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PARTICIPATORY ROAD DESIGN: AN INVESTIGATION INTO IMPROVING ROADS, DRIVERS' ATTITUDE AND BEHAVIOUR USING PARTICIPATORY DESIGN

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ABSTRACT

Improving road safety is currently based mostly on Education, Enforcement and Engineering or the 3 Es. Despite these measures having saved millions of lives since their inception in around 1915, millions of people are still injured or killed in accidents worldwide annually. One relatively unexplored area is the use of driver's tacit (unspoken) knowledge to help in the reduction of accidents, particularly in the area of speed management. Participatory design may offer a way to help utilise drivers' tacit (hidden) knowledge for the improvement of speed management and road safety techniques in a positive and ethical manner. Involvement in the process may also aid in the improvement of drivers' behaviour and attitudes. Previous research in participatory design indicates that the benefits of participatory design are quick acceptance of new designs and innovative solutions to difficult problems, as well as a sense of ownership of the new artefact. My research has investigated the efficacy of using participatory design in road safety. This was done by having participants take part series of four different types of workshops aimed at improving driver behaviour and attitudes as well as road design using models. The research involved a total of 105 participants with group sizes ranging from 3 to 28 people. It was found that participatory design workshops were capable of: allowing people to redesign a variety of roads and improve them by reducing their estimated speeds, without adversely affecting other ratings such as safety, aesthetics, preference and liveability; improving self reported driver behaviour; and allowing the interaction of people from various backgrounds in a positive and stimulating environment. Workshops were also rated highly as a teaching and design tool by all those involved in the process. Finally, unlike standard participatory design processes, some workshops also included more than just the design team with the inclusion of additional participants as audience members. This was also found to be a practical method of including more people in the participatory design process without reducing the effectiveness of the process.

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Writing a thesis is a daunting task. It’s something that doesn’t make any sense to anyone who hasn’t written one. I think the best description of a thesis was given by Linda Nikora at a recent research retreat, I believe it went something like, “It’s not something I want to talk about at the moment.” That being said, it has been a challenging experience; spiritually, mentally, physically, and anything else I can think of. I’ve almost forgotten how to use “I” in any writing I do, and feel afraid to write a sentence without referencing it...

I would like to start by thanking my supervisors Samuel Charlton and John Perrone who put up with my somewhat rubber timeframes and put up with my occasional “I feel like throwing this all in” moments. Of course, my Mother, Father and sister for listening to me go on and on about the thesis amongst other ramblings. My friends Armon, Saburo, and Rob who got me out of a few dark patches and gave me plenty of ideas and kept me amused with various witty anecdotes. Mr Allan Eaddy for spending many hours on my computer. Also my office mates Amanda, Derek, and Shiloh, who put up with my quirky ideas and various stuff I went through. My flatmate Glenn, and last and certainly not least Suze for helping me get my beloved (and occasionally hated) Toyota Supra going and keeping it going as well as putting up with frantic phone calls when yet another confusing problem cropped up. As I write this list I realise that there are so many people who have been supportive throughout my journey and doubtless there will be some who I have forgotten. But thank you to you all, even if you simply asked how things were going!

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LITERATURE REVIEW AND INTRODUCTION

Outline

This study draws from literature from several areas. The first of these areas concerns methods used to reduce speeds and improve safety and the efficacy of these methods. The second focuses on drivers' attitudes towards driving and breaking road rules. The third area deals with the description of participatory design and its possible application to speed management and road engineering. The literature on each of these areas will be reviewed in separate chapters and will be referred to again when discussing the research problem in detail. This, the first chapter, discusses the impact of road accidents on society in general and then describes the main methods of road accident reduction, enforcement, engineering and education (the three Es). Self Explaining Roads (SER) are also discussed in this chapter.

Accidents and Their Impacts

Automobiles and accidents have gone hand in hand since the popularisation of the automobile in the 1900s. Incidents such as automobile enthusiasts racing on public roads killing pedestrians tended to create tensions between automobile enthusiasts and the general public (Flink, 1975). In 1924, automobile accidents accounted for 23,600 deaths and 700,000 injuries in the United States alone. The National Traffic and Motor Vehicle Safety Act of 1966, set standards in the USA that started a turn around in the number of fatalities attributed to the motor vehicle that has continued until today. However, despite an impressive decrease in the number of fatalities, from 306,388 in 1980 to 181,116 in 2006, for Organisation for Economic Co-operation and Development (OECD) countries around the world (Organisation for Economic Co-operation and Development, 2006), the World Health Organisation estimates that there are still approximately 1.2 million people killed worldwide annually (World Health Organization and Association for Safe International Road Travel, 2007).

There has also been a levelling off of progress in recent years. Many countries are now unlikely to meet their fatality reduction targets set for 2010-2012 (Organisation for Economic Co-operation and Development, 2006). A survey of all 50 OECD member countries found that the top three contributors to accidents are; speeding; drink driving, and failure to wear seat belts. In New Zealand, figures show that 391 people were killed and 3219 people were hospitalised in 2006 with a social cost of 3.045 billion dollars. During this period, speeding was the number one contributor to serious and fatal crashes, with a total social cost of 828 million dollars (Joint OECD/ECMT Transport Research Centre, 2006). With speeding still causing so many accidents around the world, it is clear that in terms of lives lost, injuries caused and economic cost, addressing the issue of speed management is still very important. When looking at the levelling off of progress in the past few years, it appears there is still room for exploring different strategies which may be used to reduce help reduce the incidence of speeding and the associated costs. Using psychological principles to improve speed management may help to further the road toll by improving driver behaviour, attitudes and also improving road design.

The Three Es

Introduction

A significant body of literature is concerned with the various methods used to improve road safety and reduce deaths and injuries on the road (Baas et al., 2004; Carsten et al., 1995; Denton, 1980; Department for Transport, 1994; Eugenia et al., 2006; Glendon and Cernecca, 2003; Godley et al., 1999; Ha et al., 2003; Janssen, 2000). So far these methods have been largely constrained to trinity of the highway safety movement developed by Julian Harvey in 1915 enforcement, engineering and education or, the three Es (Eastman, 1984). A more recent development has been the introduction of SER (Self Explaining Roads) (Theeuwes and Godthelp, 1995; van der Horst and Kaptein, 1998). The principle behind SER is that roads should be designed in order to elicit the correct behaviour by drivers. Enforcement involves ensuring road users obey road rules and speed limits by punishing those who disobey them. It also works as a deterrent simply by its presence. Examples of enforcement include patrol vehicles and speed cameras (de Waard and Rooijers, 1994; Hakkert et al., 2000; Hauer et al., 1982; Stuster and Coffman, 1998). Engineering aims to improve road safety and reduce speeds by altering road design, examples of speed management techniques include traffic calming (Brindle, 1992; Bunn et al., 2003; Department For Transport, 1997; Institute of Transport Engineers, 1999; Kjemtrup and Herrstedt, 1992; Taylor and Tight, 1997), and changes in road markings (Carsten et al., 1995; Davidse et al., 2004; Godley et al., 1999, 2004, 2002; Steyvers and de

Waard, 2000). Education aims to reduce accidents by improving drivers' skills and/or knowledge thereby improving driver behaviour and attitudes (Christie, 2001; Engström et al., 2003; Hatakka et al., 2002; Hedlund and Compton, 2005; Parker and Stradling, 1996; Vernick et al., 1999; Zhao et al., 2006). SER is a design philosophy that uses psychological principles to design roads that elicit correct driving behaviour by design (Janssen, 2000; McKenzie-Mohr, 2000; van Vliet and Schermers, 2000; Wegman et al., 2005).

Enforcement and engineering measures have been successful in creating substantial reductions in both deaths and injuries caused by road accidents over several decades (de Waard and Rooijers, 1994; Hakkert et al., 2000; Hauer et al., 1982; Stuster and Coffman, 1998; Vaa, 1997). Studies concerning education have not been able to show consistently that there is a correlation between education and accident reduction (Christie, 2001; Engström et al., 2003), and at least one study showed a tendency for education to increase the probability of being involved in an accident (Potvin et al., 1988). The efficacy of SER on its own is still not known. This is due to the fact that the system has been introduced fairly recently and amongst a raft of other road safety measures. There are also very few empirical studies regarding the efficacy of SER. However, it appears that SER is having some impact on accident rates in the Netherlands (Wegman et al., 2005). Despite these efforts, around the world, many countries are having difficulties in meeting current targets. This chapter sets out to outline the methods currently in use and discuss their benefits and drawbacks.

Enforcement

The use of law enforcement is probably the most common and well known method of speed management. Methods have gone from police patrolling the roads to including fixed and mobile speed cameras, hidden cameras and laser speed guns (Stuster and Coffman, 1998). The ability of enforcement to reduce speeds and accidents varies, however it has generally been successful in reducing accidents and/or speeds on the stretches of road where enforcement is present. For example, the parking of a marked patrol car on stretches of 60km/h roads yielded speed reductions in average speeds of between 14 and 17km/h in the vicinity of the patrol car (Hauer et al., 1982). In a study measuring the effectiveness of different levels of intensity of enforcement De Waard and Rootjers (1994) found decreases in average driving speed of between 1km/h and 3.5km/h depending on the level of enforcement, with higher intensities of enforcement leading to larger reductions in speed. The standard deviation of speeds was also decreased, with higher levels of enforcement having larger effects that lower levels of enforcement. Police enforcement along 3-5 kilometre stretches of road was found to reduce average speeds by 0.9-4.8km/h in an experiment testing the effects of increased mobile, stationary, manned and unmanned enforcement (Vaa, 1997). In Israel an increase in enforcement on 5 project road groups was used to attempt to reduce severe accidents by 10%, but yielded a statistically significant reduction on only one of the project road groups, which yielded a 40% decrease in reported injuries. However the other four road groups did buck the national trend of increasing accidents during the period of the experiment (Hakkert et al., 2000). The use of mobile speed camera vans yielded a 2.8km/h reduction in mean speeds, a 0.5km/h reduction in variance and a 9% reduction in collisions along a 22km section of highway in British Columbia (Chen et al., 2002). And more recently a 4km/h reduction in average speeds, a 12% reduction in the number of violators and a 21% (best estimate) reduction in traffic accidents, as a result of enforcement, was reported along two 80km/h highways in Holland between 1998 and 2004 (Goldenbeld and van Schagen, 2005).

Although enforcement has been successful in reducing speeds and accidents, there are still issues surrounding enforcement that limit its effectiveness. One of the main issues with enforcement is that it is only effective at reducing speeds when there is consistent visible enforcement activity on roads where speed reduction is required. Once enforcement activity ceases, the reductions in speed are lost. The amount of time that speed reductions are found after the removal of enforcement is known as the Time Halo Effect and is usually measured in days (Martens et al., 1997). Several studies have reported on the Time Halo Effect and there is a wide variation in the amount of time that speed reductions are found after the removal of enforcement. Hauer, Ahlin, and Bowser (1982) reported speed reductions disappearing within 3 to 6 days after the removal of enforcement, with larger doses of enforcement leading to a longer period of effectiveness after removal. Vaa (1997) reported Time Halo Effects of between 6 and 8 weeks, depending on the level of enforcement and what times of day enforcement was in place. Champness, Sheehan, and Folkman (2005) found that the deployment of an overtly visible mobile speed camera for around 3 hours on a 100km/h highway achieved significant reductions in mean speed of 5.95km/h at the site of enforcement. However, an extremely short Time Halo Effect meant that as soon as the camera was removed from the site, speeds returned immediately to their pre-enforcement level.

Aside from the Time Halo Effect, enforcement also has issues with distance. Speeds upstream and downstream from enforcement sites generally tend to be higher than speeds within an enforcement site. This is called the Distance Halo Effect and is usually measured in kilometres (Martens et al., 1997). Hauer, Ahlin, and Bowser (1982) found an upstream halo effect, possibly due to the use of CB radios, and determined that downstream, the effect of enforcement reduced by half every 900 meters regardless of the level of enforcement. Teed, Lund, and Knoblauch (1993), while studying the effects of police radar signals without the presence of visible enforcement, found that the percentage of vehicles travelling faster than 10mph above a 55mph speed limit fell from 42% to 28%, but after as little as 1 mile after exposure to police radar, 38% of vehicles were again travelling above 65mph and after 5 miles 40% of vehicles were travelling that fast. Chen, Meckle and Wilson (2002) reported a spill-over effect of reduced speeds and collisions along an entire highway from the deployment of mobile speed cameras along a smaller stretch of the same highway. They attributed the spill-over effect to fact that drivers did not know when nor where the cameras would be deployed.

Similar findings have been reported in New Zealand, where it was found that hidden speed cameras had a more general speed reduction effect than visible speed cameras (Keall, Povey, & Frith, 2001). Ha, Kang, and Park (2003) when testing the effectiveness of automated enforcement systems in Korea, found that they were effective in reducing mean speeds in a 70km/h area from 85.4km/h to 73.4km/h. However, the speed reductions only became significant 1 kilometre upstream from the site, where warning signs were posted, and increased to 85kmh/h again 1 kilometre downstream from the site. Champness, Sheehan, and Folkman (2005) also found limited effectiveness with a visible speed camera. No significant differences in speeds were found 500 meters upstream from the enforcement site and speeds began to increase within 500 meters of the enforcement site and were back to pre-enforcement speeds after 1.5 kilometres.

Enforcement also does little to affect people's attitudes towards speeding. Although enforcement has been found to affect attitudes in regards to the risk of apprehension (Hakkert et al., 2000), there does not appear to be any evidence that enforcement has any impact on people's decision to exceed the speed limit. When studying the effects of different levels of enforcement on driving speed, de Waard and Rootjers (1994) found that people's attitudes towards speeding were not changed due to enforcement. Moreover, drivers who had a positive attitude towards speeding were not found to have any change in attitude, even if they had been apprehended. The authors also commented that enforcement is an external variable that appears to affect behaviour without having any impact on attitude. Holland and Conner (1996) also measured attitudes in regards to speeding and found that the intention to speed after being exposed to a week of heavy enforcement was not strongly affected. According to their research, young men (under 25) were more likely to speed after being exposed to enforcement, older men (over 25) did not change their intentions to speed, nor did women over 25. Women under 25 did reduce their intention to speed, but the reduction in intention to speed was largely attributed to a greater chance of being caught.

One other issue with enforcement is that of ongoing cost. As the above literature appears to show, due to time and Distance Halo Effects, enforcement must be consistent (i.e. patrol vehicles, mobile and fixed radar etc.), be visible to drivers, and must have a good rate of apprehension. The Distance Halo Effect means that levels of enforcement must be high over wide areas, as the range of effectiveness may only be one or two kilometres outside the zone of enforcement regardless of the level or type of enforcement. These factors mean that a large amount of financial and police resources may be needed in order to reduce speeds in areas with a lot of rural highways, such as New Zealand. Finding the balance between too much and too little enforcement can be problematic as not having enough enforcement may mean that people continue to speed, whereas having too much enforcement will mean that valuable financial and police resources may be wasted on enforcement while it may be more beneficial for them to be used elsewhere.

The proportion of police resources used for speed management has been the focus of media attention and can cause issues with public perception of the police force. Many media commentators have identified concerns regarding the revenue gathering aspect of issuing speeding tickets and the resulting lack of policing resources for other areas such as crime prevention and emergency callouts (Berry, 2004; "Speed police get out", 2005; "Speed tickets at 1000", 2005). In contrast to the revenue gathering aspect of issuing speeding tickets focused on by the media, a recent nationwide survey by the Land Transport Safety Authority (LTSA) of 1640 New Zealanders aged 15 and over found that 40% of those sampled wanted enforcement increased and 50% wanted enforcement levels maintained at their current rate and 56% of those sampled wanted penalties to remain the same and 34% wanted increased penalties (Land Transport Safety Authority, 2004). Similar results were found in a survey conducted by the New Zealand Herald where 47.6% of those surveyed said that the enforcement level was right and 22% wanted the police to come down harder on speed (Dearnaley, 2005). These survey findings indicate that only a small percentage of people felt that enforcement levels were too high. It should be pointed out that the LTSA survey was conducted to ensure that it achieved a wide cross-section of the adult population, whereas many media articles appeared to focus on only a small group of people and incidents. Despite the shortcomings of the media articles, the contrast between the media and the LTSA survey do raise questions as to the actual public perception of enforcement in New Zealand.

Engineering

Road engineering is an important part of road safety, as a poorly designed road (i.e. a road that is not designed to cope correctly with its purpose) can cause accidents and inappropriate operating speeds. The U.S. Department of Transportation, Federal Highway Administration (FHWA) defines traffic engineering as “The field of engineering that involves planning, geometric design, and traffic operations of roads, streets, and highways. It includes their networks, terminals, abutting land, and relationships with other modes of transportation for safe, efficient, and convenient movement of persons and goods.” (United States Department of Transportation - Federal Highway Administration, 2005).

Goals

Goals of traffic engineering vary from country to country, but the primary concerns of traffic engineering appear to be safety, efficiency, and economic development (Canadian Council of Motor Transport Administrators, 2006; Department for Transport, 2007a; Federal Highway Administration, 2006; Transit New Zealand, 2007). However, there are several other goals that most countries have that go beyond these three basic elements. These include improving the state highways' contribution to New Zealand's environmental and social well-being, energy efficiency and public health (Transit New Zealand, 2007), enhancing access to jobs, services and social networks, including for the most disadvantaged (Department for Transport, 2007a), and improving national homeland security, improving highway security and supporting national defence mobility (Federal Highway Administration, 2006).

Clearly designing a road for all these purposes could become problematic and lead to roads that are poorly designed or over-engineered (i.e. too many safety features) leading to inappropriately high speeds, especially when highway design incorporates significant safety factors (Fitzpatrick et al., 1997). The photo below (Figure 1) shows a typical freeway in the United States. Freeways are a good example of roads that have significant safety factors built in, along with corresponding inappropriate speeds. Out of interest, a wide road like this also makes an excellent medium for transporting troops and tanks, which is inline with the goals of the FHWA (Federal Highway Administration, 2006).

Figure 1: The Orange Freeway in California.

To complicate matters further, local and regional councils have their own specific goals in terms of improving the safety and efficiency of their local road networks, making difficult to ascertain the specific methods that traffic engineers use in order to improve the safety and efficiency in various regions. For the purposes of this thesis, the focus will be on how engineering is used to improve safety. Despite the fact that different countries and regions use different methods depending on their specific needs, there are several that are used by traffic engineers to improve road safety, including traffic calming, signs and delineation.

Traffic calming

For urban areas, traffic calming is one of the most commonly used methods in order to improve road safety, reduce speeds and/or traffic volumes, and enhance the urban environment (Kjemtrup and Herrstedt, 1992; Knapp, 2000). There are several methods that are used for traffic calming, however the Institute of Transportation Engineers (1999) says that for traffic calming to be effective two things must be done; first, the nature and extent of traffic related problems on a street or area must be assessed, and second cost-effective measures for solving the problems must be selected. Traffic calming measures can be loosely placed into two categories; volume and speed control measures, although they usually have impacts on both. Kjemtrup and Herrstedt (1992) differentiate traffic calming from speed management. They define traffic calming as: "…about reducing the passability or accessibility of cars through legislation, marking, visual or physical effects." and speed management as: "…about regulating the speed (passability) of cars through legislation, marking, visual or physical effects." (p.57). It appears that traffic calming is most concerned with reducing the accessibility of vehicles to an area, while speed management is involved with passability, that is, the slowing of traffic. However, for the purposes of this section, traffic calming will be used to describe both speed management and traffic calming, as both are associated with speed reduction.

History of traffic calming.

The beginnings of traffic calming stemmed from a large increase in car ownership in the 1950s and 60s. The increase in the increase in vehicles led to congestion on the main roads and as a result motorists opted to take short cuts through local roads, making it dangerous for pedestrians and other vulnerable road users. Initially road closures were used to try and alleviate the problem, but these proved troublesome due to difficulties with access and were largely abandoned. In Europe during the late 1960s and 70s separation of traffic was attempted by separating slower moving light traffic and faster moving heavy traffic, the concept of functional categorisation of roads was also attempted. Unfortunately the separation model was often only feasible with newly developed areas, and categorisation proved nearly impossible in established areas where roads often had vastly different designs not in keeping with their functions. In some narrow streets, separation was simply not feasible. The Dutch concept of the 'Woonerf' was also created during this period (Kjemtrup and Herrstedt, 1992) when residents who were "fed up" with large volumes of vehicle traffic in their neighbourhoods responded by developing 'Woonerven' or shared areas. These designs incorporated obstacles, such as plantings and benches, which made it impossible for vehicles to travel at speed and also made the area more pedestrian friendly.

Over the next 30 years, Woonerven spread throughout several countries in Europe and as far as Japan (Institute of Transport Engineers, 1999). Other measures that were implemented were called 'silent roads'; these were roads that had lower speed designs than normal roads. There were issues, such as bus timetabling and motorists annoyed at the fact that they had to drive at speeds lower than the posted speed limit in some areas. Residents and shop keepers were often opposed to traffic calming measures as they were concerned it would affect their business due to reduced traffic possibly leading to fewer customers (Taylor and Tight, 1997). However, when residents and other local groups were involved early in the planning process and their influence was clearly visible, projects were almost unanimously accepted by all those living on the street. In fact Taylor and Tight (1997), when studying several traffic calming schemes in the UK, concluded that success in traffic calming schemes depended on overwhelming support of the local community, which depended on the openness of the consultation process.

Methods of traffic calming.

As mentioned above, traffic calming uses multiple measures to achieve its aims of reducing speeds and/or traffic flow. Outlined below are some of the main methods used worldwide, including New Zealand, in traffic calming as outlined by the Institute of Traffic Engineers (1999).

Volume control measures.

The primary function of volume control measures is to reduce or eliminate through traffic. Measures include things such as: full street closures, (which use barriers to cut off through traffic), half closures (barriers that block travel in one direction for a short distance on two way streets); diagonal diverters (placed diagonally across intersections to block through movement); median barriers (placed in the centre of a road to block through movement at intersections), and forced turn islands (used to only allow turns in a certain direction).

Speed control measures.

There are three types of speed control measures: vertical measures, which use vertical acceleration to reduce speeds; horizontal measures, use lateral acceleration to discourage speeding; and narrowings, which use perception to slow traffic down.

Vertical measures include speed humps, which are perhaps the most common vertical measures. There are several designs of speed hump, with different heights, widths and angles. Speed tables are similar to speed humps, but they have a flat top, and they can also be used as pedestrian crossings. Speed cushions are a different type of speed hump; they consist of two raised surfaces with a gap in the centre. The benefit of speed cushions is they cause less interference to larger vehicles and emergency services, while still slowing down other vehicle traffic. Other vertical measures include raised intersections and textured pavements.

Horizontal measures achieve speed reductions by forcing drivers around curves and by blocking views of the road ahead. The most common of these is the traffic circle; they are typically, but not always, landscaped in the centre and controlled by give way signs. Roundabouts are similar to traffic circles, but are also used on higher volume roads. Other measures include chicanes, realigned intersections and lateral shifts.

Narrowings are roadways that are either physically or perceptually narrowed to reduce speeds. They are often accompanied by plantings, street furniture or other elements to add to the perception that the road is narrow. Techniques include: neckdowns (curb extensions at intersections that reduce roadway width); centre island medians; and chokers (curb extensions along a road way that narrow the street by widening the footpath or plantings).

Efficacy.

Traffic calming is perhaps one of the most studied of all speed and accident reduction methods and has achieved both speed and accident reductions all over the world. Two meta-analyses describing area-wide traffic calming, which is a method of traffic calming that is established to reduce the negative impacts bought about by road traffic by reducing through traffic in an area, while improving surrounding larger roads to carry higher traffic volumes, both found reductions in crash rates. Elvik (2001) examined 33 studies from Europe and the United States that evaluated area-wide traffic calming and found that, despite many studies having some methodological shortcomings, area-wide traffic calming schemes reduced injury accidents by an average of 15%. The accident reductions were greater on local roads (25-55%) than on main roads (8-15%), but main roads were reported to have fewer traffic calming treatments than local roads. He also found the effects of traffic calming were stable over time.

A second meta-analysis by Bunn and colleagues (2003) analysed 12 reports from around the world, describing 16 controlled before and after studies, and found that area-wide traffic calming reduced road traffic injuries (fatal and non-fatal) by 11%. Wheeler and Taylor (1999) reported on 9 traffic calming schemes in villages in the UK. Speeds were reduced in all villages an average of between 3-15mph for 85^{th} percentile speeds, with a further 2mph reduction for mean speeds. Reductions in accident frequency were also reported between one and three years after installation. Those villages with more extensive physical measures had a greater reduction in accident frequency. However, in three out of the nine villages, around 40% of residents expressed concerns about the appearance of the schemes and some complained of increased noise and vibration levels. The authors concluded that more consultation with residents would be essential for future traffic calming schemes.

A report issued by the Institute of Traffic Engineers (1999) investigated 188 locations where some form of traffic calming device had been installed on a street (mainly traffic circles and speed humps). An average decrease of 61.4% in accidents was reported after the installations. Before and after 85^{th} percentile speeds were measured at 354 sites where traffic calming measures had been installed. On average speeds fell from 56.28km/h to 45.82km/h, a decrease of 10.46km/h. Reductions ranged from 30.59km/h to an increase of 14.49km/h. The most common measures reported were speed humps and tables, other measures used included half-closures, narrowings, traffic circles and chicanes.

The Department for Transport (1994) undertook a study of 24 villages in the UK, Scotland and Wales and found where villages used gateway and traffic calming measures yielded between 2-12 mph at the gateways and 2-10 mph decreases in 85th percentile speeds within the village, with villages that had more significant gateway treatments (i.e. more physically restrictive measures) and treatments inside the village having the biggest reductions in speed. The village of Craven Arms in Shropshire also implemented gateways and traffic calming to reduce speeds in the village and achieved reductions of 9 mph at the gateways and 10 mph in the village (Department For Transport, 1997b).

Forty-nine chicane schemes and 43 speed cushion schemes were studied by the Department for Transport (1997a; Department for Transport, 1998). The chicanes achieved mean 85th percentile speed reductions of 14 mph for single lane chicanes and 11 mph for dual lane chicanes. Accident rates were available for 17 sites and the average reduction rate was 54%. The speed cushion research consisted of 34 cushion schemes. Mean speeds over the cushions was 17 mph (85th percentile 22 mph), with wider cushions having a greater speed reduction than narrower cushions. In 2004, the Department for Transport (2004) also reported on the effectiveness of traffic calming in Bird Lane in Essex. The method in this case reduced the road width from two lanes down to one. Both mean and 85th percentile speeds were reduced, but remained around 5mph above the new 20mph speed limit and traffic flow also reduced by around 20%. Around 50% of residents were happy with the scheme. Brindle (1992) reports on a survey done of 1,044 records of mostly individual traffic management devices. Out of the 516 responses to the survey regarding speed management 96% reported a decrease in speed, but the authors state that the information reported was “subjective” in 85% of those cases. The authors criticised the level of evaluation done in these cases, as the primary objective of the devices was to reduce speeds.

