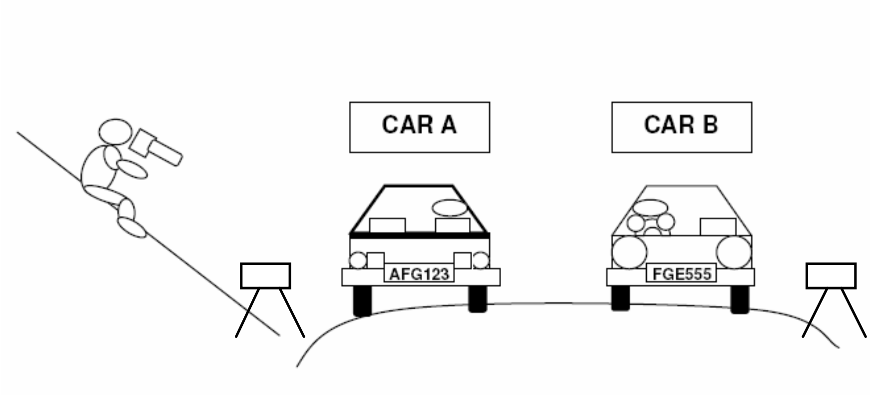
Description of Methodology

The first part of the project will be to adapt the “hands on” methodology so that it can be applied day or night. Thereafter, an experimental control will be to upgrade a section of the State Highway with road-markings that have a much greater impact on the driver’s senses by being readily visible for a much greater distance ahead, and that continue to function in wet weather. The methodology requires an intensive investigation of driving behaviours prior to the improvement in the road markings. In addition to hand positions other observations will include, speed in dry and wet weather, headway in dry and wet weather, and these repeated for both day and night. After the improvement to the markings repeated observations of the same behaviours will be taken. In addition, a small-scale survey of the drivers will accompany the observations, to ensure the validity of assumption about the subjective perception of the roading context and its changes through the proposed improvement.

The requirement to view the hand positions will use infra-red flood lighting. The human eye is sensitive to wavelengths of light in the range 450–750 nanometres (nm). Wavelengths longer than 750 nm are known as infrared, and are invisible to the human eye. Infrared cameras may operate with wavelengths as long as 14,000 nm (14μm). By capturing information from outside the visible spectrum, and then reproducing it as visible light, the infrared camera is able to use light that is otherwise ‘wasted’ by the human eye, and hence imaging is possible even in conditions where little or no visible light is available. The best alternative devices do not work in the conditions we encounter, for example, thermal imaging ‘sees’ the wind screen as a mirror, blocking all observations within the vehicle.

We have advanced our understanding of infrared devices by purchasing an ATM NVG 7 2+ generation light enhancement optic. This device works well in low light conditions and with the aid of dash lights internal to car, and active infra-red floodlights, there is sufficient clarity of image to manage the observations in near pitch black night conditions, notwithstanding the glare introduced by headlights. Observations are made from an elevation to the side of the vehicle stream to avoid the optics suffering form the flare effect of oncoming headlight (see figure 2.) However, the narrowing of the field of vision through a head mounted optic makes observations unreliable. To overcome this we have tested a 3+ generation light-enhancement optic in Australia (import restrictions make it impossible to undertake here, yet).

Figure 2. Graphic of the experimental conditions measure hand positions, headway, speed and lane position. Car B is the experimental observation.



The material properties of the delineation will be measured prior to and after the improvement. These properties will then be inputted into driver visibility models such as Visibility or TARVIP.

Central Laboratories is currently evaluating a non-intrusive traffic counter which uses two infra red beams, transmitted across the roadway, to detect the axles of vehicles that pass through them. The Infra-Red Traffic Logger (or TIRTL), manufactured by CEOS Pty Ltd in Australia, has the ability to count, classify and determine the speed and direction of vehicles on bidirectional, multilane roadways. This instrument will be used to measure speed and headway.

Analyses will be undertaken using multi-nomial logistic regression, or through a Mann-Whiney U test of the hands-on measure (Thomas and Walton, 2007). Robust statistical comparisons with the other 'intermediate outcome' measures (particularly, speed and headway) will isolate the partial influence of the measures on changes to driver behaviour. This will allow a profile of the nature of the changes to draw conclusions concerning the true influence, and benefits, of improved delineation on driver performance.

Result Scenarios

The base comparison is the dry/daytime condition. A risk profile for this condition can be contrasted with night, and night in the wet. A potential outcome is that we observe no difference across the scenarios, indicating that the method likely fails to measure driver's responses to changes in the external conditions. We have good reason to believe this is unlikely due to our previous testing of conditions that demonstrate variability in hand configuration patterns across conditions. The baseline conditions before the improvement of the delineation should demonstrate some difference between day and night.

The interesting results occur if the improved markings demonstrate a shift towards the pattern of driving behaviour observed in daytime conditions. This would indicate the benefit, and provide some assessment of the level of improvement that the markings generate for these conditions. The same logic holds for wet/night conditions.

Summary and Observations

The methodology we have devised is a novel approach compared to current practice. When applied to wet/night conditions these methods require us to adopt latest technology and stretch it to its technological limits. Our ability to accurately measure speed and headway is compromised by rain which makes the instruments we use less accurate that is optimal and the observations of hand positions in wet/night conditions is exceptionally difficult to achieve accurately but can be done using sophisticated night vision equipment. By overcoming these difficulties we hope to provide the first measure of how drivers respond to improved markings in real conditions and to provide some quantification of the difference those markings actually make on driver's perceptions of risk as they drive through the improved road environment.

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