The above studies show that traffic calming is generally successful in reducing both speeds and accident rates. Despite issues regarding costs, acceptance, opposition from some groups, such as emergency services, businesses, motorists, residents etcetera, traffic calming continues to be one of the most common and successful ways to reduce speeds, accidents and improving quality of life in streets around the world (Ewing et al., 1998; Kjemtrup and Herrstedt, 1992). However, there are issues that reduce the effectiveness of traffic calming. Calming arterials with high traffic volumes can present problems in terms of traffic flow, especially when considering the use of physical measures such as speed bumps (Macbeth, 1998). Similar care must be taken when considering traffic calming devices on roads with multiple functions (Garder et al., 2002). In order for traffic calming to be effective, the measures put in place must be in line with the road category and the type of traffic on the road, including pedestrians and other vulnerable road users. Another issue with traffic calming is that people may simply take another route, thereby shifting the risk of accidents from one road to another. Stuster and Coffman (1998) comment that most traffic calming studies they reviewed did not take the possibility of crash migration into account.

Aside from placement and the possibility of crash migration, there appears to be evidence that a key issue to consider when implementing traffic calming schemes is to ensure that appropriate and open consultation is done in order to ensure that both residents and drivers are happy with the schemes (Department for Transport, 1994; Taylor and Tight, 1997; Wheeler and Taylor, 1999). A lack of consultation can lead to poor public perception of the schemes and in some cases force the removal of the schemes (Department for Transport, 2007b). Residents may not be aware of improvements in speed and this may lead to negative judgements of the schemes. For example, noise levels may appear to increase due to accelerating vehicles at speed humps and traffic circles (Wheeler and Taylor, 1999). Strong community support for traffic calming schemes is very important as the success of the measures does not only depend on objective empirical measures, such as speed reductions and accident rates, but also on the acceptance of the measures by the community in terms of residents' subjective viewpoints (Taylor and Tight, 1997).

Public opinion on the measures can also be problematic, especially when the benefits from the schemes are either below public expectations (Department for Transport, 2007b; Taylor and Tight, 1997; Wheeler and Taylor, 1999) or some measures generate other problems, such as noise or other environmental issues (Department For Transport, 1997b). In summary, an open consultation process and clear evidence that the public's views have been not only heard, but also acted upon is a very important factor for ensuring the success of any traffic calming scheme.

Signs

Signs are another common way method of managing drivers' speed, providing information about road conditions, and warning drivers of potential hazards. However, when attempting to reduce speed with speed limit signs alone, compliance with speed limits is generally poor. Seventy percent of vehicles on a representative sample of low and moderate speed roads were found to exceed the speed limit in one study (Harkey, Robertson & Davis, 1990, as cited in, Stuster and Coffman, 1998) with similar results found in a Canadian report (Knowles, Persand, Parker, & Wilde, 1997, as cited in, Stuster and Coffman, 1998). Coleman and Moreford (1998) report that speed limits in the United States are often seen only as guides by drivers, with few consequences if ignored. Giles (2004) in a study reporting on speed compliance in Western Australia also found that drivers tend to use posted speed limits as targets rather than delimiters.

The placement, legibility and symbology of signs have been extensively studied (Charlton and Baas, 2006) and it has been found that signs are generally not noticed or recalled by drivers. Mōri and Abdel-Halim (1981), when studying the efficiency of road signs, found that signs were not recognised more often, compared to being totally recognized when viewed in general traffic conditions. Recognisability fell further when there were preceding vehicles. Motorcycles and waiting cars also decreased the recognisability of signs. Their study raised concerns about the road sign system as a whole, since total recognisability rates were very low compared to non-recognisability rates.

Other papers also report that signs are a poor way to manage driver behaviour. Johansson & Rumar (1966) used the drivers' recall method to question around 1000 drivers over a 105 mile stretch of highway, to find out whether they remembered passing a road sign 400 meters after they passed it. On average only 47% of drivers recalled passing the road sign. This number varied depending on the road sign, with 78% recalling a pre-warning for a speed limit zone and only 17% recalling a pedestrian pre-cross warning. The authors speculated that the differences in rate of recall may be due to differences in importance placed on the sign by drivers.

Martens (2000) in a review of several papers that measured sign perception concluded that the methods used in order to measure sign perception need to be further investigated. She reviewed the four main methods of investigating sign perception; eye movement studies, verbal reports while driving, drivers' recall, and recording driving behaviour.

Eye movement studies look at tracking eye movements and use these movements to determine what drivers fixate on as well as scanning patterns. The problem with eye movement studies is that they are only able to show what attracts attention, not necessarily what is being perceived. Verbal reports while driving are done by asking drivers to report on what they see while they are driving. They provide information about what attracts drivers' attention while they are driving and give some insight into what drivers consciously consider being important, however they do not give any insight into higher mental processes, and can be problematic when drivers' workload is increased, with drivers not being able to report on everything they see. The drivers' recall method works by stopping drivers along a section of road and asking them what signs they recalled. It measures conscious perception only and gives insight into what filtering processes drivers might use (Martens, 2000). However, it does not answer the question as to why some signs may not be recalled; it may be that drivers saw some signs but viewed them as irrelevant and therefore forget them or simply forgot about them. Recording driver behaviour is simply assessing driver behaviour after they have passed a sign. It is a good measure as it only measures behaviour, it can use unaware drivers, and it can be done at many data points because it does not require a lot of resources. The main difficulty with this method is that factors other than signs, such as changes in road layout, may be reducing drivers' speeds and that not all signs have to result in a change in driver behaviour, they may simply be signs that maintain speeds for example. The perception of a sign is not just based on seeing the sign; its relative importance and relevance appears to be a large factor as to whether a sign is perceived or not.

Charlton (2006) directly compared multiple measures to assess their ability to measure the effectiveness of signs. Using the measures of a sign's attentional and search conspicuity, explicit and implicit recognition, dynamic and static comprehension and priming, he found that whether a sign was recognised and understood, as well as affecting behaviour, depended largely on the format of the sign and what message it was attempting to convey. School warning and roadwork signs, for example, were rated highly by drivers in terms of detection, recall, and comprehension, whereas slippery road signs were rated poorly along the same measures. He also reported that all measures used as described above worked well, with conspicuity and static comprehension being the most reliable. This study goes against the concerns about using several measures of sign effectiveness at the same time raised by Martens (2000). Instead this study found that using different sets of measures together can help to determine which signs are more effective and that further study of the different measures could be beneficial.

A more promising set of signs for traffic control and speed management may involve electronically activated signs. Winnet and Wheeler (2002) reported significant speed reductions after the installation of an electronic vehicle activated sign. Variable Message Signs (VMS) are more sophisticated electronic signs that can provide drivers with dynamic real time information regarding road conditions, traffic conditions etcetera. When investigating the effects of VMS during slippery road conditions on speed and following distance, VMS were found to reduce speeds by 1-2km/h in slippery road conditions, and had a small effect in improving the distance between cars (Rämä and Kulmala, 2000). A follow up study investigated whether the signs had any other effects on driver behaviour. Interviews with drivers found that drivers tended to refocus their attention on seeking potential hazards, testing the slipperiness of the road and being more careful when passing other vehicles (Luoma et al., 2000). Rämä (2005) also found that recall, comprehensibility, and behavioural effects were very good and drivers paid more attention to VMS than regular signs. Using the drivers' recall method, where drivers were stopped and interviewed after passing signs, in one installation 83%-91% of drivers recalled the speed limit and 66% recalled a slippery road sign. However, once installed, VMS can negatively impact the recall rate of standard signs in the same vicinity (Rämä et al., 1999). Another issue with VMS and electronic signs is the cost associated with their installation. VMS require sophisticated communications networks in order to function reliably (Rämä, 2005). In terms of signs and their effectiveness, it appears that simply placing a sign somewhere in order to affect driver behaviour is not an effective measure. In order for any sign to be effective it must be of the correct type for its purpose and its positioning must be carefully thought out.

Delineation

Another method of reducing speeds is to affect drivers' perception of the road. Perceptual countermeasures are based on altering drivers' perception of the road and thereby affecting speed choice. Altering the perception of speed is focused on making it appear that one is travelling faster than one actually is. Some successful techniques include transverse lines and perceptual lane narrowing (Godley et al., 1999), reducing the amount of guidance available from the road (van der Horst and Hoekstra, 1994), and affecting drivers' perception of safety with obstacles, buildings and increased pedestrian activity (Martens et al., 1997). Transverse lines at roundabouts (Denton, 1980) and intersections (Macaulay et al., 2004) have been found to be successful in reducing speeds in road environments. In a study of several different types of road markings used to reduce speeds Carsten and colleagues (1995) found that transverse lines, lines that go across a road at fixed intervals, reduced mean speeds coming into several villages by up to 4 mph and 85th percentile speeds by 8 mph. Central hatching and a "road narrows" sign reduced mean speeds by 3 mph and 85th percentile speeds by 4 mph within villages and mean speeds by 3 mph and 85th percentile speeds by 9 mph at the end of the village.

Godley and colleagues (2004) used a driving simulator to determine the effects of lane narrowing (2.5, 3 and 3.6 meter lanes) and two different median treatments (a hatched centre line and painted gravel median). He measured speeds along several combinations of lane width and median treatment. A speed reduction of 2.23km/h was found between the 3 metre and 2.5 metre lane widths, but not between the average speed of the 3.6 metre and 3 metre lanes when compared to the 2.5 metre lane. There was also no significant reduction in speed between the 3.6 and 3 meter lanes. Hatched centre markings yielded a 3.08km/h reduction in speeds compared to the painted gravel median. The study did not report 85th percentile speeds.

Steyvers and de Waard (2000) looked at road edge delineation on rural roads in the Netherlands and experimented with different types of delineation. Two types of road edge delineation (a dashed and solid edge line) were compared to two control roads (one with a centre line and the other with no road markings). The lowest speeds were found on the unmarked road, with the highest speeds reported on the road with the centre line. The road with the edge line had lower speeds that the road with the centre line and was preferred over the non-marked road by participants. An earlier driving simulator study also looked at various perceptual countermeasures including transverse lines, lane edge and herringbone treatments and the Drenthe province treatment, which employs unpainted and intermittent edge lines made of gravel chippings in conjunction with relatively narrow (2.25 m) lanes (van der Horst and Hoekstra, 1994). The study found that transverse lines reduced speeds by up to 11 km/h. The herringbone treatments reduced speeds by up to 3.75km/h. The Drenthe province treatment reduced speeds by 1.88 km/h (Godley et al., 1999). A meta-analysis on the effects of an edge line on speed and lateral position examined 13 studies describing 65 experiments. The results were inconclusive with both increases in speed of up to 10.6 km/h and decreases in speed of up to 5.0 km/h found. A literature review done by the Transportation Research Laboratory (TRL) to assess road design measures designed to reduce drivers' speed via psychological processes reported that longitudinal red strips with hatching on the edge and centre of a rural road reduced speeds by 5.6 mph in a simulator and that the Drenthe treatment reduced speeds by 3 km/h in an instrumented car (Elliott et al., 2003).

Despite several studies indicating statistically significant speed reductions, the combination of delineation treatments does not generate additive speed reductions, the effectiveness of some treatments, such as the addition of an edge line, is inconclusive, and width reduction appears to only be effective when lane width is reduced to less than 3 meters. As with VMS, there is some doubt as to the long term effectiveness of some treatments, such as transverse lines (Godley et al., 1999), which might be subject to habituation. When using delineation methods it is important that the benefits of accident reduction due to lower speeds are not outweighed by increased accident risks due to decreased lane width, if road narrowing is used, or increased cognitive load if risk perception is affected.

Summary

Engineering is capable of producing reductions in speed using various methods, but there are several issues that limit its effectiveness. The goals of engineering are problematic in themselves. Traffic engineers need to balance efficiency and safety, meaning that traffic must flow quickly as well as safely, which can lead to roads which are over-engineered with inappropriate operating speeds. Traffic calming schemes are very useful in reducing both speeds and operating speeds, but must have overwhelming public support in order to be seen as successful by those affected by the schemes, and the issue of crash migration must also be considered when implement these schemes. Signs by themselves are often not effective speed management tools and to ensure they have some impact correct type and placement of signs must be carefully considered. Even the use of VMS must be carefully thought out, as they can sometimes decrease the effectiveness of normal sign posts. Finally, delineation can be used to reduce speeds, especially using perceptual narrowing, but decreases in safety must be balanced against reductions in speed. Regardless of the engineering measures used, it appears that increased public consultation and involvement may be a useful tool in ensuring that the correct speed management measures are used in the correct locations, as local people can be aware of traffic issues that engineers may miss. Public consultation would also be of use for other engineering strategies, particularly if there is a possibility of a road being over-engineered. Getting driver feedback on the look and feel of a road would help to ensure that the road would be fit for purpose and not cause issues such as excessive speeds.

Education and Training

The third major method of managing speeds and improving road safety is education. This section focuses on driver education and training programs, rather than public education campaigns that use advertising. The goals of driver education and training are to improve road safety by enhancing the skills and knowledge of drivers. Training is focused on improving driver skills and education is focused on improving drivers' knowledge. Perhaps the best description of the aims of driver education and training can be had using the Goals of Driver Education (GDE) model (Hatakka et al., 2002). It is based on a hierarchical definition of the task of driving. The lowest level in the hierarchy refers to basic skills such as being able to manoeuvre the vehicle effectively (things such as braking, steering etc.), this is essentially driver training. The second lowest level focuses on mastering traffic situations (things such as knowing the road rules and behaving accordingly, using seatbelts etc.). The third level is related to the context and goals of driving. This is where drivers decide when to drive, with whom to drive and what type of vehicle they want to drive in.

The fourth level refers to the goals and motives of the person in a general sense (e.g. how someone might deal with stress or conflict, substance abuse etc.) (Engström et al., 2003). The GDE model (Table 1) outlines what a driver training or education course should cover in order to ensure that the goals in each of the four levels of the GDE model hierarchy are addressed. Hatakka and colleagues (2002), when describing the GDE, note that most driver training and education programs are focused more on the lower level vehicle manoeuvring and traffic situation elements of driver training and education rather than the higher level elements of goal setting for both driving and life.

Efficacy

Several studies report on the efficacy of driver training and education and so far results are somewhat mixed. Many studies have found that the effects of education and training are questionable. In a review of several large scale studies done in the United States, Australia and Sweden, Engström and colleagues (2003) found that the efficacy of driver training was questionable, but that there may be some issues with the use of crash rates in order to determine the effectiveness of driver education and training programs, due to difficulties in retrieving crash data and the fact that crashes often have multiple causes.

Table 1

Goals of driver education model (Hatakka et al., 2002).

Hierarchical level of behaviour (extent of generalisation):	Content of driver education:		
	Knowledge and skills that must be mastered	*Risk-increasing factors that require awareness and/or avoidance*	*Self-evaluation*
Global goals for life and skills for living	General values and life goals, how behavioural style, group norms etc. affect driving	Behavioural style, life goals and values, social pressure, substance abuse etc.	Awareness of impulse control, motives, lifestyle, values etc.
Goals and context of driving for a specific trip	Trip related issues, such as environment choice, social pressure etc.	Trip goals, purpose of driving, social pressure, driving state etc.	Planning skills, driving motives etc.
Traffic situations	Road rules, speed, signalling, safe following distances etc.	Wrong speed, vulnerable road users, neglect of rules, narrow safety margins	Hazard perception, awareness of strengths and weaknesses etc.
Vehicle manoeuvring	Vehicle properties, dynamics, steering etc.	Risks connected with vehicles and driving	Awareness of strengths and weaknesses regarding driving

Another review on the effectiveness of driver training programs for learner drivers, recently licensed drivers and experienced drivers concluded that “driver training could not be considered an effective crash countermeasure.” (Christie, 2001, p.1). Potvin, Champagne, and Laberge-Nadeau (1988) found that the introduction of a mandatory training course for those seeking a first driver’s license in Quebec had no significant impact on accident rates for drivers aged 18 and over and also found it may have increased numbers and risks of accidents for young female drivers. They commented that this may have been due to a change in law that meant that there was no longer an economic advantage in waiting to be 18 before obtaining a driver’s license. Those who would have waited instead of taking driving lessons were less safety-oriented than those who would have elected to take the course.

Other studies have found positive and negative effects of driver training. Vernick and colleagues (1999) reviewed nine driver education programs and concluded that there was no convincing evidence that driver education programs reduce crash involvement rates for young drivers, at either the individual or community level. They also concluded that communities may want to look at other methods of reducing crash involvement for younger drivers such as graduated licensing. Zhao and colleagues (2006) reviewed the role of driver education in a graduated driver’s license program. They found that in the first stage of the drivers licensing system that there were significantly lower odds of learner drivers being involved in an accident, but that there was no significant effect of driver education in the second stage of licensing. They speculate that the impact of driver education may depend on when it is administered, but do not offer an explanation as to why.

Some studies have found that some driver training programs lead to drivers overestimating their own skills. Gregersen (1996) hypothesised that training can also cause drivers to over-estimate their own skills. Two groups of drivers were given different training: one group (skilled) was given instruction on how to improve their ability to handle critical situations and the other group (insight) was given insights into the unpredictable nature of critical situations, After one week, the skilled group rated their skill as higher than the insight group, but no difference was found in their actual skills. Katila and colleagues (2004) investigated the efficacy of skid training. They found that those who had had skid training felt more confident in their ability to deal with slippery conditions than those who had not, but there was no difference in reported accidents between the two groups.

Other studies show some positive effects of driver training and education. Dorn and Barker (2005) investigated the difference between police trained drivers and non-police trained drivers. Rather than measuring crash rates, they measured other variables to do with safe driving practice, such as overtaking and reactions to hazards. They found that police-trained drivers were more cautious overall and tended to take fewer risks. However, they noted that police trained drivers generally also drove more kilometres per annum and had more experience driving in urban areas. The ANDREA project (Bartl et al., 2002), which set out to determine whether rehabilitative education programs were successful in reducing recidivism, found that several programs for reintegrating drunk drivers were able to reduce recidivism rates of participants by around 50%. The authors noted several similarities in these programs including, small group size, a 3-8 week running period, they were led by professionals who were able to discuss problematic personal aspect with participants, and the contents of the courses were client-centred and looked more at personal self reflection rather than teaching. The one course that was reported to be unsuccessful in reducing recidivism rates was more short term, with a larger number of participants and was run by experts in law etc, but not by people who were experts in leading problematic groups. Treffner, Barrett and Petersen (2002), investigated different strategies used by driving instructors and experienced drivers when braking, cornering, emergency braking, and other everyday manoeuvres. They found that driving instructors used different and more effective techniques for braking, swerving, cornering and maintaining postural stability than untrained drivers.

Summary

It is difficult to say whether driver training and education are effective ways to help reduce crash rates and improve road safety. Training appears to be successful in improving drivers' skills, but this does not seem to translate to a reduction in the number of crashes. However, one bright note in the literature appears to be surrounding drunk driver rehabilitation courses, where recidivism can be reduced by around 50%. The biggest difference between the successful course mentioned above and other driver education and training courses is that it focused on the higher levels of the GDE matrix, that is, more to do with generalised life goals and self-awareness and less on the lower pedagogical teachings of the lower two levels. It may be that for driver training and education to be effective it must be broadened to cover all four levels of the GDE matrix, as a high level of skills at the lower levels without an awareness of the road, one's own attitudes, behaviours and goals may create a highly skilled dangerous driver (Hatakka et al., 2002). However, it remains problematic as to how to teach the higher levels of the GDE framework. The above literature appears to show that pedagogical methods did not appear to work for drunk drivers, and are of limited effect for improving the driving behaviour of novice drivers or other offenders. Part of improving driver education may be to involve drivers more fully in the development of driver education courses to determine how best to teach the higher levels of the GDE, although this would require further study.

Self Explaining Roads

Because vehicles travel at a variety of different speeds on different roads with different functions, it can be difficult to ensure speeds are managed in an orderly manner. Managing speed is normally addressed using enforcement and engineering. However, the restrictive physical measures used by traffic calming are not always suitable for every situation, especially on roads with high traffic flows, and so other measures must be employed in order to ensure that vehicles travel at the appropriate speed for the road. Usually these measures involve enforcement, which has limitations. A new approach to dealing with speed management and road safety is called Self Explaining Roads (SER), it is a design philosophy structured around the idea that people attempt to structure their worlds and uses these principles to help create categories of road for different functions. In terms of engineering, the SER philosophy is different to both area-wide traffic calming and traffic calming. Traffic calming focuses on reducing speeds and traffic flows in certain areas, but does not take surrounding roads into account. Area-wide traffic calming does look at improving roads surrounding traffic calmed areas, but its main focus is still on traffic calming. The major difference is that neither of these two types of traffic calming is concerned with developing a well defined hierarchy of roads as SER does.

Principles Behind SER

When encountering the same or similar situations multiple times, people begin to develop more cognitively economic ways of dealing with them. These methods are called scripts and schemata. Schemata work by patterning of situations or elements rather than on the objects themselves. They are said to use a dynamic constructive process in order to develop. They contain generalised information about certain types of events and objects rather than specific information about a single object or event (Anderson, 1977). A script on the other hand emphasises sequences and contains more specific information about how to handle more specific events and the sequence in which they occur. Schank and Abelson (1977) describe a script as:

> A structure that describes appropriate sequences of events in a particular context. A script is made up of slots and requirements about what can fill those slots. The structure is an interconnected whole, and what is in one slot affects what can be in another. Scripts handle stylized everyday situations. They are not subject to much chance, nor do they provide the apparatus for handling totally novel situations. (p. 41)

Scripts and schemata rely on background information (prototypes) to allow people to make inferences from minimal information. This reliance on background information also allows schemata to help interpret ambiguous situations. For road networks, schemata can be problematic when it comes to speed maintenance. A wide four-lane 50km/h road without constant reminders of the appropriate speed limit can confuse people and they may use the schema they reserved for a four lane highway, and its associated higher speed limit, in order to determine the appropriate speed. If this schema is high-level it may be very resistant to change (Anderson, 1977) and therefore the placement of a few signs to reduce the operating speed would be ineffective. It is reasonable to assume that road users will develop prototypical representations of different types of roads. Some roads will be easier to categorise by drivers than others, a motorway for example, but some rural roads may cause confusion (Theeuwes and Godthelp, 1995).

SER uses scripts and schemata to help design roads that elicit the correct behaviour for each road in the network (Charlton and Baas, 2006). In order to achieve this SER has five guiding principles which are; functionality, homogeneity, forgiveness, recognisability (or predictability), and state awareness. Functionality refers to the idea that each road within a road network matches its actual use with its intended use. Homogeneity is meant to ensure that a road category does not have large differences in speeds, driving directions and traffic types, an example would be that all collector roads follow a certain set of rules (e.g. a 40km/h speed limit, 3.5 meter lane width, cycle lanes) regardless of where this particular category is situated. Forgiveness means that the road environment should be designed well enough to cope with difficult driving conditions, such as heavy traffic or slippery road conditions. Recognisability is perhaps the most important of three principles of sustainable safety as it ensures that road users are familiar with the behaviour required by different road types and what they might expect from other road users. Finally state awareness refers to drivers being able to assess their own capability of handling the driving task (Dijkstra, 2000; Janssen, 2000; Nije and Talens, 2001; Theeuwes and Godthelp, 1995; van der Horst and Kaptein, 1998; van Vliet and Schermers, 2000).

SER works by combining the use of physical measures, visual treatments and drivers' own habits (Charlton and Baas, 2006). First an appropriate speed for a given road is determined, and then road designs that afford that operating speed are identified. These are applied to this road and all other roads that have the same function. The principle of functionality translates into the development of a few specific categories of roads that have only one function. The standard in the Netherlands is; through roads, distributor roads and access roads (Dijkstra, 2000; Janssen, 2000; Nije and Talens, 2001; Theeuwes and Godthelp, 1995; van der Horst and Kaptein, 1998; van Vliet and Schermers, 2000). Once these categories are defined, roads within these categories are designed to ensure that their physical appearance matches their function (recognisability) and that they are appropriate for the types of traffic that will use them (homogeneity). Using examples from several self-explaining road schemes used overseas, Charlton & Baas (2006) produced an example of a proposed design of how the three categories could be designed for New Zealand roads. It is shown in Table 2.

Table 2

Generalised design characteristics for speed maintenance (Charlton and Baas, 2006).

Characteristics	Road category				
	Through		Distributor		Access
	Urban	Rural	Urban	Rural	Residential
Design speed	60 – 70	100 – 110	50	80	30 - 40
Number of lanes	2+2	2+1 or 2+2	1+1 or 2+2	1+1 or 2+1	1 or 1+1
Lane Width (m)	3.75	3.5	3.5	3.25	2.5
Centre median	Planted median	Barrier	Raised or planted	Barrier	None
Cycle lane	Yes (sep)	No	Yes	No	Shared
Footpath	No	No	Yes	No	Shared
Road surface	Smooth	Smooth	Smooth	Smooth or rough	Coloured and/or textured
Centre line	None (mdn)	None (mdn) or double	Dashed	Double or dashed w/RRPMs	None
Edge line	Solid	Solid	Solid	Solid	None
Clear zone (m)	1 – 10	1 – 10	0 – 6	1.58 – 8	0 – 1.5
Other	Landscaping	Side barriers & RRPMs	Raised zebra crossings	Side barriers & RRPMs	Speed humps

Efficacy

Kaptein, Janssen, and Claessens (2002) used a picture sorting task and driving simulator task to determine whether roads designed using SER principles would be easier to classify and also improve driving behaviour. They found that the SER roads were better separated into their respective categories and that speeds on the simulator task were faster, but more consistent between drivers. Speeds choices were also more inline with road categories for SER roads. The researchers also attempted to determine what it was that the participants were using to determine their speeds. They found that participants reported using more natural objects to choose their speeds with the non SER roads and more manipulated objects (i.e. manmade changes in the road environment) with SER roads. Zakowska (1997) also looked at how people categorised roads. Roads from the five official categories in Poland I (freeways) to V (minor roads) were shown to participants. They were asked to rate the roads on fluency, legibility, safety, aesthetics and speed. It was found that safety, legibility and fluency increased with higher road categories (i.e. level I), ratings of road aesthetics increased slightly with an increase of road category, environmental attractiveness was not related to road category, and that speed choice was well correlated with higher road categories only. For lower category roads, speed choice and subjective safety ratings contradicted, with speed choice highly overestimated.

In the Netherlands, SER has gone off the drawing boards and into practice. The program, called Sustainable Safety, has used the principles of SER as its core. Wegman, Dijkstra, and Shermers (2005), have evaluated the start up sustainable safety program, which was launched in 1997. They report a 9.7% decrease in fatalities and a 4.1% drop in the number of in patients during the period. They do note however, that other activities, such as enforcement and education continued over the same period.

It appears that SER is successful in reducing speeds and crash rates in the Netherlands, but there is a paucity of studies regarding its efficacy and only a small number of peer reviewed articles surrounding the design philosophy. The inherent difficulty in assessing the effectiveness of any road safety measure is that they are generally undertaken as part of a strategy that involves multiple measures, therefore, although it is possible to assess reductions in speed, crash rates and other positive benefits, it is almost impossible to determine which measures, or indeed, which combination of measures had the most effect.

Driver Attitudes

As the 3 Es and self-explaining roads do little to involve drivers and hence affect their attitudes towards speed, it is important to determine what effect drivers' attitudes have on their driving behaviour and whether attitudes can be used to predict drivers' attitudes towards speed. Drivers' attitudes have been studied for several years, but although there appear to be links between attitudes and driver behaviour, other factors also appear to be involved when attempting to predict what may cause driving behaviour at any given time (Fildes et al., 1991; Goldenbeld et al., 2000; Kanellaidis et al., 1995). The predictive value of attitudes has been studied using the Theory of Planned Behaviour (TPB) (Ajzen, 1991) and it is used for much research (Elliott et al., 2007; Stead et al., 2005). The TPB has its origins in the Theory of Reasoned Action (Fischbein, 1994), but has an additional factor to improve its predictive capability.

Although the TPB has been found to be reasonably successful in predicting behaviour using attitudinal data, other factors such as subjective norms, anticipated regret, age, vehicle type and road conditions all contribute to a drivers' behaviour at any time in different degrees (Fildes et al., 1991). This chapter gives an outline of research on drivers' attitudes and how attitudes may predict driver behaviour.

The TPB was used by Parker, and colleagues (1992) in a study to find out whether the factors outlined by the TPB could be used to predict intention to commit violations. Using a questionnaire; they investigated four common violations, that is, drinking and driving, speeding, close following and dangerous overtaking. They found that aside from age and gender, that attitude towards behaviour, subjective norm and perceived behavioural control accounted for 42.3% of the variance in intention to drink and drive, 47.2% in terms of speeding, 23.4% for close following and 31.7% for dangerous overtaking. It was also found that for all of the violations studied, subjective norm had a larger impact on people's intention to perform any of the violations than the other two factors.

Parker, Lajunen, and Stradling (1998) also found that attitude towards the behaviours studied, in this case initiating aggressive behaviour and retaliating aggressively to another driver's behaviour, subjective norms and perceived behavioural control were all useful in predicting the self report of aggressive behaviour. Interestingly, subjective norms were much less strongly related to the behaviour than attitude towards the behaviour and perceived behavioural control, indicating that the predictive value of each of the factors in the TPB can be affected by the behaviour being studied.

As well as having validity in the prediction of drivers' self reported behaviour, the efficacy of the TPB as an intervention was tested in an experiment to see whether applying the factors of attitude towards the behaviour, subjective norm and perceived behavioural control could be used to influence drivers' attitude towards speed. To do this Parker and Stradling (1996) conducted a study which attempted to use the TPB to reduce intentions to speed in a 50km/h urban area was done to address this question in terms of driving. The study utilized short videos designed to influence drivers' beliefs, attitudes, and intentions in relation to speeding. The study focused on changing normative and behavioural beliefs, perceived behavioural control, and anticipated regret. It was found that normative beliefs were altered in that participants felt that friends would be less likely to expect them to speed in a 50km/h area than prior to watching the video. After viewing the video on perceived behavioural control, participants actually felt that they had less control than before watching the video. Results were mixed in terms of anticipated regret in that one video did alter participants' views in relation to speeding where as the other did not. Unfortunately, when asked whether participants would speed in a 50km/h area in the next 12 months none of the participants reduced their intention to speed. When questioned on their attitude towards speed, only the participants who viewed the video on anticipated regret significantly changed their attitude towards speed, reducing the positive feelings they had towards speeding. This experiment shows that changing attitudes can be very difficult and the authors point out that affecting lasting attitudinal change with just one intervention is problematic (Parker and Stradling, 1996). The TPB appears to have predictive validity, but its effectiveness as an intervention appears to require further study, in terms of affecting driving behaviour.

Several of the studies above, which use the TPB and self reports, have been criticized due to the fact that they use statements of intent, rather than statements of past behaviour when attempting to generate correlations, and that they rely on preference for a behaviour rather than actual behaviour. Finally, the studies also appear to ignore the influence of the surrounding environment on drivers (Rothengatter, 2002). Not including the road environment in these studies is a major issue as all of the behaviours being investigated occur within the context of driving and hence the road environment. The road environment has repeatedly been shown to affect driver behaviour (Carsten et al., 1995; Charlton and Baas, 2006; Denton, 1980; Gabany et al., 1997; Godley et al., 1999, 2004, 2002) and changing the road environment is the key to the promising SER philosophy (Charlton and Baas, 2006; Dijkstra, 2000; Kaptein et al., 2002; Theeuwes and Godthelp, 1995; van der Horst and Kaptein, 1998; van Vliet and Schermers, 2000).

The attitude that one is a superior driver due to advanced driver training or certain types of experience (e.g. racing) is one argument that is often used, although simply being trained may only give drivers the perception that they are better drivers without any actual improvements in skill (Gregersen, 1996). In an article from the 1970's researching the possible introduction of a "Master Driver's License" by the National Highway Traffic Safety Administration, the authors pointed to magazines at the time that mentioned the new license should be given to drivers who have an appreciation for vehicles or race track experience, because they are safer than the average drivers. For example a quote from an editor of *Road and Track* magazine, “I have for many years claimed that the licensed racer is far safer than ordinary chaps, on grounds of practiced skills, mental ability, cognizance of the hazards in driving, keen interest in driving and so on” (Girdler, 1972, p. 98, as cited in, Williams and O'Neill, 1974). However, when the authors sampled 3000 national competition license holders from Florida, New York and Texas and examined accident and violation records, licensed race car drivers were over-represented in reported crashes, speeding violations, other moving violations and non-moving violations, with the over-representation of speeding violations being statistically significant in all three states, reported crashes in New York, Florida and non-moving violations in New York (Williams and O'Neill, 1974). These finding indicate that the attitudes race car drivers had about their own skills were in direct conflict with violations and accident statistics. More recent research done in New Zealand found that an interest in motor racing negatively affected the attitudes and behaviour of young male drivers (Warn et al., 2004). However, drivers still appear to hold to the idea that they are better than the average driver.

Self enhancement bias, that is, drivers hold the attitude that they are better than other drivers (McKenna et al., 1991) and downward comparison, that is, that drivers feel that others are worse than they are, but they themselves are average, was investigated in New Zealand by Walton and Bathurst (1998). They asked a sample of 86 New Zealand drivers to discuss their perceptions of their own and others’ speeds in 50km/h and 100km/h zones. Between 85% and 90% of drivers claimed to drive slower than and more safely than the average driver, but rather than having an enhanced opinion of their own driving skills, they simply felt that others drove more quickly and less safely than they did, in other words they found evidence for downwards comparison. Unfortunately, drivers in New Zealand still appear to have a cavalier attitude towards speeding with 36% of drivers saying that they enjoy driving fast and half of all males between 15 and 34 say that they like driving fast (Land Transport Safety Authority, 2004) Patterson, Frith, and Small (2000) also point out that New Zealanders have a poor attitude towards speeding. They found that people in New Zealand tend to have the misguided view that they are superior drivers and that they are able to drive at high speeds without endangering other road users. This is inline with attitudes around the world where speeding is not seen as a serious offence. Rolls, Hall, Ingham, and McDonald (Rolls, Hall, Ingham & McDonald, 1991, as cited in, Holland and Conner, 1996) mentioned that speeding drivers were capable of driving safely, but simply chose not to do so, or were not aware of the increased accident risk they had due to their behaviour. It appears that attitudes towards speed and speeding are somewhat contradictory. When surveyed, New Zealanders appear to want enforcement yet, 36% of those surveyed by the LTSA say they enjoy driving fast (Land Transport Safety Authority, 2004). It would also appear that many drivers feel that they are superior to others and therefore feel that they do not need to abide by the same rules as others as they don't feel that they increase their own risk of causing an accident by driving fast.

A similar finding was found in a Greek study of younger drivers who were asked about their own speeds, the speeds of others and whether ad campaigns about speeding were aimed at them. When asked how often they complied with speed limits on inter-urban and urban roads out of a sample of 207 drivers 73 or 35.3% reported that they seldom or never complied with speed limits, paradoxically in this same group, between 35% and 58% of them believed that a reduction in speed limits could reduce accidents. A factor analysis revealed that 3 major factors contributed to speed limit violations with egocentric behaviour of the driver explaining 40.5% of the variance indicating support for the notion that drivers once again have a positive bias when it comes to their own driving behaviour (Kanellaidis et al., 1995). This apparent ambivalent attitude of drivers towards speeding can create issues when attempting to draw conclusions from surveys that claim that people are happy with enforcement levels and keeping to the speed limit. Although people may be for enforcement and its associated penalties, keeping to the speed limit and maintaining speed limits at their current level, it may be that they answer these questions from the point of view that the rules don't apply to them. This may be due to the fact that they feel that they are superior drivers or that although they themselves are average, other drivers on the road are somehow below average. This raises the question whether attitudes towards driving can be used to predict actual behaviour on the road.

Overall, attempting to use attitudes to explain why people commit driving violations is not an easy task. In terms of human factors alone, attitude, emotions, subjective norm, and perceived behavioural control all appear to impact drivers' speed choice. All of these factors have influence over drivers' choices and if one or more of these factors is distorted by things such as a self optimism bias or downwards comparison, or a peer group that condones certain types of violations, these can impact drivers' choices and it is also likely that the influence of these factors is fluid depending on the situation at hand. Other variables not covered by the TPB have also been shown to affect drivers' behaviour (Fildes et al., 1991) and it is important to take the road environment into account when examining the predictive value of attitudes (Rothengatter, 2002).

Summary

Drivers appear to have a mixed attitude towards driving, with a tendency to believe that other drivers are not as safe as they are, coupled with a desire for increased enforcement. However, attitudes do appear to have some value in predicting driver behaviour, but are moderated by other variables such as subjective norms, anticipated regret, gender, and road environment. It appears that affecting driver attitudes towards speed could be a useful tool in speed management, but doing so without taking enforcement, engineering and education and road environment into account would probably not achieve major reductions in speeds and associated accidents. It is also possible that taking public attitudes towards the 3 Es, particularly enforcement, into account, could also be of use in improving their overall effectiveness. In fact, public attitudes can make the difference between the success or failure of a traffic calming scheme (Department for Transport, 2007) and education programs appear to be more successful when allowing people to delve more deeply into their own underlying attitudes (Bartl et al., 2002).

Participatory Design

The previous chapters examined the 3 Es, SER, and driver attitudes. Although the 3 Es, with the possible exception of education, have been successful in reducing accidents and improving speed management, there has been a levelling off of progress in the past few years and 1.2 million people are still dying on roads around the world annually (World Health Organization and Association for Safe International Road Travel, 2007). There appears to be evidence from engineering and education that increased driver involvement can improve the efficacy of these two tools, with public involvement improving the chances of a traffic calming scheme being successful (Department for Transport, 2007), not only empirically, but also in terms of public perception and that a focus on higher levels of driver education programs, that is goal setting and more of a focus on underlying attitudes, can improve the efficacy of these programs (Hatakka et al., 2002). There is also the possibility that involving drivers in the implementation of enforcement strategies may reduce the limitations and improve public perception of enforcement.

Participatory design may offer a way to increase the meaningful involvement of drivers in the implementation of speed management strategies. Participatory design focuses on eliciting people's tacit (silent or unspoken) knowledge and involving users/workers in every stage of a design process as equal partners with designers (Spinuzzi, 2005). Tacit knowledge is knowledge that people hold implicitly about various aspects of their lives (Reber, 2004), but in the case of participatory design the term tacit knowledge focuses on the knowledge that people hold about the way that they interact with various systems, including the workplace, computers and production lines, amongst others. The following chapter sets out to describe participatory design in terms of its history and processes as well as describing some of the issues that can hamper its success. Finally, the chapter explains how participatory design could be used to in combination with the 3 Es and SER in order to improve their effectiveness.

History

Participatory design in Europe stems from four labour organisation experiments that took place between 1964 and 1967 called the Norwegian Industrial Democracy Project, which investigated how social groups formed around production technologies and attempted to reform wage systems and job distribution for workers. The project led to two different research programs, the British "socio-technical systems" approach and the Scandinavian "collective resources" approach (Asaro, 2000). Participatory design progressed further during the 70s movement towards democracy in the workplace in Scandinavia. Two issues pushed forward the empowerment of workers, the first was the improvement of the workplace environment and the second was the introduction of computerised systems, which workers feared would lead to widespread deskilling and increased control by management. During this period several acts were put into place to improve conditions for workers, including the Norwegian

Work Environment Act of 1977, which attempted to provide participatory rights to all workers. Most were aimed at empowering workers by ensuring that work environments were satisfactory and that workers had more input into production practice, as well as having more representation through unions and the introduction of shop stewards (Asaro, 2000; Ehn, 1993; Spinuzzi, 2005). Despite these efforts, workers were still largely powerless in terms of changing policy. The main reasons for this were that management's goals and strategies were built into the new systems and the imbalance of power between management and workers was still present in most discussions and individual users also lacked power (Kensing and Blomberg, 1998).

Given these roots, participatory design has two main features that distinguish it as a design strategy. The first is political as participatory design raises issues of democracy, power and control at the workplace. The second and now the more emphasised feature of participatory design is technical in that the strategy promises that the participation of skilled workers can contribute to quality products and successful design (Ehn, 1993). Carroll and Rosson (2007), describe the principles of participatory design in a similar albeit slightly different way, as moral and pragmatic. With moral referring to the right to be involved in decision making and pragmatic referring to the workers knowledge being used to improve production techniques and/or product or service design.

Ehn (1993) describes three ground breaking projects that took placed during the 1970s. These projects were the precursors to modern participatory design. The first took place in 1970 when the Norwegian Iron and Metal Workers Union (NJMF) began investigating the implementation of computer systems, union goals, demands that would be placed on computer systems, and an investigation into knowledge requirements with the NJMF. The second project DEMOS on trade unions, industrial democracy and computers took place in Sweden between 1975 and 1979. The project was done by an interdisciplinary research team and workers and trade unions at a daily newspaper, locomotive repair shop, a metal factory and a department store. The project's aims were to identify how unions could influence the design and use of computer based systems. The third and final project was called UTOPIA. It started in 1981 as a joint effort between the Nordic Graphic Workers' Union and researchers in Sweden and Denmark. The project looked at the trade union based design of computer technology and work organisation. It used a process of mutual learning where graphics workers learnt about the possibilities and constraints of computer systems while designers learnt about their crafts and profession. These three projects helped establish an environment where unions and workers were able to be much more influential in the introduction of computerised systems and in the improvement of the workplace. These projects also highlighted the benefits of improving communication and equality between workers, designers and management in order to develop artefacts that were accepted by both management and workers.

Participatory Design Methodology

As participatory design is now applied to various fields such as computer software, urban design, environmental management etc, it is difficult to find an all-encompassing description of participatory design methodology (Spinuzzi, 2005) and trying to develop a single unifying participatory design methodology has not been the aim of participatory design researchers (Kensing and Blomberg, 1998). However, true participatory design studies and projects do tend to follow a set of tenets. Three basic stages can be seen in almost all participatory design research. The first stage involves designers meeting with users to familiarize themselves with how the users work with each other. Workflow, work procedures, routines, teamwork and other aspects of the work are also investigated. In the second stage, designers and users work together to envision the new workplace and look at work organisation structures. User's goals and values are also defined in order to determine the outcomes of the project. The third stage is where the ideas that were envisioned in stage two are further developed. Users and designers work together to iteratively shape prototypes. Usually these stages are iterated several times to improve the design process by allowing better exploration of issues by the same users and designers.

Spinuzzi (2005) also outlines some basic methods for each of these stages. The first or exploratory stage generally involves an examination of the site. This is done by visits, observations, walkthroughs, interviews and other methods adapted from ethnography. In stage two, users and designers interact with each other most heavily using varying methods to ensure good communication between users and designers. Stage three uses various techniques such as prototyping (de Looze et al., 2001; Dinka and Lundberg, 2006), paper prototyping (Demirbilek and Demirkan, 2004), pilot projects (Bèguin, 2003) and more recently the use of computerised systems (Hanzl, 2007), amongst other similar techniques. These methods are done iteratively with participants going through each of the methods several times until a satisfactory outcome has been achieved. For example, Thursky and Mahemoff (2007) report on the use of participatory design in the development of an antibiotic decision support system in an intensive care unit (ICU). First a multidisciplinary team was created to investigate the workflow and relationships between workers that existed in the ICU. This was followed by in-depth communication with workers and finally information from these exchanges was used aid in the development prototypes of the decision support system. After several iterations and further development of the prototype systems, the final version of the decision support system was created and put into use in the ICU.

Participatory Designs' Applicability to Road Design

The development of speed management techniques could benefit from participatory design, as involving the public usually consists of consultation or informing which are described as tokenistic (Arnstein, 1969) or pseudo-participation (Luck, 2003). Public involvement in transport planning in the UK, for example, has been criticised for lacking evidence of substantive impacts on local transport planning (Bickerstaff et al., 2002). They attribute this to a lack of clarity and guidance in government policy. They conclude that public participation in the UK is still largely concerned with informing the public and thereby very much tokenistic. Transit New Zealand's project manual (Transit New Zealand, 2006) has a brief section on information days, which states that those running the meetings should "not get too involved with discussing the project as the meeting focus will then concentrate on defending the detailed design, rather than achieving the meeting's objectives." (p. 95). And to pre-emt concerns, questions and objections as this is the best way to convince or persuade an audience. This policy also indicates a reluctance to involve the public any further than providing them with information and a platform to express their views, which may or may not be ignored. This is despite evidence that a lack of consultation in traffic calming schemes can lead to dissatisfaction and potential removal of the schemes (Department for Transport, 2007). Below are some of the potential benefits of using participatory design in road safety.

Participatory design is effective in the early detection of problems (Sundin et al., 2004), which is relevant to the implementation of speed management strategies.

Enforcement is often placed on roads where there are excessive speeds and/or related accidents, if problems with the design of new roads could be dealt with prior to building, this would reduce the need for enforcement. Traffic calming solutions could also benefit from this type of approach, as a lack of consultation and public involvement often leads to issues with the scheme.

Participatory design can achieve trust and understanding between users and designers while developing successful solutions (Weng et al., 2007). This has implications for enforcement and engineering as a participatory approach to speed management in these arenas could help to improve drivers' attitudes towards enforcement and engineering solutions. It could also help to improve the relations between local authorities and the public (Arnstein, 1969; Bickerstaff et al., 2002) leading to more fruitful results from public involvement in speed management.

A participatory approach is capable of generating a large amount of solutions in a relatively short period of time and also improving awareness of ergonomic issues at the same time (Loisel et al., 2001). This shows that involvement of people using a participatory approach does not necessarily lead to a long drawn-out consultation process as feared by some roading authorities (Transit New Zealand, 2006) and that it is capable of producing effective solutions to problems. The increased awareness of ergonomic issues could also translate to improved driver behaviour bought about by explicit involvement of drivers, rather than the current set of speed management strategies which largely rely on implicit methods to affect speeds.

Being an iterative process participatory design can allow designs to be modified easily if they do not perform as expected (Bèguin, 2003; Hess et al., 2004). This has implication for traffic calming solutions and possibly enforcement strategies where hoped for goals are not achieved (Taylor and Tight, 1997; Vaa, 1997). Drivers' experience of newly implemented speed management schemes may also benefit from further iterations in design after implementation.

Participatory design also generates solutions that are quickly taken up by stakeholders, increases the likelihood of success, generates a sense of ownership and allows for the discussion of gaps in users' knowledge (Thursky et al., 2006; Thursky and Mahemoff, 2007). These could have positive implications for the 3 Es and SER. First, the efficiency of the development process could be very beneficial in developing speed management strategies, especially traffic calming, second the quick uptake of artefacts due to the sense of ownership generated by the participatory process would be useful in improving attitudes towards enforcement and other speed management strategies that may be seen to punish drivers on the surface. The ability of the process to allow for discussions of gaps in users' knowledge has implications for SER, which elicits correct behaviour through design (Theeuwes and Godthelp, 1995; Wegman et al., 2005; Wegman, 2003). Since SER works implicitly to reduce speeds, a discussion of drivers' lack of knowledge using participatory design may help to generate more effective SER strategies by including explicit road safety measures where implicit strategies may not be sufficient.

As roads are used by millions of people on a daily basis, it is likely that any participatory approach used with speed management will have input from several sources and potentially 100s of people. Participatory design allows for this and also for the incorporation and use of local knowledge in design (Fontalvo-Herazo et al., 2007).This may help speed management strategies to avoid pitfalls such as crash migration from a neighbouring traffic calming scheme, which may not be noticed, at least initially, by road engineers. Using a participatory approach may also be useful for solving speed issues that may be somewhat peculiar to a local community.

Finally, there is no doubt that an important part of any speed management strategy is cost/benefit analysis, as the costs of road deaths are almost always measured in dollars lost (Joint OECD/ECMT Transport Research Centre, 2006) as well as lives. Participatory design appears capable of generating solutions for multiple issues on a small budget (Pehkonen et al., 2008). This is important as any Government authority will want to ensure that a speed management strategy is done in a cost effective manner and that it will have a return on its investment in terms of money saved by a reduction in injuries and lives lost.

The Efficacy of Participatory Design

Despite the potential positive implications of using participatory design in road safety, more recent participatory design related papers, perhaps to answer the critiques of earlier user involvement projects (Ives and Olson, 1984), are heavily focused on reporting on the process of participatory design projects, but are much less focused on outcomes, with an emphasis on qualitative methods. This coupled with a somewhat vague definition of success, and lack of formalized methods (Pilemalm et al., 2007; Spinuzzi, 2005) makes assessing the effectiveness of participatory design difficult in many cases.

Participatory design research has been criticized for a lack of set methodology (Spinuzzi, 2005) and a lack of formalisation (Pilemalm et al., 2007). Part of the reason for this criticism is possibly due to the most frequently used methods of analysing participatory design projects being qualitative and focused on the process rather than outcomes (Bèguin, 2003; Demirbilek and Demirkan, 2004; Dinka and Lundberg, 2006; Olsson, 2004; Timpka et al., 1995). Although these research approaches enable researchers to make detailed accounts of participatory design workshops and how people feel about being involved, this focus on qualitative approaches makes it difficult to directly compare participatory design studies. The other issue with the current focus on process and the use of qualitative research methods is a lack of tangible outcome measures. participatory ergonomics projects tend to use more quantitative research methods (Hess et al., 2004; Loisel et al., 2001; Saleem et al., 2003), but even the field of participatory ergonomics has been criticised for projects being difficult to compare in terms of process and outcomes due to a broad range of practices and ideas (Haines et al., 2002). Research into developing frameworks and methodology for both participatory design and participatory ergonomics is ongoing (Haines et al., 2002; Spinuzzi, 2005), but due to the various areas in which participatory design and participatory ergonomics is used, it is unlikely that an all-encompassing framework will be developed in the near future. However, the formalisation of outcome measures in order to enable a comparison of the various methods of participatory design is one area that future research should address. Despite these shortcomings, there are studies that report on successful participatory design and participatory ergonomics projects and several of the studies report on successful solutions that are strongly related to the issues faced by the 3 Es and SER.

Sundin, Christmanson & Larsson (2004) report on a participatory ergonomics project that involved designers, production engineers, ergonomists and workers (indirectly) in the development of an assembly line for a new chassis design. The process involved the formation of a work group, analysis of the existing chassis design, prototyping and analysis of the new design and finally computer visualisation of the new chassis design. The outcomes of the project were reductions in physical stress placed on workers during the assembly process and reduced assembly time, and importantly the early detection of problems with assembly prior to full implementation.

Weng and colleagues (2007) report on a participatory design process that was used to design groupware technology for clinical trial protocol writing. Using exploration, analysis and prototyping, participatory design was used to create a piece of software that enabled collaborative writing. The software was seen as successful in that it was seen as work informed and user oriented. The process was seen to bring forth tacit knowledge that was used in the design of the software. It also generated enthusiasm due to several ideas from users being incorporated into the design of the software. The iterative nature of participatory design also helped to build trust between designers and users, promoted a better understanding of users by designers and designers by users, and improved users' knowledge of the design process by frequent negotiations of changes with users.

A reduction in time off work caused by sub acute back pain was achieved using participatory ergonomics (Loisel et al., 2001). A four step process was used to develop ergonomic solutions to reduce sub acute back pain. First workers were interviewed and the workplace was investigated by ergonomists. Next the jobsite was visited and the injured workers' tasks were observed both by ergonomists and the injured workers. Finally, workers and ergonomists worked together to develop solutions to the issues found at the various jobsites. Employers at the jobsites were then given the opportunity to implement the solutions created. A total of 226 solutions were generated and approximately half of these were implemented. The modifications were cost effective, possibly facilitated a faster return to work for several injured workers, and an increase in ergonomic awareness was found amongst employer representatives, union representatives and workers. The authors also comment that the ergonomic modifications may also have had a preventative effect in terms of back injury.

When investigating a participatory ergonomics intervention to reduce the incidence of lower back disorder in concrete labourers Hess and colleagues (2004) found that the iterative nature of participatory ergonomics and the use of workers' knowledge was able to improve the skid plate design, which led to further reductions in the amount of lifting of the hoses used to dispense concrete at building sites. This consequently reduced the incidence of several movements linked to the developed of lower back disorder. The skid plates were chosen by workers and researchers as a tool to reduce lifting, but did not perform to expectations. As participatory ergonomics allows iteration of steps as part of its process, workers developed the “field fix” which led to design improvement in the skid plate. This study demonstrates that the workers’ tacit knowledge of their jobs and workers’ continuing involvement in the design process can be very beneficial.

A study looking at 7 cases were participatory ergonomics was used in the development of physical stress reducing products found that participatory ergonomics was successful in most cases, but that the most successful products were created where there was direct worker participation, strong management support, a broad analysis of the problem at the beginning, relevant experts as part of the steering group, an analysis of any potential negative impacts and finally the use a stepwise approach. They also found that participatory ergonomics was capable of producing both productivity and health and safety benefits (de Looze et al., 2001). This study also shows that a participatory approach is capable of producing both productivity and efficiency improvements.

Participatory design has also been used in a health setting to develop an antibiotic decision support system in an intensive care unit (ICU) (Thursky et al., 2006; Thursky and Mahemoff, 2007). The software was developed with the help of knowledge, experience and input from staff in the ICU. Participatory design was used to ensure that the software was designed with users in mind through the entire development process. The use of participatory design made the development of the software much more efficient and thanks to the heavy involvement of users the uptake of the new software was very quick. In the first 6 months the software was used over 6000 times and there was a significant decrease in overall and broad spectrum antibiotic use. It is also of interest to note that the decision support system dealt with a lack of knowledge regarding some types of antibiotics, by providing additional information and help with diagnosis. The lack of knowledge was discussed openly by staff in the ICU.

Pehkonen and colleagues (2008) used a participatory ergonomics intervention to improve workload and musculoskeletal health in 59 municipal kitchens in

Finland. Workers participated in several workshops in order to analyze and improve tasks in the kitchen that caused problems with ergonomics. A total of 402 changes to kitchen practices were implemented as a result of the study and workers reported that they felt that their musculoskeletal health was improved as a result of the changes made. Workers also reported more confidence in dealing with ergonomic issues and reported that ergonomic considerations were now part of their decision process when purchasing new kitchen equipment. They also reported more knowledge and awareness of ergonomic issues. Finally, all of the changes made in the kitchen were done without an increase in budget. This study, as in the ones above, shows that a participatory approach is capable of generating multiple improvements. What is interesting about this study is that it was done over a relatively large scale with several businesses and workers involved.

Bèguin (2003) reported on a case study using participatory design to design an alarm system to guard against chemical runaways in a chemical plant and found unexpected potential solutions due to the nature of participatory design. The study started out by developing an understanding of workers' strategies for preventing chemical runaways and found that workers were using methods to prevent chemical runaways that were not scientifically validated and unknown to management. It is not mentioned whether the methods used were indeed validated, but the approach did bring them to the attention of the researchers and also gave the workers a voice. Eventually through several iterations, a new system was implemented to attempt to prevent chemical runaways, but the system ended up being used for a purpose other than for what it was intended. Further iterations and rethinking the problem finally found that it was actually impossible for workers to prevent a chemical runaway if it happened, due to lack of staff and issue with the architecture of the building. This study shows the strength of participatory design in terms of iteration. Thanks to ongoing worker involvement and evaluation, this study found that what was initially thought to be causing the problem was actually not as big an issue as the environment in which the chemical runaways were occurring.

Finally, Fontalvo-Herazo, Glaser and Lobabto-Riberio (2007) used participatory design to develop an indicator system as a tool for coastal management at a village level in Brazil. The process used 406 residents from different villages and through a series of meetings was able to come up with an indicator system that was useable by stakeholders and allowed them to develop indicators that measures changes and progress over time. Indicators chosen by residents were environmental, social, governmental and economic. Although the indicators used were seen as unusual and unbalanced, the authors commented that they did indeed reflect the situation faced by villagers, and as a result were a very useful tool. This is another study that shows participatory design is capable of dealing with large numbers of people over a wide area and is still able to generate successful solutions. The authors also comment that conflict between group members was managed, in some cases with help from the community.

The above studies show that participatory design and participatory ergonomics are capable of producing innovative solutions to various problems, from back pain to improving the environment. Benefits of participatory design and participatory ergonomics that are relevant to speed management include; early detection of problems, improvements in efficiency, improvements in working conditions, quick uptake of solutions, improved acceptance of new solutions, improved knowledge and awareness of the issues surrounding problems, tacit knowledge of users bought forward and used in design, improved trust between designers and users, a better understanding of designers by users and users by designers, and the iterative approach of participatory design can reveal issues that may be missed in initial exploration of problems.

INTRODUCTION TO EXPERIMENTS

The literature in the preceding chapters has outlined several of the major methods currently used to improve road safety and manage speeds. So far it appears that these methods are by in large focused on the 3 Es, with the exception being SER. Despite methods being successful in reducing road deaths and injuries, many countries are now struggling to meet their 2010 goals, due to a leveling off of progress in improving road safety. Unfortunately, only enforcement and engineering have had consistent results in improving road safety, with education's effectiveness being somewhat difficult to ascertain, with several large scale studies casting doubt on the ability of education and training to reduce accidents. Furthermore, both enforcement and engineering suffer from issues that limit their effectiveness. Enforcement is only effective while it is visible and engineering is often faced with multiple tasks of moving traffic quickly and safely, leading to roads with inappropriate speeds.

To add to these limitations, neither the 3 Es nor SER does much to explicitly affect driver attitudes or behaviour at an individual level, but rather rely on implicit methods to manage speeds and improve driver behaviour. Given that several variables, such as age, gender, road environment, attitudes, subjective norms etc. affect drivers' behaviour at any given time and that the influence of these variables can vary at any given time, relying heavily on implicit methods for speed management and road safety can be problematic, especially if one or more of the variables increases or decreases in its influence over driver behaviour. An example maybe a driver going from a well designed SER environment to a poorly categorised system of roads while in a state of emotional arousal, such as anger. Another issue may be when drivers become explicitly aware implicit methods of speed reduction, leading a decrease in their effectiveness. Also drivers appear to be somewhat unaware of their own attitudes and tacit beliefs. This means that many of these attitudes and beliefs may be influencing their behaviour from behind the scenes (Fishbein and Ajzen, 1993). On the other hand, bringing these attitudes and beliefs to the awareness of the driver may help them to improve them.

In addition, none of the 3 Es or SER does a great deal to involve drivers or the general public in their design and implementation. In fact, drivers are often seen as a problem that needs to be enforced, engineered, or educated into shape, while often ignoring any knowledge or other input that drivers may have about themselves or the road environment, which may be of help in further reducing road fatalities and injuries.

Even when the public is consulted for road projects, the effort is often either implicitly (Bickerstaff et al., 2002) or explicitly (Transit New Zealand, 2006) designed to ensure that members of the public are kept out of the design process as much as possible and persuaded to share the view of the agency implementing the designs. This despite several papers from Participatory Design demonstrating that user involvement can improve the quality of products, workplace environments and computer systems, as well as improve the acceptance and uptake of any changes that are made (Bèguin, 2003; Ehn, 1993; Thursky et al., 2006; Thursky and Mahemoff, 2007; Weng et al., 2007). Literature from traffic calming also indicates that public involvement through an open and inclusive consultation process can often mean the difference between a successful and unsuccessful traffic calming scheme (Department for Transport, 2007; Taylor and Tight, 1997).

Increasing an individual's awareness of his/her tacit attitudes and beliefs may be useful in improving driver behaviour and attitudes. This is because people are often unaware that they hold tacit (implicit) attitudes that could be affecting the way that they behave without their knowledge. An example of this could be implicit racism (Fischbein, 1994). Using a participatory approach to involve drivers in road design would allow their tacit knowledge and possibly attitudes to be brought forth and examined. Indeed, as outlined previously, several studies where a participatory approach was used to develop solutions for problems in a diverse range of situations, from kitchens to intensive care units, found that taking part in the participatory design process increased awareness about design processes and issues surrounding the artefacts that were created. Pehkonen and colleagues (2008) reported that those taking part in the kitchen studies now considered ergonomics when purchasing new kitchen equipment. Not only are those who participated made more aware, they were also able to come up with a wide range of successful solutions to the issues that the process set out to address. Literature regarding message framing (which looks at whether the negative or positive framing of a message impacts its effectiveness) and issue involvement (which investigates whether high or low involvement in an issue affects behaviour relating to that issue) and its impact on and how they react has also found that those who are more highly involved with an issue tended to process issues more deeply (Maheswaran and Meyers-Levy, 1990) and produce more cognitions (Millar and Millar, 2000). Positive framing (looking at ways in which road safety measures work to save lives and reduce speeds) as opposed to negative framing (the impacts of not obeying the speed limit or driving to the conditions) of road safety measures may improve the effectiveness of road safety measures, as long as this framing is coupled with higher involvement of drivers in road safety issues (Johnson and Eagly, 1990; Millar and Millar, 2000).

Research Motivation and Aims

With approximately 1.2 million people dying each year as a result of traffic accidents (World Health Organization and Association for Safe International Road Travel, 2007) and a levelling off of progress in the reduction of road deaths around the world (Organisation for Economic Co-operation and Development, 2006), it is clear that there is still more to be done in the way of reducing accidents and speed management. Currently the 3 Es and SER appear to have little input from drivers and the public and changing driver attitudes and behaviour remains problematic. It may be that the key to further improving the efficiency of the 3 Es and SER and changing driver attitudes and behaviour may lie in involving drivers and the public in speed management and other road safety improvement schemes through a participatory approach. Literature from participatory design and participatory ergonomics indicates that a participatory process is capable of generating solutions for a wide range of problems and that involvement in the process improves participants' awareness of the problems and changes their behaviour in a positive way (Demirbilek and Demirkan, 2004; Ehn, 1993; Fontalvo-Herazo et al., 2007; Loisel et al., 2001; Pehkonen et al., 2008; Thursky and Mahemoff, 2007). The designs are also often quickly and enthusiastically implemented due to a sense of ownership created by the participatory design process. Furthermore, there appears to be evidence that the extraction of tacit knowledge through involvement leads to more cognitions and deeper processing of issues (Fischbein, 1994; Janov and Holden, 1975; Johnson and Eagly, 1990; Millar and Millar, 2000). Therefore, participatory design appears to address the issues of attitude and behaviour change and public acceptance of speed management schemes (i.e. traffic calming) and enforcement and also provide a way of teaching the higher levels of the GDE.

This research aimed to discover whether actively involving drivers in the design of speed management strategies through a participatory design approach can generate successful speed management solutions as well as change drivers' attitudes and behaviour. Below is an outline of the general methods used for the experiments. The experiments also have their own separate method sections with deal with issues specific to those experiments.

Logic Behind Experiments

The experiments followed the following structure:

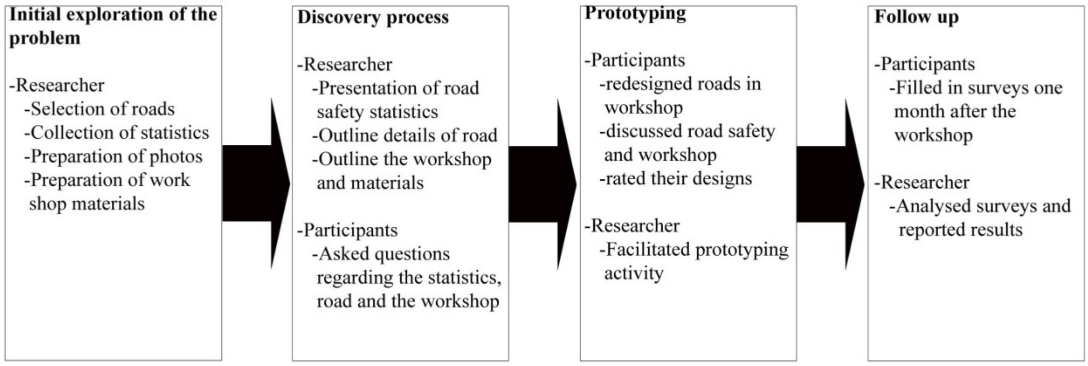


Figure 2: Experimental structure.

Initial Exploration of the Problem

For each of the workshops, the researcher examined various roads around Hamilton area to determine which roads would be suitable for redesign within the workshops. Information regarding speed limits, traffic flows, average speeds, crash rates and road specifications (e.g. road width and markings) were gathered using data from the Hamilton district council, the LTNZ CAS (Crash Analysis System) database, which is used to keep track of and analyse crash and crash related data. The exception to this was for the third experiment, where participants had roads that they wished to redesign. In this case, the researcher met with a representative from the organisation involved in the experiment and consulted with the representative regarding appropriate sections of road. Information regarding traffic flows, accident rates and dimensions were gathered using data from the Auckland district council and the LTNZ CAS database. Photos representing the road sections were also taken.

Discovery Process

Each workshop began with a presentation of road safety statistics, current methods in use to improve road safety, an outline of participatory design techniques and an exploration of what the workshop would entail. The presentations varied between workshops, but the general outline remained the same throughout. These presentations ensured that participants had access to as much information as possible prior to the prototyping phase, allowing for as a full a participation as possible (de Jong and Vink, 2002; de Looze et al., 2001; Smart and Whiting, 2001). Although this part of the process was focused more on imparting information to participants, they were free and encouraged to ask questions if they wished to do so.

Prototyping

Following the presentation, participants were asked to begin the redesign of the road or roads, depending on the workshop. Due to participants' time constraints, the prototyping session was restricted to approximately one hour. Brief prototyping sessions have been found to be successful in previous participatory design projects (Olsson, 2004). The process was also made to be as unstructured as possible to allow users tacit knowledge to be accessed (Olsson and Jansson, 2005), although the researcher was present as a facilitator in case the participants went off topic or failed to remain within their time constraints (Luck, 2003). In the first three workshops, participants were able to redesign roads without any input from road designers, as differences in the way designers and users approach a design task can create issues where designers can take control of the process (Mankin et al., 1997; Olsson, 2004). Issues of power may have also presented participants from being fully involved in the design process (Kensing and Blomberg, 1998).

Prototyping was done using scale models and various modelling tools. These allowed the users the freedom to design whatever artefacts they wish and the results were easy for both users and designers to understand (Spinuzzi, 2005).

Follow Up

In order to determine whether or not the workshops had any impact on participants' attitudes and behaviour, surveys were distributed before, after and one month after the workshops regarding participants' self reported driving behaviour. The idea behind this was to see whether or not the process had any impact on their overall attitudes towards speed and their driving behaviour.

Statistical Analyses

Statistical analyses for the four experiments below include analyses such as Multiple Analysis of Variance (MANOVA), Analysis of Variance (ANOVA) and multiple regressions. Despite sample sizes being small, numbers were sufficient for these analyses. Kirk (1982) states that for a large effect size a minimum sample of 10 is required and for a medium effect size, the number is 25. Furthermore, given these requirements, it is far more likely that a Type II error would occur, rather than a type I, indicating that any significant findings are not the result of a Type II error. In regards to multiple regression analyses, Kerlinger and Pedhazur (1973) state that approximately 3 to 4 subjects per variable are required for a regression equation to be reasonably accurate. Where these conditions were not met, non-parametric tests were done in order to ensure results were as accurate as possible and reduce the chances of Type I and in particular Type II errors.

EXPERIMENT ONE

Experimental Goals

The goals of the first experiment were to:

First determine whether participatory design could be successfully used to design roads that were better than existing roads and second to find out whether taking part in could positively affect participants' attitudes towards speed. A secondary goal was to determine whether these ratings were affected by or, interacted with, demographic variables, driver behaviour ratings, attitudinal variables, or participatory design process ratings. In order to further investigate the participatory design process, it was also important to determine whether any differences existed between the different groups who took part in the experiment in terms of these ratings. Differences in ratings between males and females were also investigated, given the differences in accidents statistics mentioned in the introduction. The road chosen for the experiment is shown below in Figure 3. Although the road is located in Hamilton, it was not necessarily one that participants used on a daily basis. The road chosen for this experiment was used as it had issues with excessive speed due to its design and therefore made a good example for participants to work on to assess the general efficacy of participatory design as a tool to allow the redesign of problematic roads.

Participants

Prior to beginning the research ethical approval was obtained from the Psychology Department Human Research Ethics Committee at the University of Waikato. Twenty-Eight participants, recruited via the Parent Teacher Association at a local primary school, took part in the workshops. Participants were not paid for their participation, but the school received $10 per participant, which went towards the Parent Teacher association. Nine of the participants were male and nineteen of the participants were female. Their ages ranged from 16 to 71 (mean 45.29, SD 12.83). Kilometres driven varied from 5,000km to 50,000km per annum with a mean of 15,346.15km (SD 11603.25km) and they had between one and fifty two years of driving experience with an average 27.50 years (SD 13.25).

Materials

The experiment had three materials. A presentation, a questionnaire and a toolkit.

Presentation

A 15 minute "participatory road design presentation" containing information on various road safety statistics, speed reduction and safety measures, and a description of the road that participants were working on was given at the beginning of the presentation to familiarise the participants with what they would be attempting to do. The presentation first outlined road safety statistics from New Zealand and around the world to inform participants why this research was important. Second it outlined the 3Es and self explaining roads. Following this explanation various road safety treatments, including traffic calming, delineation, and enforcement were outlined. Finally, participants were given details regarding the road which they were to redesign in the workshop (see Appendix A for a copy of the presentation).

Questionnaire

The questionnaire had both pre and post workshop components. The pre workshop component consisted of four sections. The first section consisted of demographic questions such as age, driving experience, and number of kilometres driven. The second section consisted of questions regarding driver behaviour drawn from the Driver Behaviour Questionnaire (DBQ) (Reason et al., 1990), which has been used extensively to investigate driver behaviour around the world (Bener et al., 2008; Davey et al., 2007; King and Parker, 2008). The third section used questions drawn from the speeding subsection of the LTSA survey of public attitudes to road safety (Land Transport Safety Authority, 2004) to discover more about participants' attitudes towards speed. This questionnaire is used in New Zealand to measure attitudes towards road safety and consisted of a sample of 1513 New Zealand drivers in 2004, road ratings and workshop ratings (see appendix for complete questionnaire). The fourth sections asked participants to rate the road that they were to redesign in the experiment. Participants were given two photos of a road and asked to rate the road's estimated speed, how safe they felt the road was, its aesthetics, and how likely they were to use drive down this road (preference).

Estimated speed was written down by participants in kilometres per hour and safety, aesthetics and preference were rated using seven point Likert scales.

The post workshop component of the questionnaire consisted of three sections. The first section again used the same questions as in section 3 of the pre workshop component in order to determine whether any changes in participants' attitudes occurred as a result of the workshop. The second section asked participants to rate their redesigned road. It used the same questions as in the fourth section of the pre workshop component in order to determine whether participants felt that they had improved the road. The third section asked participants questions regarding the participatory design workshop in order to find out how they felt about the process. This section had questions regarding participation, changes in attitude, and the effectiveness of the participatory design process as a teaching tool and so on.

Figure 3: Road to be redesigned in the workshop (North facing).

Figure 4: Road to be redesigned in the workshop (South facing).

Presentation

A 15 minute “participatory road design presentation” containing information on various road safety statistics, speed reduction and safety measures, and a description of the road that participants were working on was given at the beginning of the presentation to familiarise the participants with what they would be attempting to do. The presentation first outlined road safety statistics from New Zealand and around the world to inform participants why this research was important. Second it outlined the 3Es and self explaining roads. Following this explanation various road safety treatments, including traffic calming, delineation, and enforcement were outlined. Finally, participants were given details regarding the road which they were to redesign in the workshop (see Appendix A for a copy of the presentation).

Toolkit

Participants used a toolkit to construct their designs. The toolkit consisted of scale model cars, road signs, trees, shrubbery, pavement, plain card, coloured card, coloured paper, plain paper, felt tip pens, whiteboard markers, pens, scissors, knives, tape, and modelling clay. The toolkit also included a speed reduction measures booklet (Appendix E) which gave various methods of reducing speed and increasing road safety, along with their advantages and disadvantages.

Figure 5: Toolkit, road template and countermeasure booklet.

A Styrofoam model of a section of the road was used by participants to aid in their design process. The road was designed in 1/87 scale and represented 50 meters of road in the real world. It was based on a road approximately 14 meters wide with two 7 meter lanes. The road had a relatively high traffic flow. All existing road markings were removed so participants would not be influenced by existing designs. The edges of the road were painted green to simulate an empty verge.

Procedure

Recruitment of participants took place through contacting representatives of various primary and intermediate schools in the Hamilton area. If the representatives responded to initial requests, further details of the experiment were given for them to distribute to other members of the school (i.e. staff and Parent Teacher Associations). Representatives of the school took personal details of interested parties and the researcher then contacted them to arrange a time for them to take part in a workshop. A total of six workshops were held with between 4 to 5 participants each. Workshops ran for approximately 1.5 hours. Rooms were equipped with a data projector and screen and were set up as shown in Figure 6 below.

Figure 6: Workshop in progress.

Before beginning the workshop, participants were told that participation was voluntary and that they were allowed to leave at any stage of the experiment, and any information collected during the procedure was confidential and that no names or any other personally identifying information would be used. The researcher then outlined the workshop procedure and participants began to fill in the questionnaire.

Once participants completed the first half of the questionnaire, the researcher gave the "participatory road design presentation". The toolkit and speed reduction measures booklet was then described and participants were instructed to begin the redesign process. This was left up to the participants; however the researcher was present to answer any questions that the participants had about the any aspect of the workshop, tools or the design process. When the design was completed it was photographed and participants filled in the second half of the questionnaire.

Results

Results Layout

Results were analysed and are laid out as follows:

- Road ratings before and after the workshop
- Differences between groups
- Variables predicting estimated speeds and speed change
- Associations between predictor, demographic and DBQ variables and attitudes ratings
- Participatory design process ratings
- Gender and group differences
- Associations between participatory process, road and attitude ratings

Road ratings

Participants came up with a variety of road designs, shown in Figure 7 below.

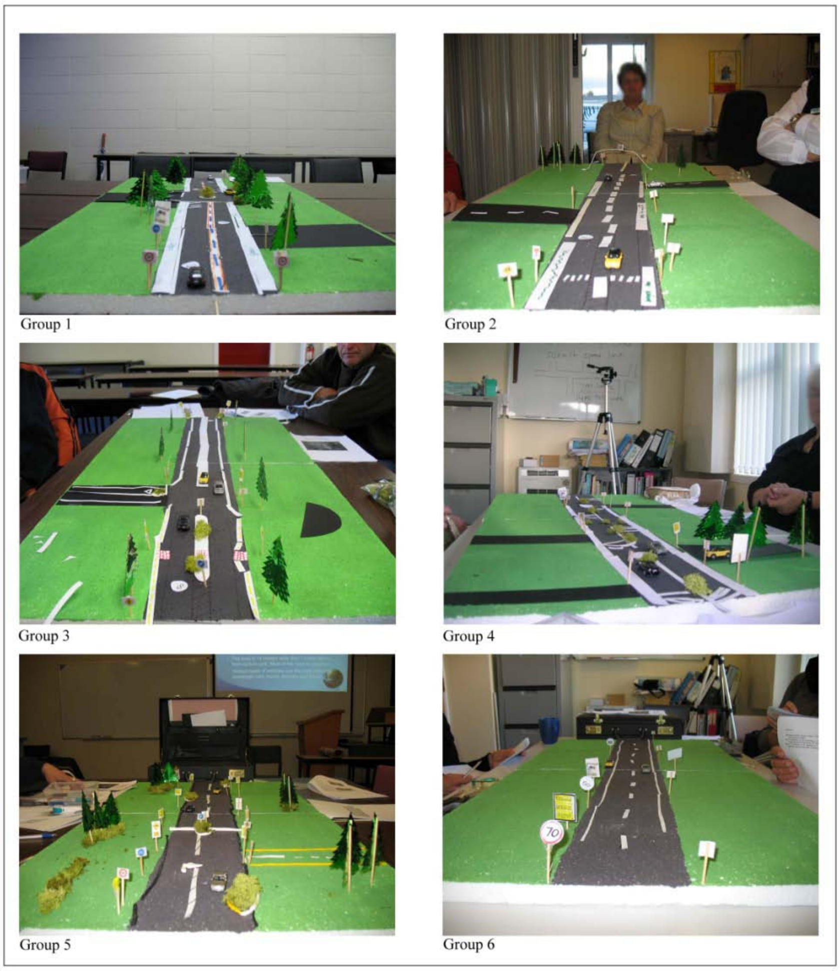


Figure 7: Tramway road as redesigned by groups 1 to 6.

Speed, safety, aesthetics and preference ratings for Tramway Road before the workshop and after the workshop (redesigned) were analysed first using a 2 X 2 mixed design MANOVA, using Workshop (before and after the workshop) and Gender with the four dependent variables of speed safety, aesthetics, and preference. The MANOVA revealed a significant main effect for Workshop across all the road rating measures, Wilks' Lambda = .638 $F(4, 22) = 3.12$ $p < .05$. There were no significant gender or gender/workshop interaction effects. One way repeated measures ANOVAs with no gender factors examining the before-after effect of workshop revealed that estimated speed and road aesthetic ratings were significantly different, $F(1, 25) = 8.64$, $p < .01$ and $F(1, 25) = 4.50$, $p < .05$ respectively. Figure 8 shows that estimated speed decreased significantly from a mean of 56.92.64 km/h to 51.73 km/h. The standard deviation also decreased from 8.1 km/h to 4.73 km/h, indicating that participants also were more uniform in their estimated speed choice after the workshop.

Figure 9 shows that road aesthetic ratings rose from a mean of 4.85 to 5.3 out of a possible 7, indicating that participants found the road that they had created more pleasing to the eye than the road shown in the before photos.

Road safety and preference ratings remained relatively unchanged, with mean safety ratings 5.48 (SD 1.06) before the workshop and 5.33 (SD 1.04) after the workshop. Preference ratings were 6.44 (SD .89) before and 6.15 (SD .99) after.

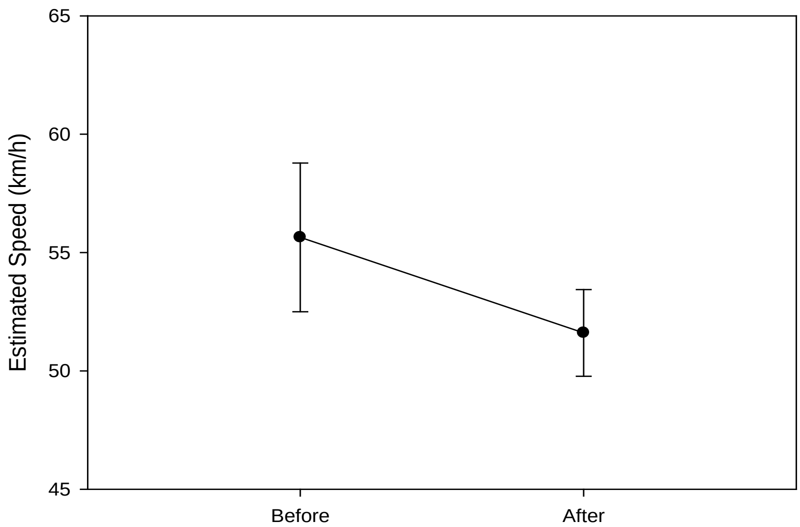


Figure 8: Mean estimated speed before and after the workshop (95% CI).

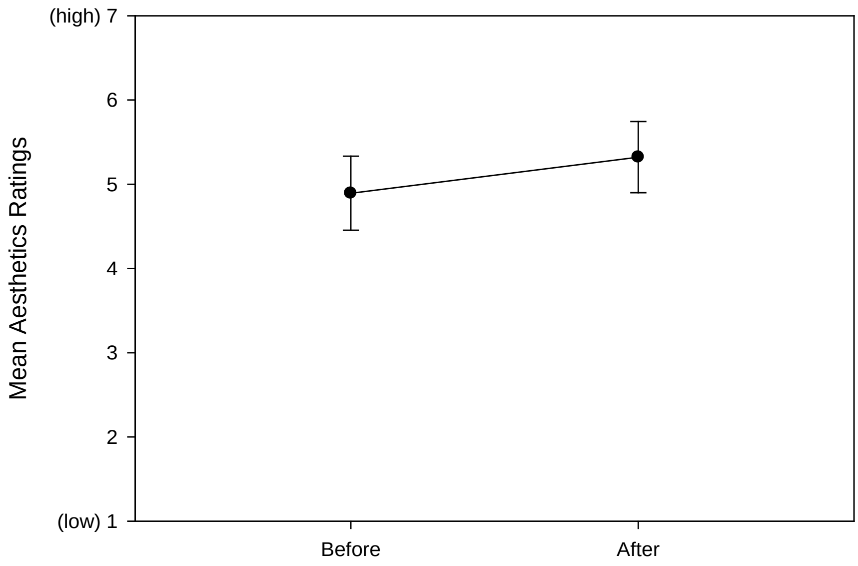


Figure 9: Mean aesthetics ratings before and after the workshop (95% CI).

Group (Workshop) Differences

In order to examine whether there any differences between the 6 groups of participants taking part in the workshop, a 6 X 2 MANOVA comparing the six workshop groups' before and after ratings of the three measures of estimated speed, safety, aesthetics and preference (whether participants would drive on this road). The MANOVA did not reveal any significant effect of Workshop, or group effects on ratings of workshop sessions. However, univariate statistics did reveal a significant interaction effect between workshop and group for the measure Preference (how likely participants were to use the road), $F(1.96, 21) = 4.55$ p < .01. An LSD post hoc test revealed that Group 2 had a significantly lower "after" score than group three, $p < .05$. Figure 10 reveals that Groups 2 and 6 preferred the road that they had designed less than the before road, whereas the other groups were at more likely to drive down the road that they had created compared to the before road. In order to determine what differences between groups may have accounted for Group 2's lower preference ratings, a Kruskal-Wallis test was calculated for the demographic measures of age, gender, kilometres driven, number of years that participants held a drivers' license and driving experience (years). The Kruskal-Wallis test was done in favour of a one-way independent ANOVA due to non-normal data distribution. The test revealed significant differences between the six groups for age X^2 (5, $N = 28$) = 12.08, $p < .05$, driving experience X^2 (5, $N = 28$) = 11.9, $p < .05$ and kilometres driven X^2 (5, N = 28) =

15.30, *p* < .01. An LSD post hoc test revealed that group 2 had driven a significantly higher amount than groups 1, 2, 3, 4 and 6 (*p* < .01) and 5 (*p* < .05). Although differences in age and experience were found between groups, these differences were not found to exist for Group 2.

Variables Predicting Estimated Speeds and Speed Change

Based on differences in accident statistics between males and females, age and kilometers driven (Parker et al., 1995), A series of cross-correlation and regression analyses were conducted. Following examination of the cross-correlations a first set of regression analyses used the demographic variables of age, gender (dummy variable of "maleness"), and kilometres driven as predictors of estimated speed before the workshop, estimated speed after the workshop and change in estimated speed, that is change in how fast participants estimated that they would drive down this road.

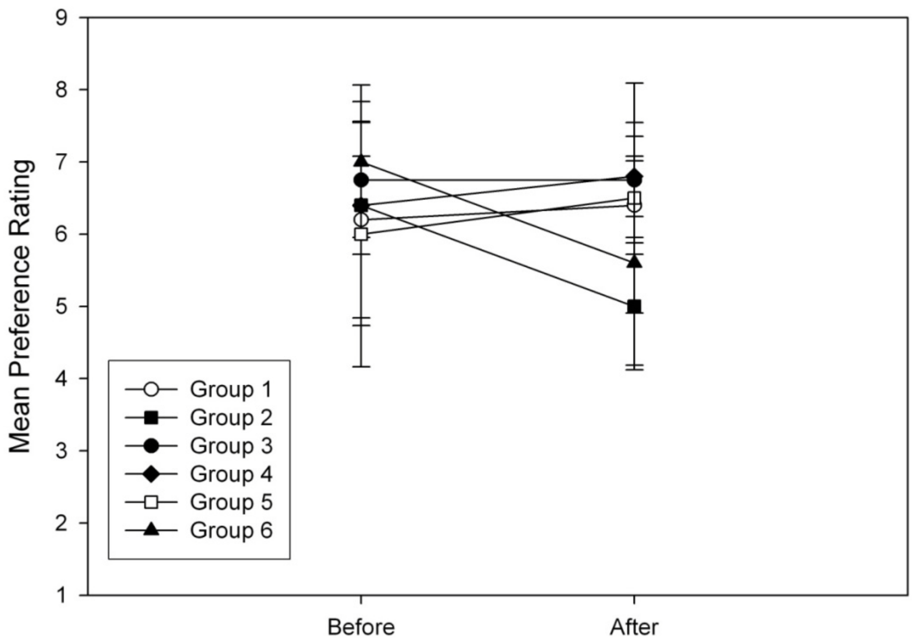


Figure 10: Ratings before and after the participatory design workshop of preference (95% CI).

The regression predicting estimated speed before the workshop was marginally significant, (p = .059) and revealed that gender explained 14.00% of the variance, R^2 = .14, *p < .06, df*(1, 24), F = 3.92, Constant, B = 60.63 SE B = 7.54, β = .36, Gender, B = -6.57 SE B = 3.32, β = .36. The regression predicting estimated speed after the workshop was not significant. The regression predicting change in estimated speed was significant and revealed that kilometres driven and gender explained 23.4% of the variance, R2 = .234, $p < .05$, $df(2, 23)$, F = 3.52.

Table 3

Demographic variables predicting change in estimated speeds (n =28).

	B	*SE B*	β
Step 1			
Constant	13.69	7.83	
Age	-.01	.015	-.01
Gender	-7.28	3.52	-.39
Kilometres driven	.00	.00	.36
Step 2			
Constant	13.39	3.75	
Gender	-7.27	3.43	-.39*
Kilometres driven	.00	.00	-.35

* $p < .05$

Regression analyses predicting speed change measures from other survey measures (i.e. DBQ and LTSA attitude survey measures) failed to account for significant amounts of variance. Questions from the LTSA attitudes towards road safety survey were also used as predictor variables, but failed to explain any of the variance for estimated speed before the workshop, estimated speed after the workshop, or speed change.

Associations Between Predictor, Demographic and DBQ Variables and Attitudes Ratings

In order to determine whether any of the predictor variables, demographic and DBQ measures were associated with any of the attitude survey results before or after the workshop, bivariate correlations were used. Bivariate correlations were also run with an attitude change variables (After – Before). Table 5 below indicates that aggressive violations correlated with 6 variables. Overall aggressive violations correlated negatively with factors to do with punishment and positively with those factors that indicated a relaxing of road rules, such as raising speed limits. Similarly, violations correlated negatively with measures relating to punishment and positively with those that relate to a relaxation of the rules or in this case breaking the rules (i.e. “the likelihood that you will drive 55km/h or higher in a 50km/h zone. Only two of the demographic variables were correlated with attitude change variables. The variable gender was negatively correlated with a change in “do you enjoy driving fast on the open road”, (R = -.407, $p < .05$) and "those who get caught speeding are unlucky (R = -.426, $p < .05$). For both of these variables, males had a greater change in their ratings, they were more likely to say they enjoyed driving fast on the open road after the workshop and more likely to agree with the statement that "people who get caught speeding are just unlucky" than females after the workshop.

Participatory Design Process Ratings

The workshop was rated by participants to find out how they felt about the process, the measures that they had designed, and whether they felt that the experience had changed their attitude towards speed. As Table 4 shows, ratings for the workshop were generally high. Rating scales were from 1 to 5, with 5 being the highest rating and 1 being the lowest. The exception was question one, 'was the introduction to the workshop clear' where 1 was the highest rating and 5 the lowest rating.

Table 4

Means and Standard deviations for workshop measures (n = 28).

	Mean	*SD*
Was the introduction to the workshop clear	1.36	0.62
Was the process easy to follow	4.46	0.84
Were you able to fully participate	4.32	1.06
Were you able to contribute	4.64	0.83
Were you happy with the measures you designed	4.50	.745
Has this workshop changed you attitude towards speed	3.22	1.31
How would you rate participatory design as a way to design speed reduction measures	4.13	0.90
Rate the effectiveness of participatory design as a way to teach people about speed	4.07	0.81
Has this workshop changed your estimate of the "before" scenario's safety	3.50	1.10

Gender and Group Differences

A Kruskal-Wallis analysis of variance comparing male and female scores revealed that there was a significant difference between males and females X^2 (1, N = 28) = 6.30, $p < .05$ for the question regarding whether participants felt that the workshop had changed their attitudes towards speed. Males had a lower rating (mean = 2.33, SD 1.12) than females (mean = 3.67, 1.19) indicating that males felt the workshop changed their attitude less than females. A second significant difference was found between males and females for the question regarding the introduction to the workshop X^2 (1, N = 28) = 4.21, p < .05. Males had a higher score (mean 1.67, SD = 0.71) than females (1.21, SD 0.54), indicating that females felt that the introduction to the workshop was clearer than did males.

A second Kruskal-Wallis analysis of variance was done to determine whether there were any group differences for any of the measures. A significant differences was found for the question, "has this workshop changed your attitude towards speed" X^2 (5, N = 28) = 11.13, p < .05. An LSD post hoc test revealed that group 4 was significantly different from groups 1, 3, 5 (p < .05) and 6 (p < .01).

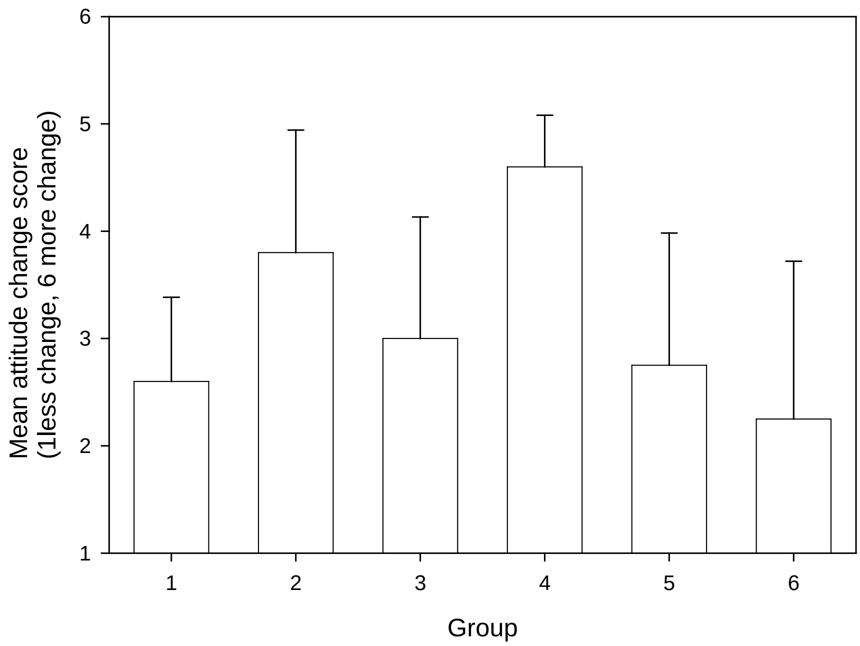


Figure 11: Mean attitude change ratings for each group.

Figure 11 above shows that group four had a higher rating that the other groups indicating that they felt that the participatory design workshop had more of an impact on their attitudes than the other groups.

Associations Between Participatory Process, Road and Attitude Ratings

Table 6 shows what significant correlations were found between participatory design workshop process ratings, road ratings and the attitudes towards speed survey.

Table 5

Correlations between demographics and DBQ measures and attitude survey results before and after the workshop (n = 28).

	Age	Gender	License	Experience	Kms driven	Violations	Aggressive violations	Errors
Enjoy	-	-	-	-	.48*	-	-	-
Risk	-	-	-	-		-.46*	-.46*	-
Risk (after)	-	-	-	-	-	-	-.40*	-
Penalties	-	.38*	-	-		-	-.38*	-
Enforcement	.38*	-	-	-		-	-	-
Enforcement (after)	-	-	-	-	-	-	-.41*	-
Speed limits	.60**	-	.50**	.52**		-	-	-
Speed limits (after)	.60**	-	.50**	.52**		-	-	-
100km/h limit	-	-	-	-	.50**	-	.53**	-
50km/h limit	-	-	-	-		-	-	-.39*
50km/h limit (after)	-	-	-	-		.48**	.50**	.67**
License loss for 3 tickets	.60**	-	.59**	.59**	-	-	-	-
Likelihood over 55km/h	-	-	-	-		.51**	-	-
Likelihood over 55km/h (after)	-	-	-	-	-	.54**	-	-

$^{**}p < .01$, $^{*}p < .05$

Table 6

Correlations for Participatory Design workshop measures (n = 28).

	Easy process	Fully participate	Everyone contributed	Happy with countermeasures	Attitude change	Speed reduction design
(after) How fast	-.50**					
Was the introduction clear	-.47*					
Fully participate	.49**					
Everyone contributed	.55**	.52*				
Enjoy driving fast		.42*				
(after) The road safety		.46*	.41*	.48*		
(after) The road aesthetics		.42*				
Was the introduction clear		-.41*				
happy with countermeasures		.68**				.54**
Teaching about speed		.45*	.54**	.61**	.66**	.62**
(After) Would you drive down this road			.39*			
(After) Speeding penalties not severe				-.48**		
(After) enforcement lowers speed limit				-.40*	.42*	
Speed reduction design				.59**	.49**	
Gender					.49**	
(After) Unlucky to get caught					-.41*	
(After) Automatic loss of license for 150km/h					.43*	
How fast						-.54**
Attitude change						.49**

**p* < .05, ***p* < .01

The correlations showed that there was a relationship between the variable measuring the amount they felt they were able to contribute to the process. The participants rated the participatory design workshop better as a teaching and design tool, felt happier with the countermeasures that they had designed and also rated the speed reduction countermeasures that they had rated higher for road safety and aesthetics.

Interestingly, how happy participants were with the countermeasures they designed correlated negatively with after ratings for “penalties for speeding are not very severe” (after) (R = -.48) and “enforcement helps lower the speed limit” (after) (R = -.40). These correlations show those participants who had higher ratings for the first question and lower ratings for the second questions (meaning that they disagreed with the statements) tended to have higher satisfaction ratings for the countermeasures that they had designed.

Three attitudinal variables correlated with whether participants felt that the workshop had changed their attitude. That enforcement helps to lower the speed limit (R = .42) and that automatic loss of license for 150km/h in a 100km/h zone is fair (R = .43) correlated positively with attitude change and negatively for participants who agreed with the statement that those who get caught speeding are unlucky (R = -.41). Gender correlated positively with the attitude change variable, indicating that females were more likely to say that the workshop had changed their attitudes. It therefore appears that those who felt it was fair to be punished for breaking the rules were more likely rate their reported attitude change higher than those that did not feel it was as fair to be punished for breaking the rules.

Summary

The purpose of the first experiment was to find out whether participatory design could be used to improve road designs and to see whether being involved in the process would have a positive effect on driver’s attitudes toward speed. The roads that were designed by participants were rated as more aesthetically pleasing and all roads had significant decreases in estimated speeds. Gender was a good predictor of change in estimated speed ratings and estimated speed choice before the workshop, but not after the workshop.

The redesigned roads had a mean estimated speed decrease of 5km/h, bringing estimated speeds down to slightly over 1km/h above the speed limit. Standard deviations in estimated speed also fell by around 4km/h. The decrease in speed variation may also help to improve overall road safety.

Aesthetics ratings also improved, indicating that participants felt that they had improved the overall look of the road and its surrounding environment. Road safety and preference rating remained unchanged before and after the workshop. However, the road was already highly rated in terms of both these variables, so it is unsurprising that differences in these ratings were absent. Overall, no differences were found between groups, apart from road preference ratings, where one group had lower preference ratings for the road that they had designed compared to the original road.

Gender predicted estimated speed before the workshop and estimated speed change. Males had higher estimated speed ratings and speed change ratings than females.

Unfortunately, the workshop had little impact on participants' attitudes towards speed, apart from two variables, the first being "do you enjoy driving fast on the open road and the second "those who get caught speeding are just unlucky", where males were more likely to agree with those statements than females after the workshop. However, the questionnaire did give insights into the interactions between attitude ratings and other variables.

Aggressive violations and violations correlated negatively with attitude variables related to punishment and positively with variables related to relaxing road rules. Age and experience correlated positively with variables related to punishment. The workshop was highly rated, with high workshop ratings correlating positively with road ratings. There was also some evidence that those who did not like enforcement, were happier with the designs that they created. Females and those who liked punishment for breaking the road rules were more likely to say that the workshop had an impact on their attitudes than those who did not like punishment for breaking road rules.

Most attitude ratings were not predicted by demographic or behavioural variables, but there was a tendency for attitudes towards variables associated with punishment and breaking road rules (e.g. driving over the speed limit), and increasing the speed limit to be positively correlated with violations and aggressive violations. Age and experience tended to be positively correlated with variables to do with punishment, but not negatively with variables to do with intentions to violate or relax road rules. However, these results should be interpreted with caution as the mean age of participants was 45 years.

The workshop was rated highly overall, however, the lowest rating was for the question regarding attitudes. This corresponds to the lack of change in attitudes found in the before and after questionnaire. There were 3 variables that correlated positively with reported attitude change, all of which were to do with favouring enforcement. Despite the lack of overall attitude change, other attitudes remained stable and those who rated the workshop highly as a way to design countermeasures were more likely to say that the workshop had an impact on their attitudes.

There were some issues with the experiment. The roads that were created by participants were self rated, meaning that participants may have been more likely to rate themselves better than those who did not participate in the workshop. It would have been interesting to find out whether these ratings would be different if the roads created by the participants were rated by others. Driver behaviour ratings were only rated before the workshop, so it was impossible to tell whether the workshop had any effect on driver behaviour. Attitudes were also only measured directly after the workshop. It may have been possible that some changes may have occurred some time after the workshop. Furthermore, the experiment only looked at one particular type of road, rather that various types. It would also have been of interest to determine whether the process could achieve similar results on different types of roads with different issues.

EXPERIMENT TWO

The goals of the first experiment were to first determine whether participatory design could be used to improve a road using drivers' knowledge. These improvements were measured by reducing a road's estimated speeds, safety, aesthetics and driveability before and after the workshop. Second find out whether taking part in a participatory design workshop would improve participants' attitudes towards speed. To do this, participants' attitudes towards speed were measured before and after the workshop by means of a survey.

The first goal was achieved, the main goal of reducing estimated speeds was achieved by participants, all groups were able to significantly reduce estimated speeds with their redesigned roads and they were also to significantly improve road aesthetics. Participants' attitudes were found to change slightly, but these changes were only found for a few attitude variables and may have only been temporary. However, the workshop was able to shed light on associations between participants' attitudes, their demographic and driver behaviour data.

Despite these positive findings, there were some potential problems with the experimental design. First of all, the changes made to the road by the teams were self-rated. These ratings were therefore subjective and possibly biased as a result, especially since the participants had invested their own time and effort into creating the redesigned roads. Second, attitudes towards speed were only rated directly after the workshop; some attitudes may not have changed in such a short period. Third, the DBQ was only administered before the workshop; therefore it was not known whether the workshop had any positive impacts on driver behaviour. Fourth, teams were only asked to redesign one road and therefore only touched the surface of the participatory design process. Therefore this may not have given an accurate representation of the ability of participatory design process to improve road design. Finally, based on the kitchen study which found that participants changed their habits when buying kitchen appliances (Pehkonen et al., 2008), it was likely that participants may have perceived other roads differently after the workshop and this was not measured.

The goals of the second experiment were similar to the first that is, to see whether participatory design could be used to successfully redesign and improve a road, as well as improve attitudes toward speed. However the additional issues mentioned above were addressed with this experiment. The efficacy of participatory design in improving roads was further tested by adding two extra roads to be redesigned by participants. Attitudes were tested in the longer term with the addition of a one month follow up survey. Driver behaviour was also measured one month after the workshop to determine whether the participatory design process had any influence on this. Finally, as participants were involved in road redesign, it was also of interest to determine whether their perception of other roads was changed as a result of this activity. This was measured by getting participants to rate a set of four control roads before and one month after the workshop.

Methods

Participants

Prior to beginning the research ethical approval was obtained from the Psychology Department Human Research Ethics Committee at the University of Waikato. Thirty-two participants, recruited via various community organisations, took part in the workshops. Participants were not paid for their participation, but the community organisations from which they were recruited from received $10 per participant. Sixteen of the participants were male and sixteen of the participants were female. Their ages ranged from 18 to 69 (mean 47.30, SD 14.67). Participants drove between 3,000 and 42,500 kilometres per year with an average of 15,269.87 kilometres (SD 10,142.01 km) and had between 3 and 51 years of driving experience with an average of 29.27 years (SD 12.97 years). They reported an average of 0.20 infringements and 0.13 crashes in the past year.

Materials

Questionnaire

As with the first experiment, the questionnaires collected ratings regarding demographics, attitudes, and driver behaviour. However, the questionnaires had several alterations made and the times in which it was administered were changed (see Appendix B for the questionnaires). First, rather than one questionnaire, there were three questionnaires in total, which were administered at different times. The diagram below (Figure 12) illustrates the questionnaires that participants were given and at which times.

The Screening questionnaire was sent out to participants prior to the workshop. It had three sections and the first asked questions regarding demographics, the second about driver behaviour (using the DBQ), and the third asked questions about attitudes towards speed.

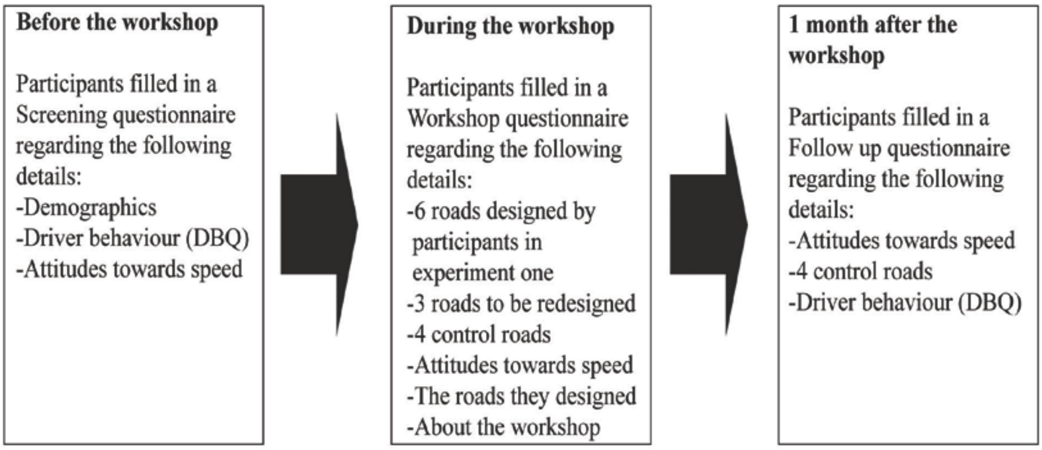


Figure 12: Questionnaires given to participants.

The Workshop questionnaire was administered after a workshop was completed and had four sections. The first asked participants to rate the 6 roads designed by participants in experiment one, the 3 roads to be redesigned in the workshop (experimental roads), and a set of 4 control roads. The second section asked about their attitudes towards speed, the third asked them to rat the roads that they had designed and the final one asked them to rate the participatory design workshop. The Follow up questionnaire was administered approximately one month aft the workshop and had three sections. The first asked participants about their attitudes towards speed, the second to rate four control roads, and the final asked them about their driving behaviour.

The three roads chosen for redesign were chosen because each of them had different issues (Figure 13). The first road, Newell Road, shown below in is in a rural area and had a speed limit of 80km/h, being in a rural area with adjoining roads having speed limits of 100km/h meant that keeping drivers at 80km/h was problematic. Furthermore, there were an increasing number of people moving into the area increasing the dangers of pedestrians being hit by vehicles travelling at high speeds. The second road, River Road, had both speed and accident issues. The photo below shows that the road is both wide and straight, leading to high operating speeds. The final road, Church Road, was chosen as it was close to a new shopping centre development, meaning that more and more people were using the road as a through road.

Figure 13: Experimental roads for experiment two.

The four control roads, shown below in Figure 14, were chosen as each of them were 50km/h roads with quite different appearances, especially in terms of their estimated operating speeds. Furthermore, these roads were non-local, so participants would be unlikely to have any preconceptions of the speed limits on these roads.

Spring Street
Moffat Road
Cameron Road
Central Road

Figure 14: Control Roads rated by participants before and one month after the workshop.

The questionnaire and the roads were presented to participants in the form of large photographs (digitally enhanced for the redesigned roads), as shown in Figure 15.

Several changes were made to the attitude rating questions in all three of the questionnaires. Several questions were added and some were removed. Furthermore, the speeding subsection of the Driver Attitude Questionnaire (DAQ) (Parker and Stradling, 1996) was also added. The DAQ is a 40-item measure of attitudes towards various aspects of driving including drinking and driving, close following, overtaking, and speeding. The changes are outlined in Table 7.

The DBQ (Reason et al., 1990) was used to rate self-reported driver behaviour as in the previous study, but was administered twice, once before the workshop and again one month after the workshop.

Figure 15: Tramway Road as redesigned by groups from the first experiment one.

Presentation

The 15 minute “participatory road design presentation” containing information on various road safety statistics, speed reduction and safety measures that was used in experiment one was given to participants at the beginning of the workshop (Appendix A). However, a description of the each of the three roads that participants would be redesigning was also given prior to the redesigning of each of the roads to familiarise the participants with what they would be attempting to do was added to the presentation. Information included road width, traffic flow and the safety and speed issues that the road had (see Appendix B for the additional slides used in this experiment).

Toolkit

Participants used the same toolkit used in experiment one to construct their designs.

Table 7

Changes made to the attitude rating section of all three questionnaires.

Additional Questions:
Demerit points only for 70km/h in a 50km/h zone
Fine only for 70km/h in a 50km/h zone
Demerit points and a fine for 70km/h in a 50km/h zone
Demerit points only for 120km/h in a 100km/h zone
Fine only for 120km/h in a 100km/h zone
Demerit points and a fine for 120km/h in a 100km/h zone
Removed Questions:
Speed limits on the roads I normally use are:
Should the 100km/h limit be raised, lowered or left as is?
Should the 50km/h limit be raised lowered or left as is?
DAQ Items:
I would be happier if speed limits were more strictly enforced
People stopped for speeding are unlucky because lots of people do it.
Stricter enforcement of speed limits on 50km/h roads would be effective in reducing the occurrence of accidents.
It's okay to drive faster than the speed limit as long as you drive carefully.
Speed limits are often set too low, with the result that many drivers ignore them.
Speeding is one of the main causes of road accidents.
I know exactly how fast I can drive and still drive safely.
I would favour stricter enforcement of the speed limit on 50km/h roads.
Sometimes you have to drive in excess of the speed limit in order to keep up with the traffic flow.

Procedure

Participants were recruited through contacting representatives of various community organisations in the Hamilton and Bay of Plenty areas. Contact with these representatives was made via telephone, e-mail, and personal contact. If the representatives responded to initial requests, further details of the experiment were given for them to distribute to other members of the organisation. Representatives of the organisations took personal details of interested parties and personal contact by the researcher was made with them to arrange a time for them to take part in a workshop. As participants would be redesigning more than one road, the Screening questionnaire was sent out to participants to allow them to fill it in at home, thereby allowing more time for the design process during the workshop.

For this experiment a total of seven workshops with between 3 and 6 participants were held. Again the workshops were timed to correspond with times that participants had available during the week. At the time of the workshops, participants were given a consent form and were told that participation in the research was voluntary and that they were allowed to leave at any stage of the experiment. Participants were also told that any information collected during the procedure was confidential and that no names or any other personally identifying information would be used in the experiment.

The researcher then outlined the workshop procedure and participants were asked to rate the roads described in the materials section; first the 6 roads designed by previous groups (Figure 15) were rated, second were the 4 control roads (Figure 14), and finally the 3 roads (Figure 13) that they would be redesigning. Once participants completed rating the roads, the researcher gave a 10~15 minute presentation on road safety statistics, road safety measures and a description of the road that they would be working on. Following the description of the road, the researcher described the toolkit and speed reduction measures booklet. Participants were then instructed to begin their design process. Since three roads were redesigned in this experiment, the researcher described each road prior to each individual design process for that road, rather than describing all three roads at once. The design process was left up to the participants; however the researcher was present to answer any questions that the participants had about the any aspect of the workshop, tools or the design process. The researcher also ensured that participants balanced their time equally between roads by imposing limits on the amount of time they had available to redesign each road.

Once the designs were completed, the participants were asked to fill in the second half of the Workshop questionnaire, which included road, attitude and workshop ratings. During this time the researcher took photographs of the designs that the participants came up with. Questionnaires were also collected at this time. Approximately one month after the workshop, the Follow up questionnaire was send out and collected to determine whether there were any changes in attitude towards speed, driving behaviour and the way that participants perceived roads after the workshop.

Results

Results Layout

- Results are laid out and analysed in the following order:
- Ratings for the roads created by participants in group one
- Ratings for the 3 experimental roads before and after the workshop and 3 control road ratings before and one month after the workshop
- Attitude ratings before, after and one month after the workshop
- Driver Behaviour ratings before and one month after the workshop
- Participatory design workshop ratings
- Variables predicting estimated speed and speed change ratings
- Attitudinal variables correlating with estimated speed and speed change ratings

Ratings for Previously Designed Roads

As was mentioned in methods section, there was some concern that the self-rating of roads designed by participants in experiment one may have been inaccurate due biased ratings caused by participants having created the roads themselves. Due to this issue, participants in experiment two were asked to rate the roads that were redesigned by the groups in experiment one.

Participants rated the 6 designs that were created by the 6 groups who took part in experiment one. Variables used were speed, road safety, road aesthetics, and preference. First, a one-way ANOVA was conducted to determine whether any overall differences existed between design (groups from experiment one) and non-design groups (groups from experiment 2). This analysis found that Road safety, aesthetics and preference ratings were all different between design and non design groups. $F(1, 206) = 7.05$, $p < .01$, $F(1, 206) = 16.25$, $p < .001$, and $F(1, 206) = 20.23$, $p < .001$, respectively.

To determine whether this overall finding related to all of the redesigned roads repeated measures ANOVAs with post hoc testing were done to determine whether any differences existed between the roads that were designed by the previous group. The variables used for this were estimated speed, road safety, road aesthetics, and preference. speed was significantly different between roads, *df*(3.28, 68.96), *F*(290.24, 63.41) = 4.58, $p < .01$, as was road safety was significantly different between roads, *df*(6, 126), *F*(4.91, .87) = 4.05, $p < .001$, as was road aesthetics, *df*(6, 126), *F*(3.02, .64) = 4.50 , $p < .001$, and preference *df*(6, 126), *F*(5.09, .58) = 5.93, $p < .001$ and speed *df*(3.28, 68.96), *F*(290.24, 63.41) = 4.58, $p < .01$.

Ratings for Roads 1A – 1F, First Experiment's Participant's Ratings Versus Second Experiment's Participants' Ratings

To determine for which roads subjects' ratings of their own design (the design group) were different to others subjects' ratings of the same design (in this case participants in experiment two, or the non design group), independent Kruskal-Wallis tests were run for the variables; road safety, road aesthetics, preference and speed for roads 1A through to 1F. Kruskal-Wallis tests were chosen as a alternative to ANOVA tests due to small sample sizes for design groups in experiment one, which ranged from 4-6 participants per group.

Road 1A's road safety and preference ratings were significantly different (Figure 16), H(1) = 4.02, $p < .05$ and H(1) = 4.96, $p < .05$. In both cases, the design group rated the roads higher (mean = 4.57, SD = .39 versus mean = 3.80, SD = 1.03 and mean = 4.57, SD = .39 versus mean = 3.90, SD = .88) than the non-design group. Other ratings were not significantly different.

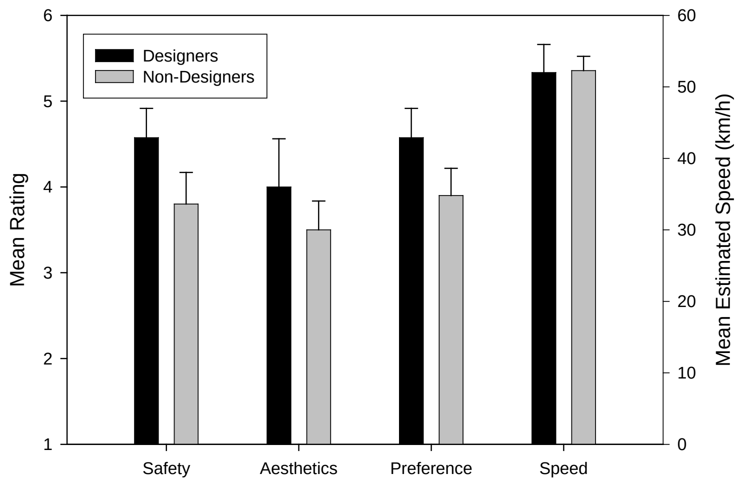


Figure 16: Designers versus non-designers safety, aesthetics, preference and speed ratings for Road 1A (95% CI).

None of the variables for road 1B had any significant differences between design and non-design groups (Figure 17).

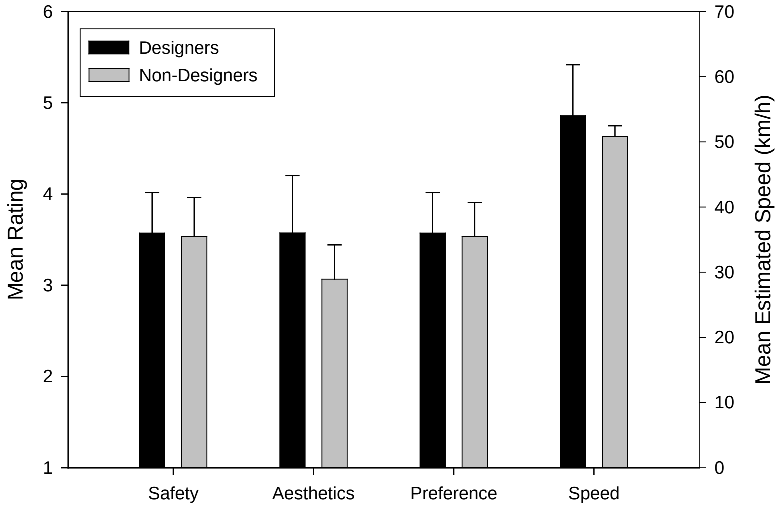


Figure 17: Designers versus non designers safety, aesthetics, preference and speed ratings for Road 1B (95% CI).

There were significant differences for road safety, and preference between groups for road 1C (Figure 18). H(1) = 9.28, $p < .01$ and H(1) = 7.56, $p < .01$, respectively. Mean ratings for both road safety and preference were both higher for the design group than the non-design group (mean = 4.82, SD .36 versus mean = 3.03, SD .96 and mean = 4.82, SD .36 versus 3.27, SD 1.11).

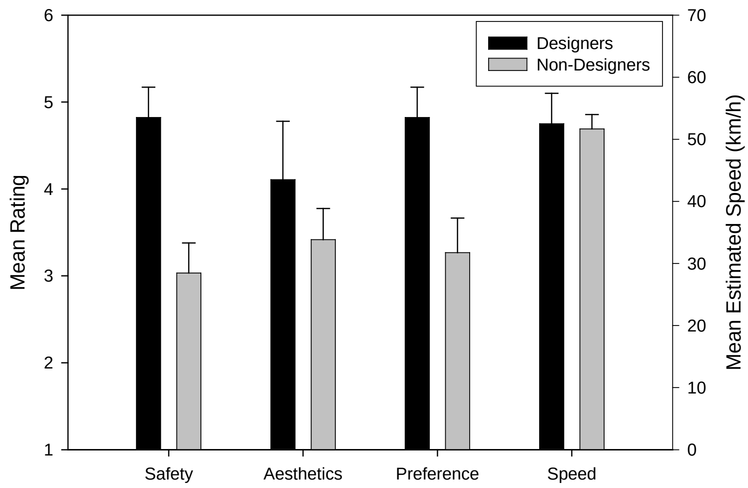


Figure 18: Designers versus non designers safety, aesthetics, preference and speed ratings for Road 1C (95% CI).

Road 1D (Figure 19) yielded significant differences between the design and non-design groups for the variables road safety, aesthetics and preference, H(1) = 11.08, $p < .01$, H(1) = 7.20, $p < .01$ and H(1) = 12.02, $p < .01$. For all three variables, the design group rated the roads higher than non-design group, (mean = 4.86, SD .32, mean = 4.00, SD 1.20, and 4.86, SD .32 versus mean = 2.77, SD 1.14, mean = 2.53, SD .90, and mean = 2.58, SD 1.10).

Figure 19: Designers versus non designers safety, aesthetics, preference and speed ratings for Road 1D (95% CI).

Road 1E (Figure 20) was significantly different between the design group and the non-design group for the variable, road safety, H(1) = 5.07, $p < .05$. The design group rated the road as less safe than the non-design group (mean = 4.64, SD .71 versus mean = 3.45, SD .93).

None of the variables for road 1F had any significant differences between design and non-design groups (Figure 21).

Road 1G was not created by either group, but was rated by both groups, so makes for a useful comparison (Figure 22). A one way independent ANOVA was done to determine whether any differences existed between groups one and two for the same variables as in the above tests.

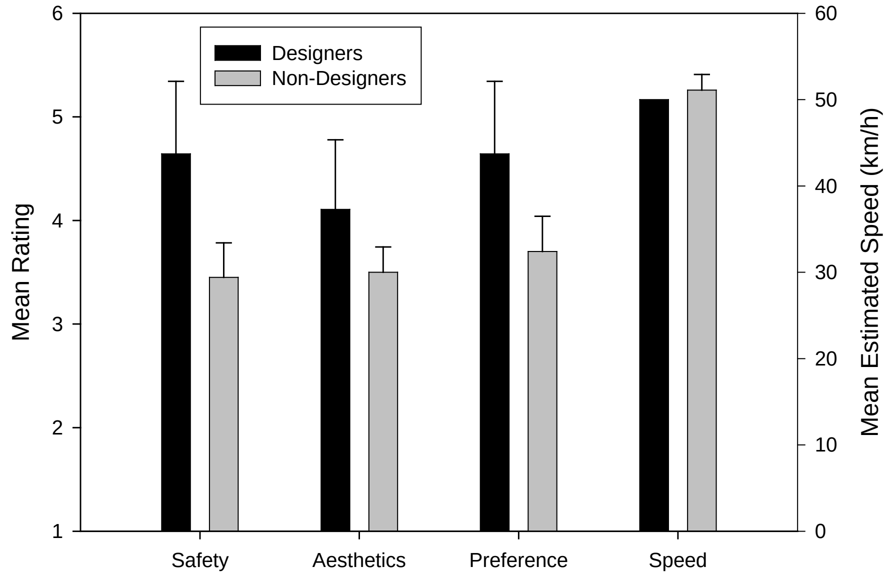


Figure 20: Designers versus non designers safety, aesthetics, preference and speed ratings for Road 1E (95% CI).

Figure 21: Designers versus non designers safety, aesthetics, preference and speed ratings for Road 1F (95% CI).

Significant differences were found for road safety and preference. $F(1, 48) = 22.78$, $p < .001$ and $F(1, 48) = 25.22$, $p < .001$. Mean ratings were higher for the design group than for the non-design group, mean = 4.62, SD .63 and mean = 4.62, SD .63 versus mean 3.77, SD .61 and 3.57, SD .85.

Figure 22: Designers versus non-designers safety, aesthetics, preference and speed ratings for Road 1G (95% CI).

Differences in Road Ratings for Non-Designers

Given the differences found in ratings between designers and non-designers, it was also of interest to find out whether there were differences between the non-designers' ratings of roads 1A through to 1G. To do this, repeated measures ANOVAs were done for all roads that were rated by non-designers for the variables, estimated speed, road safety, aesthetics, and preference. Differences between roads were found for all four ratings.

Estimated speed ratings were found to be significantly different between roads, $F(3.28, 68.96) = 4.58$, $p < .01$ (Greenhouse-Geisser adjusted). Figure 23 above shows that road 1G, the road not redesigned by participants in experiment one had the highest mean estimated speed. Post hoc tests revealed that road 1G had a mean estimated speed rating of 56.82km/h, which was significantly higher than estimated speeds for roads 1A to 1E, $p < .05$, $p < .05$, $p < .01$, $p < .01$, $p < .01$ respectively. Mean estimated speeds for roads 1B (54.34km/h), 1D (48.18km/h), and 1E (51.73km/h) were significantly lower than mean estimated speeds for road 1F (54.34km/h), $p < .05$, $p < .05$, and $p < .01$ respectively.

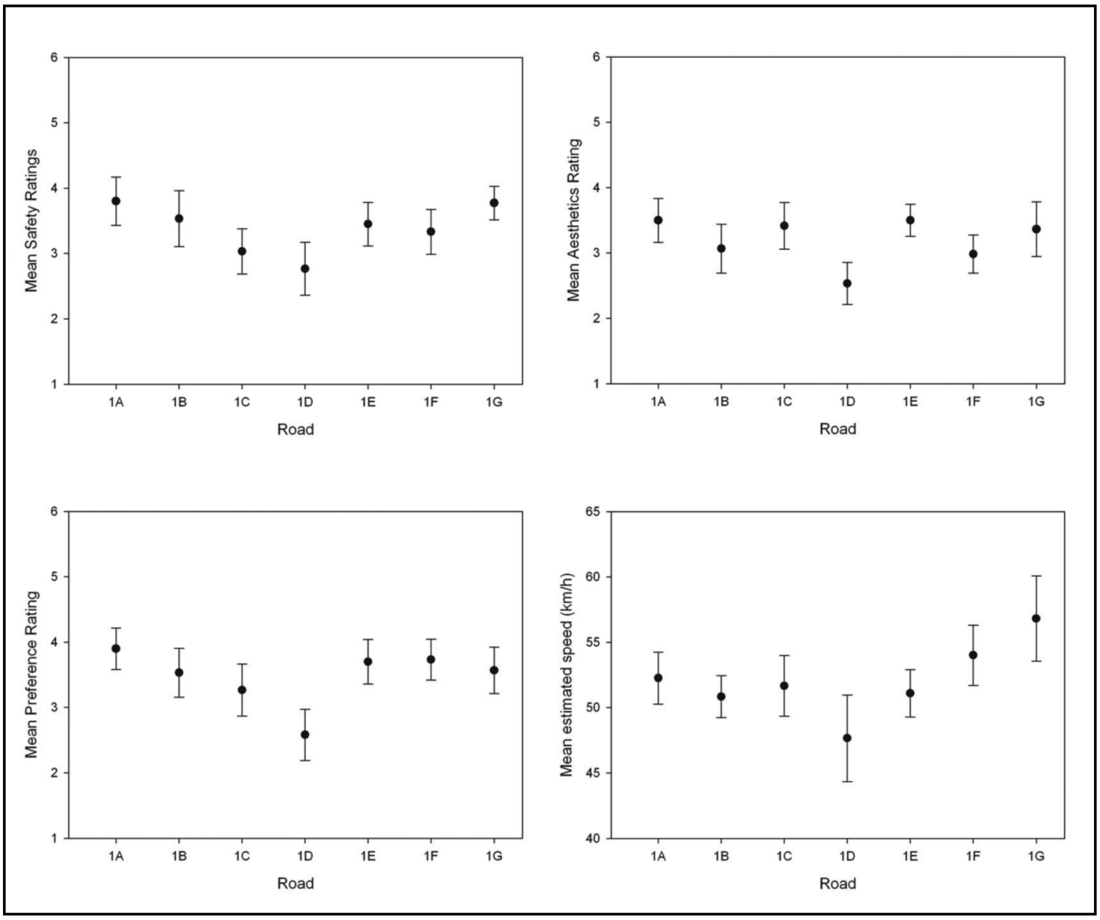


Figure 23: Safety, Aesthetics, preference and estimated speed ratings for non-designers (95% CI).

Safety was also found to be significant between roads $F(6, 126) = 5.64$, $p < .001$. Post hoc tests revealed that roads 1C and 1D with mean safety ratings of 2.96 and 2.77 were rated as significantly less safe than road 1G, which had a mean safety rating of 3.77. Road 1A with a mean rating of 4.14 was rated the safest road and was significantly safer than roads 1C, 1D, 1E (3.48), 1F (3.55) and 1G, $p < .001$, $p < .001$, $p < .05$, $p < .05$, and $p < .05$ respectively. Road 1D was the rated the least safe and was significantly less safe than roads 1A, 1B, 1E, 1F and 1G, $p < .001$, $p < .05$, $p < .05$, $p < .05$, and $p < .01$ respectively. Road 1C was rated as significantly less safe than road 1A, 1B, 1E, 1F, and 1G, $p < .001$, $p < .05$, $p < .05$, $p < .05$, and $p < .01$ respectively.

Aesthetics ratings were also significantly different between roads $F(6, 126) = 4.73$, $p < .001$. Road 1G (3.36) was rated as significantly better aesthetically than road 1D (2.55). As with safety, road 1A was rated the best in terms of aesthetics with a mean rating of 3.59. It was rated significantly higher than roads 1B (2.96), 1D, and 1F (3.02), *p* < .05, *p* < .001, and *p* < .05 respectively. Road 1D was the lowest rated road aesthetically. It was rated significantly lower than road 1A, 1C (3.39), 1E (3.50), and 1G, *p* < .001, *p* > .01, p > .001, and *p* > .01 respectively.

Preference ratings were found to be significantly different between roads, *F*(6, 126) = 6.82. Road 1G (3.57) was road as less preferable than road 1A, which had a mean rating of 4.05, *p* < .05, but more preferable than road 1D, which had a mean rating of 2.61, *p* .01. Road 1A was the most preferred road with a mean rating of 4.05. It was significantly more preferred than road 1C (3.23), 1D and 1G. Road 1D was the least preferred road, it was rated significantly lower than roads 1A, 1B (3.73), 1C, 1E (3.72), 1F (3.86) and 1G, *p* < .001, *p* < .001, *p* < .05, *p* < .01, *p* < .01, and *p* < .01 respectively. Both roads 1E and 1F were rated significantly higher than roads 1C and 1D, *p* < .05 and *p* < .01 respectively.

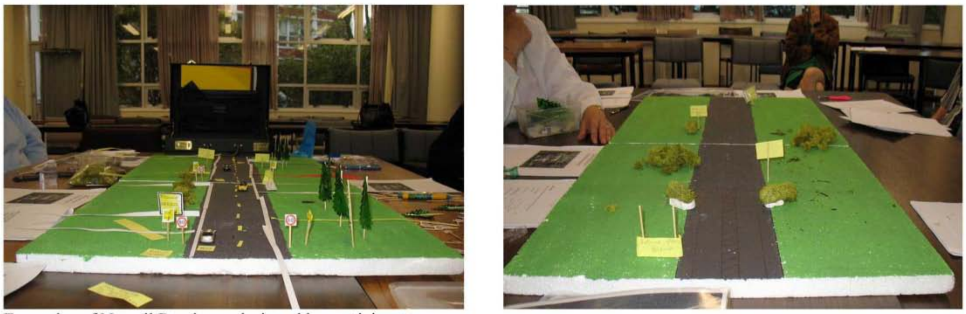
Changes in Road Ratings for Experimental Roads (Newell Road, River Road, and Church Road)

In this experiment, the efficacy of participatory design was investigated further by adding additional roads with differing issues for participants to redesign. Examples of participants' designs are shown below (Figure 24).

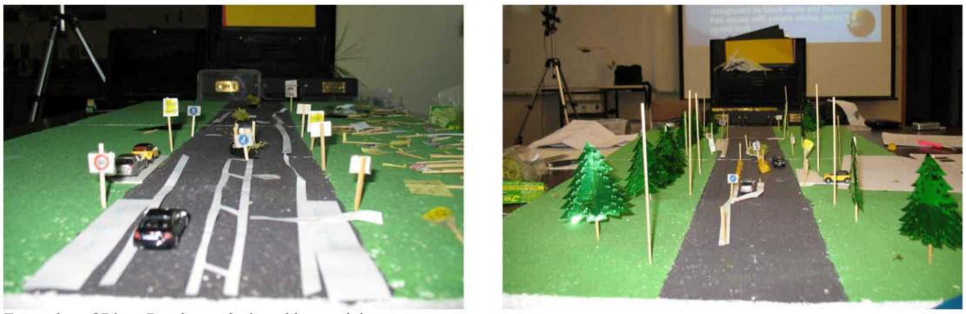
Estimated Speed Ratings

Estimated speed ratings fell significantly for all three experimental roads after the workshop (Figure 25). Mean speeds for Newell Road fell significantly from 79.67km/h to 75.48km/h, standard deviation also fell from 11.67km/h to 8.19km/h. Mean speeds for River Road fell significantly from 66.92km/h to 54.08km/h. The Standard deviation also fell from 17.90km/h to 4.93km/h. Mean speeds for Church Road fell significantly from an average of 53.93km/h to 50.02km/h. Standard deviation also fell from 6.67km/h to 2.35km/h. *F*(1, 29) = 4.36 p < .05, *F*(1, 28) = 11.47 *p* < .01, and *F*(1, 29) = 10.71 *p* < .01 respectively.

Prior to the workshop speed ratings varied between roads. Newell Road had a different speed limit than River Road through to Church Road (80km/h versus 50km/h), so although speed ratings were significantly different for this road, they are not reported. River Road had significantly higher estimated speed ratings than Church Road, *p* < .001, with a mean speed of 66.91km/h versus 53.93km/h.



Examples of Newell Road as redesigned by participants



Examples of River Road as redesigned by participants

Examples of Church Road as redesigned by participants

Figure 24: Examples of participants' designs for Newell, Church, and River Roads.

Safety, Aesthetics, Preference and Liveability Ratings

Aside from speed ratings, participants were also able to improve other ratings for the roads and the graph below (Figure 26) shows that they were able to improve safety, aesthetics, and preference ratings for Newell Road and Church Road and ratings for River Road, which were already high, remained stable. The graph also shows that liveability ratings for all three roads were somewhat mixed more mixed but remained stable overall. The graph also shows that ratings did not go far above 4 out of a possible 5 and that for safety, aesthetics, and preference ratings differences between roads were substantially reduced.

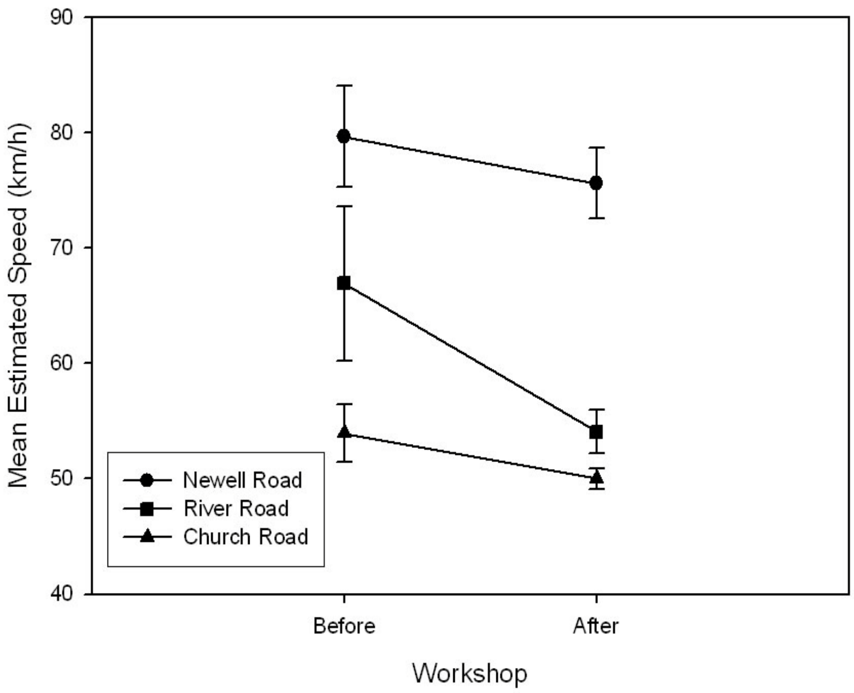


Figure 25: Mean Estimated speed ratings for roads Newell Road, River Road, and Church Road before and after the workshop (95% CI).

Safety.

Univariate statistics for Newell Road found that road safety ratings increased from a mean rating of 3.15 (SD 1.01) to 4.27 (SD .69). Safety ratings for Church Road increased significantly, from 3.23 (SD 1.07) to 3.98 (SD .68).). Ratings for River Road did not change significantly as it already had a high safety rating (4.00) prior to the workshop. ($F(1, 29) = 24.75$ p < .001 and $F(1, 29) = 11.82$, $p < .01$, respectively).

Post hoc testing revealed that before the workshop River Road was rated significantly safer than roads Newell Road, $p < .01$ and Church Road $p < .001$ with a mean safety rating of 4.00 compared to Newell Road at 3.15 and Church Road at 3.23. After the workshop, roads were not found to be significantly different in terms of safety.

Aesthetics.

Univariate statistics revealed that aesthetics ratings for Newell Road increased from a mean of 3.32 (SD .95) to 4.08 (SD .70). While River Road remained unchanged, ratings for Church Road increase from 2.93 (SD .94) to 3.70 (SD .88). $F(1, 29) = 13.69$, $p < .01$ and $F(1, 29) = 11.27$, $p < .01$, respectively.

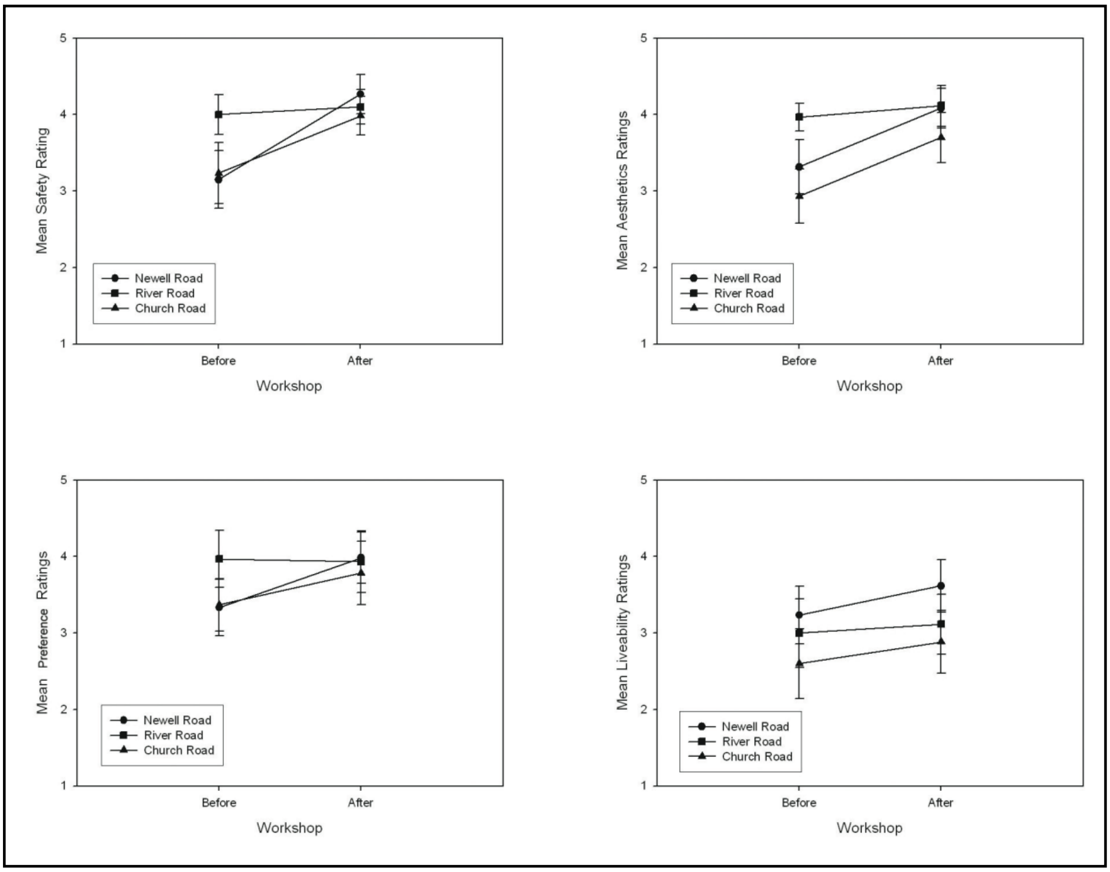


Figure 26: Safety, aesthetics, preference and liveability ratings before and after the workshop (95% CI).

Before the workshop River Road had higher aesthetics ratings than Newell Road, $p < .01$ or Church Road, $p < .001$, with a mean rating of 3.97 (SD .49) versus Newell Road at 3.32 (SD .95) and Church Road at 2.93 (SD .88). After the workshop Church Road was rated significantly lower than roads Newell Road and River Road, $p < .05$. Church Road was rated 3.70 (SD .88) compared to Newell Road 4.09 (SD .68) and River Road 4.12 (SD .72).

Preference.

Univariate statistics for preference improved for Newell Road from a mean of 3.33 (SD .99) to 3.98 (SD 0.84), $F(1, 29) = 9.53$, $p < .01$. Preference ratings for River Road and Church Road did not change significantly. Before the workshop, River Road was rated as significantly more driveable than Newell Road, $p < .01$ and Church Road, $p < .05$, with a mean rating of 3.97 (SD 1.00) compared to 3.33 (SD .99) for Newell Road and 3.37 (SD .93) for Church Road. After the workshop the roads did not have significantly different preference ratings.

Liveability.

Liveability ratings did not change significantly before and after the workshop. However, liveability ratings did differ between roads, and post hoc testing revealed that before the workshop Church Road was rated as significantly less liveable than Newell Road, $p < .05$. Newell Road was given a mean rating of 3.23 (SD 1.01) compared to 2.6 (SD 1.22) for Church Road. After the workshop, Newell Road, mean 3.62 (SD .93) was rated as significantly more liveable than both River Road, mean 3.11 (SD 1.05), $p < .05$, and Church Road, mean 2.88 (SD 1.10), $p < .01$.

Between Group Differences in Road Ratings

In order to determine whether any differences existed between groups for changes in estimated speed, safety, aesthetics, preference or liveability, a series of Kruskal-Wallis independent ANOVA tests were conducted. Estimated speeds for River Road were found to be significantly different (Figure 27) between groups (X^2 (6, N = 30) = 18.91, $p < .01$. An LSD post hoc test revealed that group 7 had a significantly different speed change rating than groups 1, 3, 5, 6 ($p < .001$) and 2 and 4 ($p < .01$).

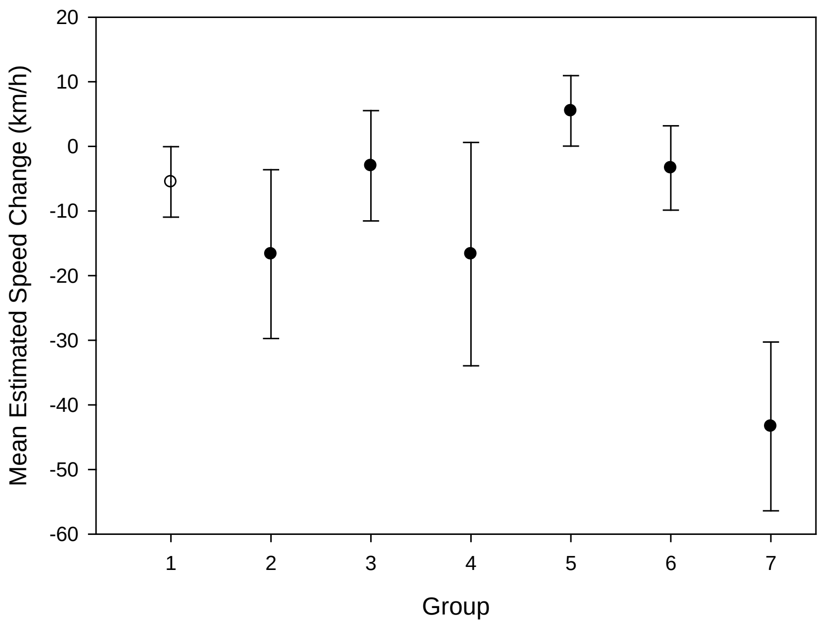


Figure 27: Mean estimated speed change for groups 1 to 7 (95% CI).

Safety, aesthetic, preference and liveability change ratings were not significantly different between groups. Given that group 7 had no prior knowledge of the speed limit on River Road, as they did not live in the area where the experiment was held, it was of interest to see whether any differences in groups remained if group 7 was excluded from the analysis. When the Kruskal-Wallis test was repeated excluding group 7, there was no longer a significant effect for group (X^2 (5, N = 24) = 10.91, p = .07. To ensure that the overall reduction in estimated speed ratings for River Road was still significant even with group 7 excluded from the analysis, a repeated measures ANOVA found that differences in speed remained significant for River Road, $F(1, 23) = 5.12$, $p < .05$. Mean estimated speed fell from 60.32 km/h (SD 11.14km/h to 54.89 km/h (SD 5.03km/h) as shown below in Figure 28.

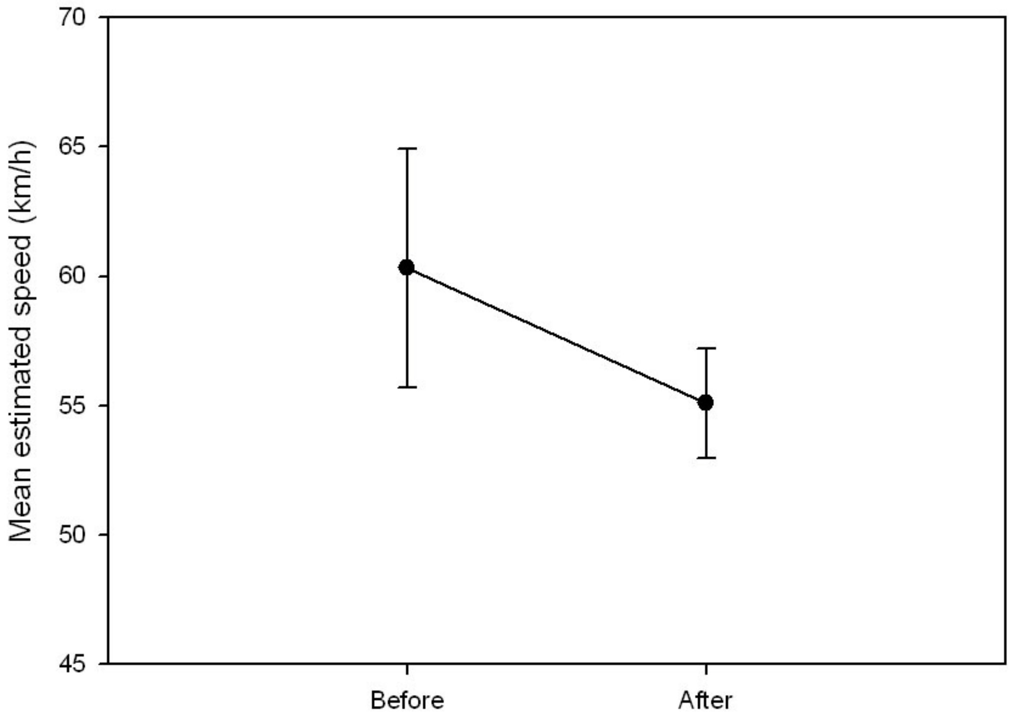


Figure 28: Mean estimated speed ratings before and after the workshop for River Road when group 7 was excluded (95% CI).

Changes in Road Ratings for Control Roads (Spring Street, Moffat Road, Cameron Road and Central Road)

Another goal of this experiment was to determine whether taking part in a participatory design workshop would have some impact on participants' perceptions of other roads, especially in terms of estimate speeds. The results are shown below.

A 2 X 4 repeated measures MANOVA was done to find out whether any significant changes occurred in the participants' ratings for the unmodified control roads (Road Type) before the workshop and one month after the workshop (Workshop). Dependent variables used were road safety, road aesthetics, preference, liveability and speed. Due to a lack of degrees of freedom, the dependent variables were analysed using separate repeated measures MANOVAs.

The MANOVA for speed found significant effects for Road Type and marginally significant effects of Workshop and Road Type and Workshop interaction on ratings of estimated speed. Wilks' Lambda = .17, $F(3, 19) = 30.72$, $p < .001$, Wilks' Lambda = .86 $F(1, 21) = 3.44$, $p = .08$ and Wilks' Lambda = .69, $F(3, 19) = 2.84$, $p = .07$, respectively.

The MANOVAs for road safety, aesthetics, preference and liveability were all significant between roads (Wilks' Lambda = .153 $F(3, 20) = 36.83$, $p < .001$, Wilks' Lambda = .30, $F(3, 20) = 15.85$, $p < .001$, Wilks' Lambda = .26, $F(3, 20) = 19.43$, $p < .001$, and Wilks' Lambda = .23, $F(3, 20) = 21.82$, $p < .001$, respectively). However, there were no significant Workshop or Road Type and Workshop interaction effects found for the above variables.

With marginal significance for speed change, backwards stepwise multiple regression analyses with an entry criteria of .05 and a removal criteria of .10 were used to determine what variables predicted speed and speed change for the four roads to determine if any demographic variables could be added as co-varying variables to increase the strength of the MANOVA. It was found that age and kilometres driven explained 46% of the variance for estimated speed change on Cameron Road. Age correlated positively with speed change and kilometres driven correlated negatively with speed change.

Demographic Variables Predicting Speed Change

Based on statistics indicating that younger drivers are consistently over-represented in accident statistics (Gregersen, 1996; Lam, 2003; Reeder et al., 1998) A MANCOVA with the co-varying factor of age was done to determine whether age affected speed ratings.

Table 8

Demographic variables predicting speed change for Cameron Road (n = 32).

	B	SE B	β
Step 1			
Constant	-10.87	7.44	
Age	0.40	0.13	.59**
Gender	-5.83	4.35	-.30
Kilometres	0.00	0.00	-.64*
Step 2			
Constant	-15.50	6.77	
Age	0.38	0.14	.56*
Kilometres	0.00	0.00	-.48*

R^2 For Steps 1 – 2 = .53, .46 respectively. * $p < .05$, ** $p < .01$, *** $p < .001$

Compared to the pervious MANOVA, which was only marginally significant for the effects of workshop and workshop and road interaction on estimated speed ratings, the MANCOVA was significant for workshop, the interaction between workshop and age, differences between roads, the interaction between roads and age, and the interaction between roads and workshop, (Wilks' Lambda = .75, $F(1, 20) = 6.63$, $p < .05$, Wilks' Lambda = .82 $F(1, 20) = 4.43$, $p < .05$, Wilks' Lambda = .44, $F(3, 18) = 7.58$, $p < .01$, Wilks' Lambda = .53, $F(3, 18) = 5.27$, $p < .01$, Wilks' Lambda = .57, $F(3, 18) = 4.48$, $p < .05$, respectively).

Univariate testing found that estimated speeds fell significantly for Moffat Road, $F(1, 20) = 5.08$, $p < .05$. Prior to the experiment participants rated Moffat Road at a mean estimated speed of 61.36km/h with a standard deviation of 9.41km/h, one month after the workshop they rated the same road at 56.14km/h with a standard deviation of 8.72km/h.

Estimated Speed also fell significantly for Cameron Road. Prior to the workshop this road was rated at a mean of 67.27km/h (SD 10.77). After the workshop it was rated at 63.86km/h (SD 11.23km/h). $F(1, 21) = 6.68$, $p < .05$.

For Cameron Road it was significant $F(1, 21) = 4.51$, $p < .05$. Age correlated positively with speed change. R = .42. Younger people reduced their estimated speed more than older people. For Moffat Road the before and after and age interaction was not significant.

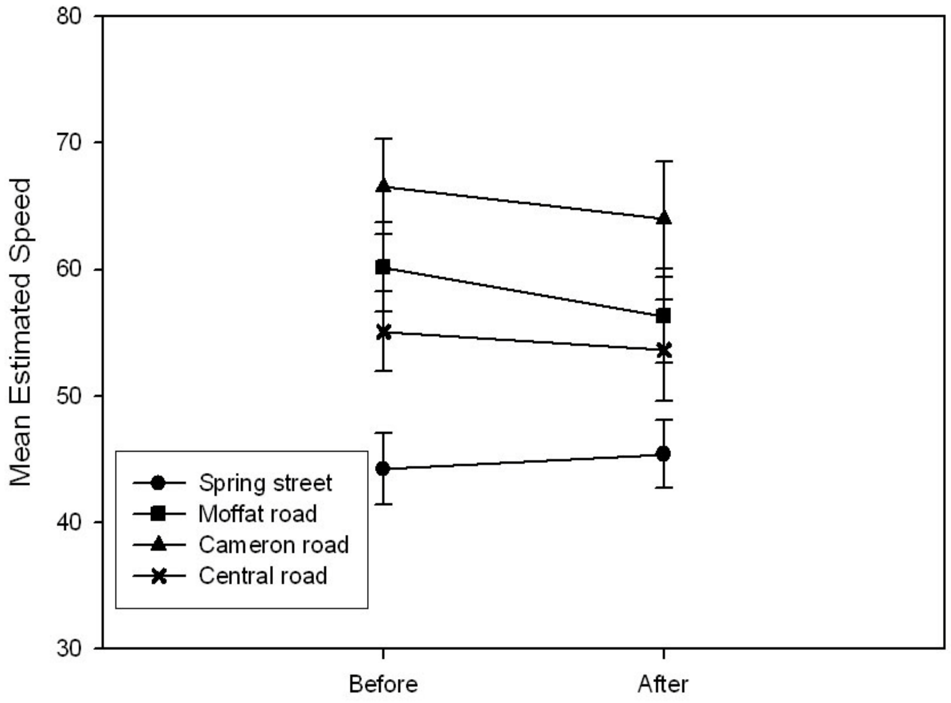


Figure 29: Mean estimated speeds for Spring Street, Moffat, Cameron, and Central Roads before and 1 month after the workshop (95% CI).

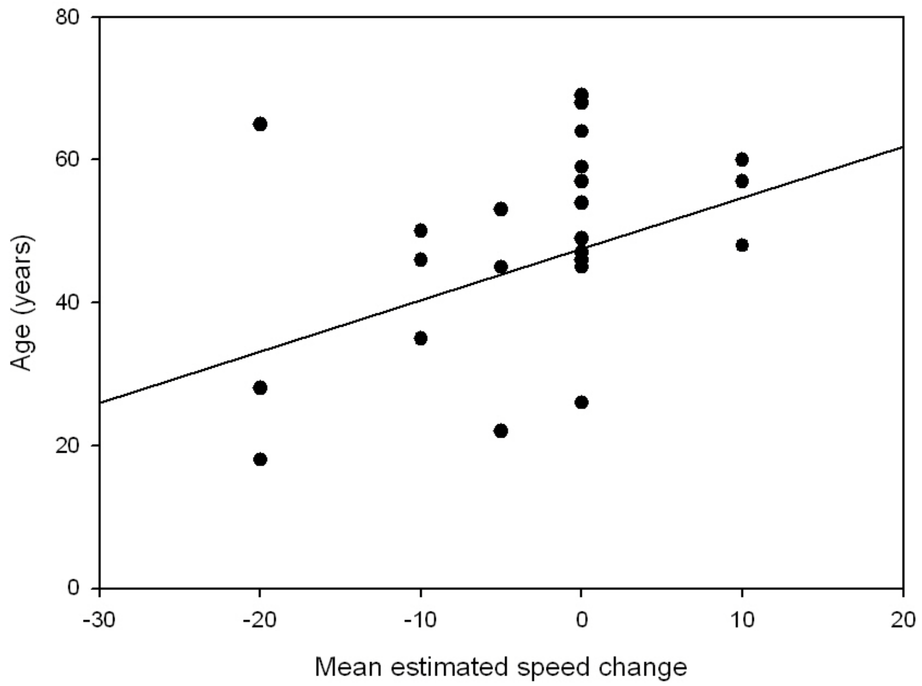


Figure 30: Speed change versus age for Cameron Road (R = .42).

Changes in Attitudes Towards Speed

Repeated measures MANOVAs were used to measure attitudes towards speed before, after, and one month after the workshop. Individual items from the LTSA attitudes towards speed section were used in the analysis, as this is how analysis was done by the LTSA, and it was unclear as to how to group the individual items into scales based on the research presented by the LTSA. Two separate MANOVAs were also done one using gender as a between subjects factor the other using age as a co-varying factor. This section was split into three sections and each section was analysed separately. The first section concerned attitudes towards enforcement and speed, the second section asked participants how they felt about punishments for driving over the speed limit, and the third section dealt with general attitudes towards speed and enforcement.

After the Workshop

Section 1.

There was no effect of workshop on attitudes in the first section either after or one month after the workshop for any of the MANOVAs.

Section 2.

There was a significant effect of workshop and workshop and age interaction on attitudes for this section Wilks' Lambda = .22, $F(8, 13) = 5.93$, $p < .01$ and Wilks' Lambda = .20, $F(8, 13) = 6.52$, $p < .01$ respectively. Univariate testing revealed that participants felt that it was slightly less fair to receive demerit points and a fine for travelling 120km/h in a 100km/h zone with the score falling from a mean of 3.9 (SD 1.21) to 3.63 (SD 1.21), $F(1, 20) = 13.96$, $p < .01$ (workshop), $F(1, 20) = 16.20$, $p < .01$. Age was found to be weakly negatively correlated R = -.32 with score, indicating that older drivers felt it was less fair to receive demerit points and a fine than younger drivers.

Section 3.

There was no significant effect of workshop on the variables in this section. With the addition of age as a co-varying factor there was still no significant effect of workshop, or for the interaction between age and workshop. The MANOVA with gender as a between subjects factor was also not significant.

One Month After the Workshop

One month after the workshop, there was still no significant effect of workshop on attitudes towards speed. Age as a co-varying factor was not significant. When gender was added as a between subjects factor, there was no significant effect of workshop or workshop and gender interaction. No differences between groups were found.

Behavioural Changes

Another new goal of this experiment was to determine whether participatory design could positively affect participants' driving behaviour. A repeated measures MANOVA was done to determine whether any differences in self reported behaviour existed before compared to one month after the workshop. The variables used were violations, aggressive violations, lapses and errors. The MANOVA found a significant effect of the workshop on self reported driver behaviour, Wilks' Lambda = .46, $F(4, 19) = 5.66$, $p < .01$. Univariate statistics revealed that there was a decrease in the number of lapses reported, mean = 6.87 (SD 3.06) and 5.46 (SD 3.68) respectively.

Participatory Design Ratings

As can be seen in the table below, the workshop, as with workshops in the first experiment, was rated highly overall. With most scores approximately four out of total five.

Table 9

Participatory design workshop ratings (n = 32).

	Minimum	Maximum	Mean	SD
Clear introduction	3.00	5.00	4.24	0.64
Easy to follow	4.00	5.00	4.45	0.51
Fully able to participate	4.00	5.00	4.67	0.48
Everyone able to contribute	3.00	5.00	4.55	0.63
Happy with methods generated	3.00	5.00	4.39	0.64
change in attitude	3.00	5.00	3.95	0.74
Rate as a way to reduce speed	3.00	5.00	4.39	0.62
rate as a way to teach	3.00	5.00	4.43	0.56

Correlations Between Attitude Change and Participatory Design Ratings

Table 10 below shows correlations between participatory design workshop ratings and attitude changes immediately after and one month after the workshop. Attitude change variables correlating directly with the variable "attitude change" were for the variables, "fine only for 120km/h in a 100km/h zone" and "automatic loss of license for 100km/h in a 50km/h zone". Both were negatively correlated with attitude change, indicating that those who stated that their attitude was more likely to have changed were less likely to agree with these statements. Other correlations generally pointed to an improvement of attitudes associated with higher participatory design workshop scores, apart from higher ratings of "participatory design as a teaching tool" being negatively correlated with "automatic loss of license for 100km/h in a 50km/h zone".

Variables Predicting Estimated Speed and Speed Change

As with experiment one, it was also of interest to determine which, if any, demographic variables predicted participants' estimated speed ratings and changes in estimated speed ratings, especially considering that estimated speed ratings and changes in estimated speeds varied between roads. Behavioural ratings were also used in regressional analyses as the DBQ has been found to be a good predictor driver behaviour.

Demographic Variables Predicting Estimated Speed and Speed Change

Experimental roads.

For estimated speeds on River Road after the workshop, kilometres driven explained 26% of the variance, with those driving more kilometres per annum making higher estimated speed choices (Table 11). Age predicted 18% of the variance for speed change on Church Road, with older people more likely to reduce their estimated speeds than younger people (Table 12).

Control roads.

Gender explained 20% of the variance in estimated speed choice for Cameron Road (Table 13) and 18% of the variance in estimated speed choice for Central Road (Table 14) before the workshop, with females having lower estimated speeds than males. Age and kilometres driven explained 46% of the variance in estimated speed change for Cameron Road, with younger drivers and those who drover higher kilometres per annum having bigger decreases in estimated speed (Table 15).

Table 10

Attitudinal variables correlating with participatory design variables (n = 32).

	Clear introduction	Easy to follow process	Able to fully participate	Everyone could contribute	Happy with speed reduction measures	Attitude change	Rate participatory design as a design tool	Rate participatory design as a teaching tool
Penalties for speeding are not very severe	.58**	.54**						
Those who get caught speeding are unlucky	-.43*	-.40*						
Those who get caught speeding are unlucky (M)	-.46*							
Enforcement helps lower the road toll								.45*
Enforcement helps lower the road toll (M)				.57**	.56**			
Demerit points only for 50km/h in a 70km/h zone			.40*					
Fine only for 120km/h in a 100km/h zone (M)						-.54**		
Automatic loss of license for 100km/h in a 50km/h zone						-.48**		-.39*
Speed limits are set too low								-.44*
I favour stricter enforcement of 50km/h limits (M)							.45	

* *p* < .05, **, *p* < .01 (M) = one month follow up survey

Table 11

Demographic variables predicting estimated speed on River Road after the workshop (n = 32).

	B	SE B	β
Step 1			
Constant	52.1	3.65	
Age	-0.06	0.07	-.17
Gender	0.78	2.28	.08
Kilometres	0.00	0.00	.57*
Step 2			
Constant	52.51	3.37	
Age	0.05	0.07	-.15
Kilometres	0.00	0.00	.53*
Step 3			
Constant	50.33	1.72	
Kilometres	0.00	0.00	.51*

R^2 For Steps 1 – 3 = .28, .28, .26, respectively. * $p < .05$, ** $p < .01$, $p < .001$

Table 12

Demographic variables predicting estimated speed change on Church Road(n = 32).

	B	SE B	β
Step 1			
Constant	2.49	4.56	
Age	-0.22	0.09	-.51*
Gender	2.16	2.85	.18
Kilometres	0.00	0.00	.37
Step 2			
Constant	3.61	4.27	
Age	-0.21	0.09	-.47*
Kilometres	0.00	0.00	.28
Step 3			
Constant	5.24	4.20	
Age	-0.18	0.09	-.43*

R^2 For Steps 1 – 3 = .28, .26, .18, respectively. * $p < .05$, ** $p < .01$, $p < .001$

Table 13

Demographic variables explaining estimated speed for Cameron Road before the workshop (n = 32).

	B	SE B	β
Step 1			
Constant	68.47	7.49	
Age	-0.01	0.15	-.01
Gender	-7.94	4.67	-.41
Kilometres	0.00	0.00	.07
Step 2			
Constant	68.3	5.04	
Gender	-7.97	4.44	-.42
Kilometres	0.00	0.00	.07
Step 3			
Constant	69.58	2.59	
Gender	-8.58	3.85	-.45*

R^2 For Steps 1 – 3 = .20, .20, .20 respectively. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 14

Demographic variables explaining estimated speed for Central Road before the workshop(n = 32).

	B	SE B	β
Step 1			
Constant	51.48	6.90	
Age	0.19	0.14	.29
Gender	-8.67	4.30	-.47
Kilometres	0.00	0.00	-.03
Step 2			
Constant	51.15	6.19	
Age	0.18	0.13	.28
Gender	-8.41	3.64	-.46*
Step 3			
Constant	59.17	2.50	
Gender	-7.87	3.71	-.43*

R^2 For Steps 1 – 3 = .26, .26, .18 respectively. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 15

Demographic variables explaining estimated speed change for Cameron Road(n = 32).

	B	SE B	β
Step 1			
Constant	-10.87	7.44	
Age	0.40	0.13	.59**
Gender	-5.83	4.35	-.30
Kilometres	0.00	0.00	-.64*
Step 2			
Constant	-15.50	6.77	
Age	0.38	0.14	.56*
Kilometres	0.00	0.00	-.48*

R^2 For Steps 1 – 2 = .53, .46 respectively. * $p < .05$, ** $p < .01$, *** $p < .001$

DBQ Variables Predicting Estimated Speed and Speed Change

Experimental roads.

Violations, aggressive violations and lapses explained 61% of the variance for speed change on Newell Road. Those with higher violation and aggressive violation scores were significantly more likely to reduce their estimated speed choices and those with high lapse scores were less likely to reduce their estimated speeds (Table 16). Violations, aggressive violations and lapses explained 43% of the variance in estimated speed choice for Newell Road prior to the workshop, with higher estimated speed choices significantly associated with aggressive violations and lapses significantly associated with lower estimated speed choices (Table 17). Violations explained 33% of the variance in estimated speed choice for River Road after the workshop with higher estimated speed choices significantly associated with higher violation scores (Table 18). Violations, aggressive violations and errors explained 35% of the variance in estimated speed choice for Church Road after the workshop. Violations and aggressive violations were positively associated with higher estimated speed choices and errors were associated with lower estimated speed choices (Table 19).

Control roads.

Aggressive violations explained 24% of the variance in estimated speed ratings after the workshop for Moffat Road, with higher aggressive violation scores correlating with higher estimated speeds (Table 20). Violations explained 18% of the variance in speed change for Cameron Road, with higher violation scores linked to larger decreases in estimated speed (Table 21).

Table 16

DBQ variables explaining estimated speed change on Newell Road (n = 32).

	B	SE B	β
Step 1			
Constant	-1.24	3.41	
Violations	-1.31	.38	-.46**
Aggressive	-1.91	-0.47	-.61***
Lapses	1.16	0.61	.34
Errors	0.50	0.59	.14
Step 2			
Constant	-1.54	3.37	
Violations	-1.31	0.38	-.45**
Aggressive	-1.90	0.46	-.61***
Lapses	1.46	0.49	.42**

R^2 For Steps 1 – 2 = .62, .61, respectively. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 17

DBQ variables explaining estimated speed before the workshop on Newell Road (n = 32).

	B	SE B	β
Step 1			
Constant	81.21	4.56	
Violations	.95	.51	.30
Aggressive	1.90	.63	.56**
Lapses	-1.85	.82	-.49*
Errors	.03	.79	.01
Step 2			
Constant	81.20	4.44	
Violations	.95	.50	.30
Aggressive	1.91	.613	.56**
Lapses	-1.83	.65	-.49**

R^2 For Steps 1 – 2 = .43, .43, respectively. * $p < .05$, ** $p < .01$

Table 18

DBQ variables explaining estimated speed choice for River Road after the workshop (n = 32).

	B	SE B	β
Step 1			
Constant	51.24	2.03	
Violations	0.71	.22	.53**
Aggressive	0.24	0.28	.17
Lapses	-0.32	.36	-.20
Errors	0.27	0.35	.16
Step 2			
Constant	51.08	2.00	
Violations	0.71	0.22	.54**
Aggressive	0.25	0.28	.17
Lapses	-0.16	0.29	-.10
Step 3			
Constant	50.26	1.29	
Violations	0.71	0.22	.53**
Aggressive	0.18	0.24	.12
Step 4			
Constant	50.62	1.19	
Violations	0.77	0.21	.58**

R^2 For Steps 1 – 4 = .37, .35, .35, .33 respectively. * $p < .05$, ** $p < .01$

Table 19

DBQ variables explaining estimated speed choice for Church Road after the workshop (n = 32).

	B	SE B	β
Step 1			
Constant	49.55	0.97	
Violations	0.23	0.11	.37*
Aggressive	0.25	0.13	.36
Lapses	-0.07	0.18	-.09
Errors	-0.27	0.17	-.34
Step 2			
Constant	49.29	0.71	
Violations	0.23	0.11	.37*
Aggressive	0.23	0.12	.34
Errors	-0.31	0.14	-.39*

R^2 For Steps 1 – 2 = .36, .35, respectively. * $p < .05$, ** $p < .01$

Table 20

DBQ variables explaining estimated speed choice for Moffat Road after the workshop (n = 32).

	B	SE B	β
Step 1			
Constant	50.55	3.11	
Violations	0.05	0.73	.02
Aggressive	0.73	0.52	.34
Lapses	0.96	1.01	.42
Errors	-0.42	0.87	-.18
Step 2			
Constant	50.61	2.90	
Aggressive	0.73	0.50	.34
Lapses	0.99	0.84	.43
Errors	-0.43	0.84	-.18
Step 3			
Constant	50.63	2.85	
Aggressive	-0.71	0.49	.32
Lapses	0.65	0.52	.29
Step 4			
Constant	53.21	2.01	
Aggressive	1.05	0.41	.49*

R^2 For Steps 1 – 4 = .30, .30, .29, .24 respectively. * $p < .05$, ** $p < .01$, *** $p < .001$

Attitudes Towards Speed Correlating with Estimated Speed and Speed Change

Finally, given that there were few reported changes in attitudes towards speed, but still reported changes in estimated speeds, associations between attitudes, estimated speed and speed changes were investigated for both experimental and control roads.

Experimental roads.

Several attitudinal variables, taken from the LTSA were measured prior to, after and one month after the workshop. The attitudinal variables measured prior to the workshop were placed in a correlation matrix (Table 22) to determine whether attitudes correlated with estimated speeds chosen before the workshop, after the workshop, as well as the speed changes. Prior to the workshop, estimated speed choice on Newell Road correlated negatively with six variables. Four were associated with enforcement, and two with the link between speed and accidents. Those who were in favour of enforcement and agreed that speed was a factor in accidents were more likely to have lower estimated speed choices for Newell Road. After the workshop only one attitudinal variable correlated with estimated speed. “The risk of being caught is small” correlated negatively with speed choice, indicating that those who disagreed with the statement had lower estimated speed choices. Speed change for Newell Road was correlated with nine attitudinal variables.

Table 21

DBQ variables explaining speed change for Cameron Road (n = 32).

	B	SE B	Β
Step 1			
Constant	6.37	6.29	
Violations	-1.05	.48	-.44*
Aggressive	-.33	.55	-.13
Lapses	-1.13	.93	-.32
Errors	1.28	.73	.45
Step 2			
Constant	6.75	6.16	
Violations	-1.10	.46	-.47*
Lapses	-1.28	.88	-.37
Errors	1.22	.71	.43
Step 3			
Constant	-.71	3.49	
Violations	-1.04	.47	-.44*
Errors	.56	.56	-.20
Step 4			
Constant	1.40	2.77	
Violations	-.98	.47	-.42*

R^2 For Steps 1 – 4 = .31, .29, .21, .18 respectively. * $p < .05$, ** $p < .01$, *** $p < .001$

Six of these concerned attitudes towards enforcement, with those having a negative attitude towards enforcement prior to the workshop reporting larger decreases in estimated speeds than those with more positive attitudes towards speeds. Those who agreed with the statements “Those who get caught speeding are unlucky” and “Speed limits are set too low” were more likely to report higher estimated speed decreases and those who disagreed with the statement that “speeding is one of the main causes of accident” were more likely to report higher estimated speed decreases.

Estimated speed choice for River Road prior to the workshop was negatively correlated with the statement "speed is one of the main causes of accidents, with those who agreed with the statement having lower estimated speed choices. Estimated speed choice for River Road after the workshop was correlated with eight attitudinal variables. Of these, five were associated with enforcement, with those with a negative attitude to enforcement reporting higher estimated speeds. Those who agreed with the statements that, "speed limits are set too low", "those who get caught speeding are unlucky" and those who were more likely to say that they would drive over 55km/h in a 50km/h zone were all more likely to report higher estimated speeds for River Road.

Estimated speed for Church Road before the workshop was positively correlated with, "speed limits are set too low, so people break them", with those who agreed with statement reporting higher estimated speeds. After the workshop, six attitudinal variables correlated with estimated speeds. Estimated speed correlated negatively with four attitudinal variables to do with enforcement. As with River Road, those who had negative attitudes to enforcement were more likely to report higher estimated speeds. Those who agreed with, "those who get caught speeding are unlucky" and "speed limits are set too low" were more likely to report higher estimated speeds.

Control roads.

As with the experimental roads, attitudinal variables from prior to the workshop were correlated with estimated speeds before and after the workshop, as well as speed change (Table 23). For Spring Street, four attitudinal variables were correlated with estimated speeds. Three of these were associated with either breaking or relaxing the speed limit. Those who agreed with these statements were more likely to report higher speed choices. One was associated with enforcement, with those disagreeing with the statement more likely to report higher estimated speeds. For Moffat Road, three variables correlated with estimated speeds. Those who agreed with the statements that a fine only for 70km/h in a 50km/h zone was fair and that you sometimes have to drive in excess of the speed limit to keep up with the flow were more likely to report higher estimated speeds. After the workshop, six attitudinal variables correlated negatively with estimated speeds. All were to do with either enforcement or the impact of speeds.

Table 22

Attitudinal variables from before the workshop correlating with estimated speeds before and after the workshop and estimated speed change (n = 32).

	Newell Before	Newell After	River Before	River After	Church Before	Church After	Change Newell
The risk of being caught speeding is small		-.50*					
Enforcing speed limits helps to lower the road toll						-.40*	
Demerits and fines for 70km/h in a 50km/h zone				-.40*			.42*
Demerits and fines for 120km/h in a 100km/h zone	-.43*			-.39*		-.42*	.55*
Automatic loss of license for 3 speeding tickets	-.41*			-.46*		-.38*	.46*
Likelihood of driving 55km/h+ in a 50km/h zone				.50**			
I would be happier with stricter enforcement	-.53**						.47**
Those who get caught speeding are unlucky (DAQ)				.40*		.45*	-.41*
Stricter enforcement of 50km/h				-.55**			.44*
Speed limits are set too low, so people break them				.51**	.41*	.43*	-.41*
Speed is one of the main causes of accidents	-.62**		-.42*				.52**
50km/h limits should be more strictly enforced	-.51**			-.48**		-.42*	.50**
Driving slightly faster than the speed limit	-.41*						

* $p < .05$, ** $p < .01$

Table 23

Attitudes toward speed variables correlating with estimated speeds and changes in estimated speed ratings for control roads (n = 32).

	Spring Street before	Moffat Road before	Moffat Road after	Cameron Road before	Central Road before	Central Road after	Central Road change
Those who get caught speeding are just unlucky					.41*		
Enforcement helps lower the road toll					-.56**		
Fine for 70km/h in a 50km/h zone		.43*			.45*		
Demerits and fines for 70km/h in a 50km/h zone	-.36*		-.49*		-.57**		
Demerits and fines for 120km/h in a 100km/h zone			-.59**				.54*
Automatic loss of license for 3 tickets in 12 months			-.43*				
Those who get caught speeding are unlucky (DAQ)						.41*	
Ok to drive faster than the speed limit if careful	.50**				.62**		
Speed limits are set too low, so people break them	.61**				.47*		
Speeding is one of the main causes of accidents			-.48*				
I know how fast I can drive and still drive safely	.37*						-.51
I favour stricter enforcement of 50km/h limits			-.55*				
Sometimes you have to exceed limits to keep up with the flow		.37*		.37*			
Driving slightly faster than the speed limit reduces safety			-.61*				

* $p < .05$, ** $p < .01$Changes in attitudes towards speed

Those who disagreed with the statements were more likely to report higher estimated speeds. Prior to the workshop, only on variable correlated with estimated speed choice for Cameron Road, which was that sometimes you have to drive faster than the speed limit to keep up with the flow. Those agreed were more likely to report higher estimated speeds.

Six variables correlated with estimates speeds for Central Road before the workshop. Three of the variables were associated with breaking the speed limit and were correlated with higher estimated speeds, two were associated with enforcement and as with previous roads, those who had a negative attitude towards enforcement reported higher estimated speeds. One variable, “Fine only for 70km/h in a 50km/h zone” was positively correlated with higher estimated speeds. After the workshop, only those who agreed with the statement, “those who get caught speeding are just unlucky” correlated positively with estimated speeds. Speed change for Central Road was positively correlated with “demerit points and fine for 120km/h in a 100km/h zone”; with those who felt it was fair having lower decreases in estimated speeds. The statement, “I know how fast I can drive and still drive safely” correlated negatively with speed change. Those who agreed with this statement were more likely to report higher estimated speed decreases for Central Road.

Summary

This experiment set out to address the issues faced by the previous experiment, as well as further investigate the efficacy of participatory design.

Firstly, experiment two looked at the possible issue of bias in ratings in experiment one. For the most important criteria of reducing estimated speeds, all the groups in experiment one were successful, as rated by non-designers. Furthermore, Figure 23 shows that road 1G, the road prior to redesign, had the highest estimated speed as judged by non-design groups. Although safety and preference ratings were generally rated higher by design groups themselves than by the non-designers, non-designers also rated road 1G lower for safety and preference, despite the fact this road was unchanged. According to these findings, it appears that there may have been some bias in self-ratings for safety and preference, but given that the non-designers also rated the untouched road lower than the designers, it not entirely clear whether the higher ratings found in experiment one were due to bias or simply due to different perspectives on the roads by different people. Regardless of the reasons for the differences found in the ratings, independent judging of roads redesigned by participatory design groups would be beneficial in insuring that improvements in roads redesigned using participatory design are due to tangible improvements and not simply due to participants having taken part in a participatory process.

The efficacy of participatory design was also further tested to determine whether participants would be able to improve different types of roads with various issues. In experiment two participants redesigned three different roads. As can be seen in Figure 24, the designs generated by participants in experiment two were varied and innovative, with several different combinations of measures used in order to address the various issues faced by the roads that were chosen for redesign in the workshop.

Participants were able to significantly reduce estimated speeds for all three roads redesigned in the workshop (Figure 25). Safety and aesthetic ratings were also significantly improved for two out of the three roads. Where ratings remained unchanged, the road was already rated highly prior to the workshop. Preference was only improved for one of the roads and liveability ratings remained unchanged for all of the roads (Figure 26). Overall, the workshop achieved the main goal of reducing estimated speed on all three of the roads and participants were also able to make some changes in safety and aesthetic ratings. These findings were similar to the first workshop, demonstrating that participatory design workshops can work on different types of roads. It also that drivers' tacit knowledge goes beyond dealing with just one type of road.

In terms of participants' perception of other roads, the two control roads with the highest initial estimated speed ratings experienced decreases in their estimated speed ratings, but only when age was taken into account. Somewhat surprisingly, younger people had bigger decreased in their estimated speed ratings than older people.

As in the first experiment, attitudes still remained largely unchanged, even one month after the workshop, but one change in attitudes was found. This was regarding how fair participants saw receiving demerit points and a fine for travelling at 120km/h in a

100km/h zone. After the experiment older people felt it was less fair to receive this punishment. Behaviour was also measured 1 month after the experiment and in this case a significant decrease in the reported number of lapses was found after the workshop.

When it came to what variables predicted speed for the roads that were redesigned in the experiment, demographic variables were relatively poor predictors, with some roads' speed change and estimated speed ratings predicted by age and kilometres driven, but not for others. DBQ predictors were also inconsistent, but less so then demographic variables. Speed change on the road with the 80km/h speed limit could be predicted by violations, aggressive violations explaining 61% of the variance. Those with higher scores had the largest decreases in estimated speed ratings. For the other two roads, high violation and aggressive violation scores predicted higher estimated speed choices after the workshop, with errors predicting lower estimated speed choices. The same predictor variables were used for the control roads, with similar results. Neither demographic, DBQ nor road ratings were consistent predictors of estimated speeds.

Regression analyses were not done for attitudinal variables. However, for both experimental and control roads, negative attitudes towards enforcement consistently correlated with higher estimated speed choices both before and after the workshop. Curiously, larger decreases in estimated speed choices also correlated with negative attitudes towards enforcement, but only for changes in experimental roads. The same was not true for control roads. However, it must be noted that for all three experimental roads and two out of the four control roads, estimated speed ratings were significantly reduced. So although higher estimated speed choices were associated with negative attitudes towards enforcement after the workshop, average estimated speeds were still significantly reduced.

So, despite the decreases in estimated speed found for the experimental and control roads, none of the demographic, behavioural or attitudinal ratings consistently explained participants' estimated speed ratings. For this experiment, Rothengatter's (2002) statement that many variables must be taken into consideration when attempting to explain driver behaviour may offer the best explanation for these curious results. It is also interesting to note that despite younger drivers being overrepresented in most crash statistics (Lam, 2003; Özkan et al., 2006), that in some cases younger participants improved their estimated speed ratings more than older drivers after taking part in the participatory design workshop. Nevertheless, the participatory design workshop was successful in achieving its main aims of reducing estimated speeds. Driver's behaviour was also improved after the workshop with a significant decrease in reported lapses.

Overall, experiment two appeared to be successful in its implementation, as participants were able to meet the goal of reducing estimated speeds on their redesigned roads. However, the redesign of three roads in this time frame was difficult for participants. Once again, there was almost no reported change in attitudes, although there was some promising evidence of a change in behaviour after the workshop.

In terms of future directions there are some changes that could be made to the experiment. Given the possibility of bias in ratings, independent judges could be used to rate roads designed in future participatory design workshops. Based on the changes in behaviour reported, changes in the attitude questionnaire may be required, looking more at intentions of behaviour, rather than just attitudes towards speed. As with experiment one, the workshop was run with only a small number of people. If this process was to be used for road redesign in a community setting or as part of an educational program, it is likely that more than 5-6 people would take part in the workshop. Neither of these two experiments addresses how to achieve this without running more workshops. Finally, for both experiments none of the participants were personally concerned with speeds or safety issues on the roads that were redesigned, which may have reduced the efficacy of the process.

EXPERIMENT THREE

Introduction and Goals

This experiment was a departure from the first and second experiments in several ways. The two previous experiments were run with small groups of around 5 participants at different times. Experiment three was run in one session, using participants who knew each other. This was done in order to determine whether participatory design could be used to facilitate a design process with larger numbers of people, something which had not been reported on in any literature on participatory design reviewed in this thesis. In addition, organising several different workshops at different times for the previous proved to be challenging, so it was thought that this method could have streamlined the recruitment and experimental process by having all participants attend one workshop.

To facilitate this, some participants took part as designers and others took part as audience members. The designers were placed in two teams, which worked simultaneously. The audience members watched the experiment and were allowed to interact with the design teams for a short period during the experiment. This was done to determine what level of involvement might be necessary to affect attitudes and behaviour, also to see whether a participatory design process can be run successfully with larger numbers of people taking part. The redesigned roads were also no longer judged by participants, in this workshop they were judged by three road safety experts.

Roads for this experiment were also changed. Participants worked on roads from their own neighbourhood that they knew well, and which they had expressed concerns over, namely excessive speeds and the number of accidents occurring on them. The roads that were used to test participants' perception of roads before and one month after the workshop were also changed. All were 50km/h roads, but not all were well designed, that is, some appeared to have far higher operating speeds than their posted speed limits. The attitudes towards speed questionnaire was also changed to focus more on participants intentions to speed, this change was based on the lower estimated speed ratings for the control roads in experiment two and the improvement found in self-reported driver behaviour. Finally, the section which measured the workshop was simplified.

Methods

Participants

Prior to beginning the research ethical approval was obtained from the Psychology Department Human Research Ethics Committee at the University of Waikato. Seventeen participants, recruited from SALT (Slower And Less Traffic), a community organisation based in Point Chevalier, Auckland, took part in the workshop and the organisation was paid $10 per participant. Seven of the participants were male and ten of the participants were female. Their ages ranged from 34 to 65 (mean 45.63, *SD* 9.95), they drove between 4,000 and 50,000 kilometres per year (mean 14,357.14, SD 12137.72), had between 17 and 41 years of driving experience (mean 27.06, SD 7.85), a mean of 0.12 infringements and 0.18 crashes. Ten of the participants took part as designers (two teams of five) and the remainder made up the audience. Three road safety experts also took part in the experiment as judges for the redesigned roads.

Materials

Questionnaire

As with the second experiment, there were questionnaires that collected ratings regarding demographics, attitudes, and driver behaviour. There were two questionnaires, they had several alterations made, and the times that they were administered were different.

- The first questionnaire was administered during the workshop. It had 7 sections in total. The first section asked participants to rate the two roads that they were to redesign, the second section asked participants to rate six control roads, the third asked about driver behaviour, the fourth asked about attitudes towards speed, the fifth about demographic information, the sixth about attitudes and the seventh about the participatory design workshop.

- The second questionnaire was given to participants one month after the workshop and had three sections. The first section asked participants to rate the two roads they had redesigned in the workshop (prior to redesign), the second asked participants to rate the 6 control roads, the third about their driving behaviour in the month after the workshop and the final section asked about attitudes. The questionnaires can be found in Appendix C.

The questionnaire for experiment three was significantly altered based on findings in the second experiment to focus more directly on attitudes towards speed rather than speed and enforcement. The attitude towards speed section was broken down into three parts, the first parts asked questions regarding attitudes towards speed and was identical to that used in questionnaire from the second experiment, but did not include the question "The penalties for speeding are not very severe.".

The focus for section two was changed from asking about attitudes towards speed to questions regarding intentions to break the speed limit. The third part comprised of items from the speeding subsection of the DAQ, but two items were removed.

Table 24:

Changes made to the attitude rating section of the questionnaires.

Questions for section two
The likelihood that you will drive more than 50km/h on a 50km/h road in the next twelve months
The likelihood that you will drive more than 60km/h on a 50km/h road in the next twelve months
The likelihood that you will drive more than 70km/h on a 70km/h road in the next twelve months
The likelihood that you will drive more than 80km/h on a 70km/h road in the next twelve months
The likelihood that you will drive more than 100km/h on a 100km/h road in the next twelve months
The likelihood that you will drive more than 110km/h on a 100km/h road in the next twelve months
DAQ Items removed:
I would favour stricter enforcement of the speed limit on 50km/h roads.
Even driving slightly faster than the speed limit makes you less safe as a driver.

As with the second experiment the DBQ was used to rate self-reported driver behaviour as in the previous study and was administered twice, once before the workshop and again one month after the workshop.

In this experiment participants redesigned two roads from their own neighbourhood over which they had safety concerns (Moa Road and Point Chevalier Road, shown below) so these were also added to the questionnaire.

Figure 31: Moa Road

Figure 32: Point Chevalier Road

The control roads were also changed. For this experiment a total of six control roads were used. The roads were as follows:

Figure 33: Control roads used for experiment three.

The section regarding the rating of the participatory workshop was also simplified. The questions were changed as follows:

- Do you feel that everyone was able to contribute to the process? (YES/NO)
- How would you rate participatory design as a way to improve road design?
- How would you rate the effectiveness of participatory design as a tool to teach people about roads and road safety?

- Has this process changed your attitude towards driving? (YES/NO). This was followed by a feedback section asking what participants felt had changed about their attitudes towards driving.

Finally a general feedback/comments box was also added.

Presentation

The 15 minute “participatory road design presentation” that was used in experiment one and two containing information on various road safety statistics, speed reduction and safety measures was changed significantly for this experiment. The presentations covered; crashes and their causes, an expanded section on the 3 Es, an explanation of SER and how it could be applied in New Zealand, speed change and maintenance treatments, participatory design, and a description of the roads to be redesigned in the experiment. The full presentation can be found in Appendix C. The presentation was given at the beginning of the workshop by an experienced road safety speaker. The presentation also included details about the two roads which participants were to redesign in the experiment. Descriptions of the road were given directly after the information regarding road safety, speed reduction and safety measures. Information included road width, traffic flow and the safety and speed issues that the road had.

Toolkit

The toolkit was identical to that used in experiments one and two, one for each team.

Procedure

As mentioned above, recruitment of participants took place via SALT. A representative from the organisation took personal details of interested parties and personal contact by the researcher was made with them to arrange for them to take part in the workshop. At this time the first questionnaire was also sent out to participants to allow more time for the design process during the workshop. The workshop was held with all participants present and was arranged to correspond with times that participants had available during the week.

At the beginning of the workshop, participants were given a consent form and were told that participation in the research was voluntary and that they were allowed to leave at any stage of the experiment. Participants were also told that any information collected during the procedure was confidential and that no names or any other personally identifying information would be used in the experiment.

The presenter then outlined the workshop procedure and participants were asked to fill in the first half of the second questionnaire. After this, a request was made for 10 participants to make up two design teams. Participants then completed the first half of the questionnaire, and the presenter gave the participatory road design presentation, including the description of the roads, the presenter then described the toolkit and speed reduction measures booklet. Participants were then instructed to begin their design process. The design process was left up to the participants; however the presenter and the researcher were present to answer any questions that the participants had about the any aspect of the workshop, tools or the design process.

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Figure 34: Workshop in progress with audience involvement

Approximately half way through the process for around 5 minutes, the audience was asked to take part in the design process more directly by asking questions and providing comments and inputs (Figure 34). Once the designs were completed, participants were asked to fill in the second half of the questionnaire. Designs were then judged by three road safety experts. Approximately one month after the workshop, the follow up questionnaire was sent out and collected to determine whether there were any changes in attitude towards speeds, driving behaviour or the way participants perceived roads after the workshop.

Results

Results were analysed and laid out as follows:

- Experimental road ratings before and after the workshop
- Control Road ratings before and after the workshop
- Differences in road ratings before the workshop
- Differences in control road ratings before the workshop
- Differences between experimental roads before the workshop
- Differences between experimental and control roads before the workshop
- Differences in road ratings between groups in experiments one, two and three
- Attitude Ratings before, after and one month after the workshop
- Behavioural ratings before and one month after the workshop

Experimental Road Ratings

The redesigns for experiment three are as shown below in FiguresFigure *35* and Figure *36*. As in previous experiments, estimated speed, road safety, aesthetics, preference and liveability were rated prior to the workshop by participants. However, after the workshop the roads were rated by three independent judges. To compare participants' ratings of the road prior to the workshop with the judges' ratings of the redesigned roads two Man-Whitney tests were conducted to determine whether the teams had made any improvements to the roads according to the judges. The roads were rated on safety, aesthetics, preference, liveability and estimated speed. Point Chevalier road was judged to have a lower estimated speed rating and an improved Aesthetics rating after redesign (Figure 37). It had a mean estimated speed of 48.09 km/h as rated by participants prior to the workshop (SD 8.27 km/h) and 38.33 km/h (SD 7.64) as rated by the judges after the workshop, $U = 5.50$, $p < .05$.

Figure 35: Participants' redesign of Moa Road.

Figure 36: Participants' redesign of Point Chevalier Road.

Aesthetics ratings also improved, with participants rating the aesthetics an average of 2.26 (SD 0.97) and judges rating them at 3.92 (SD 0.52) after the workshop, $U = 4.00$, $p < .05$. Preference and liveability ratings for Point Chevalier road were not significantly different between judges and participants. None of the ratings for Moa road were significantly different before and after the workshop (Figure 38).

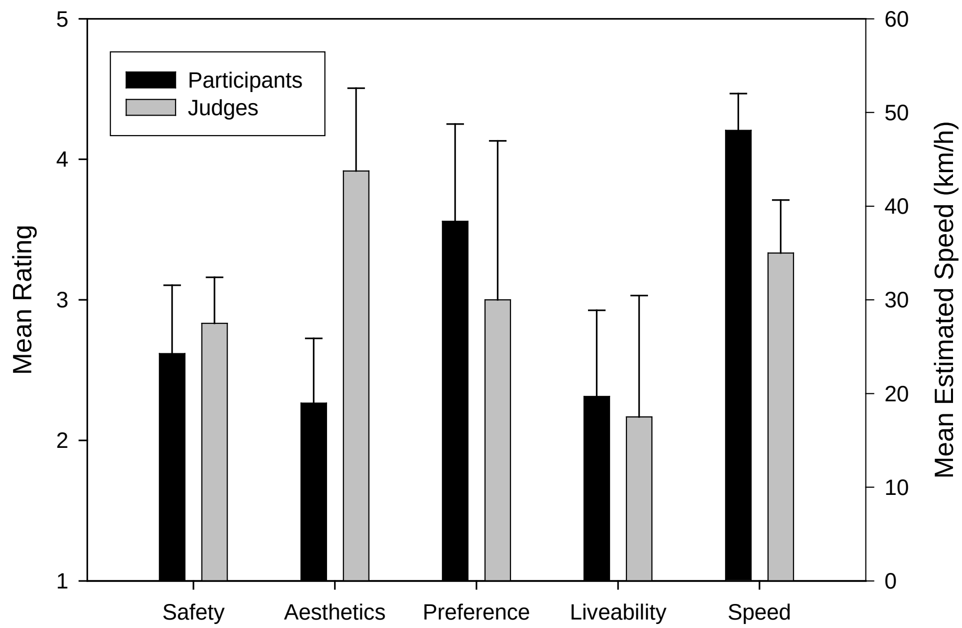

Figure 37: Participants ratings prior to the workshop versus judges' ratings after the workshop for Pt Chevalier Road (95% CI).

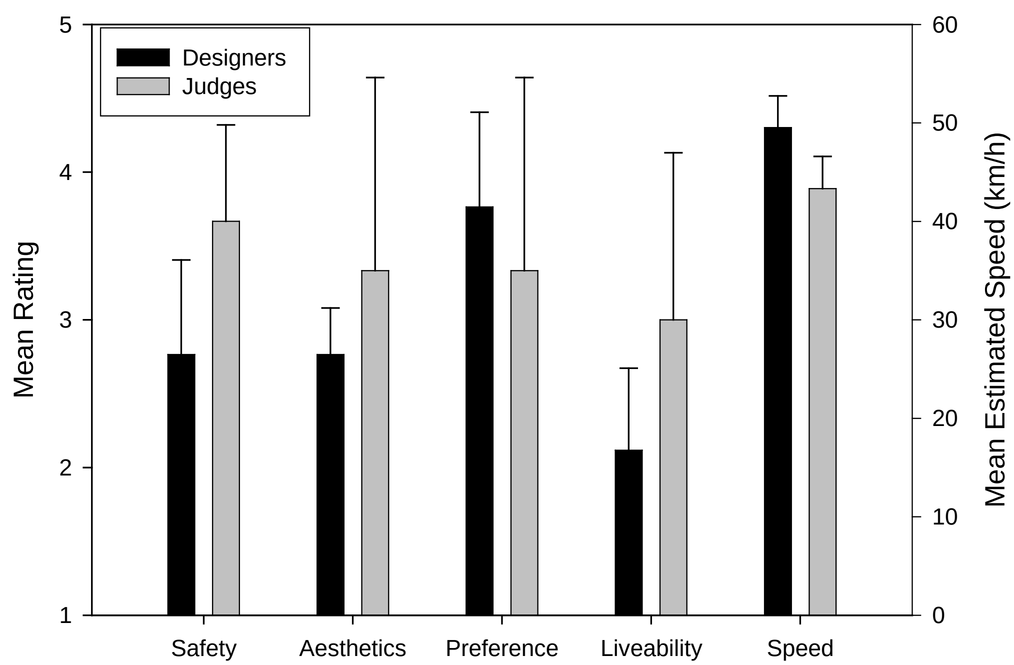

Figure 38: Participants ratings prior to the workshop versus judges' ratings after the workshop for Moa Road (95% CI).

Control Road Ratings

A total of 6 control roads, were rated by participants before the workshop and one month after the workshop. Ratings used were estimated speed, road safety, aesthetics, preference and liveability.

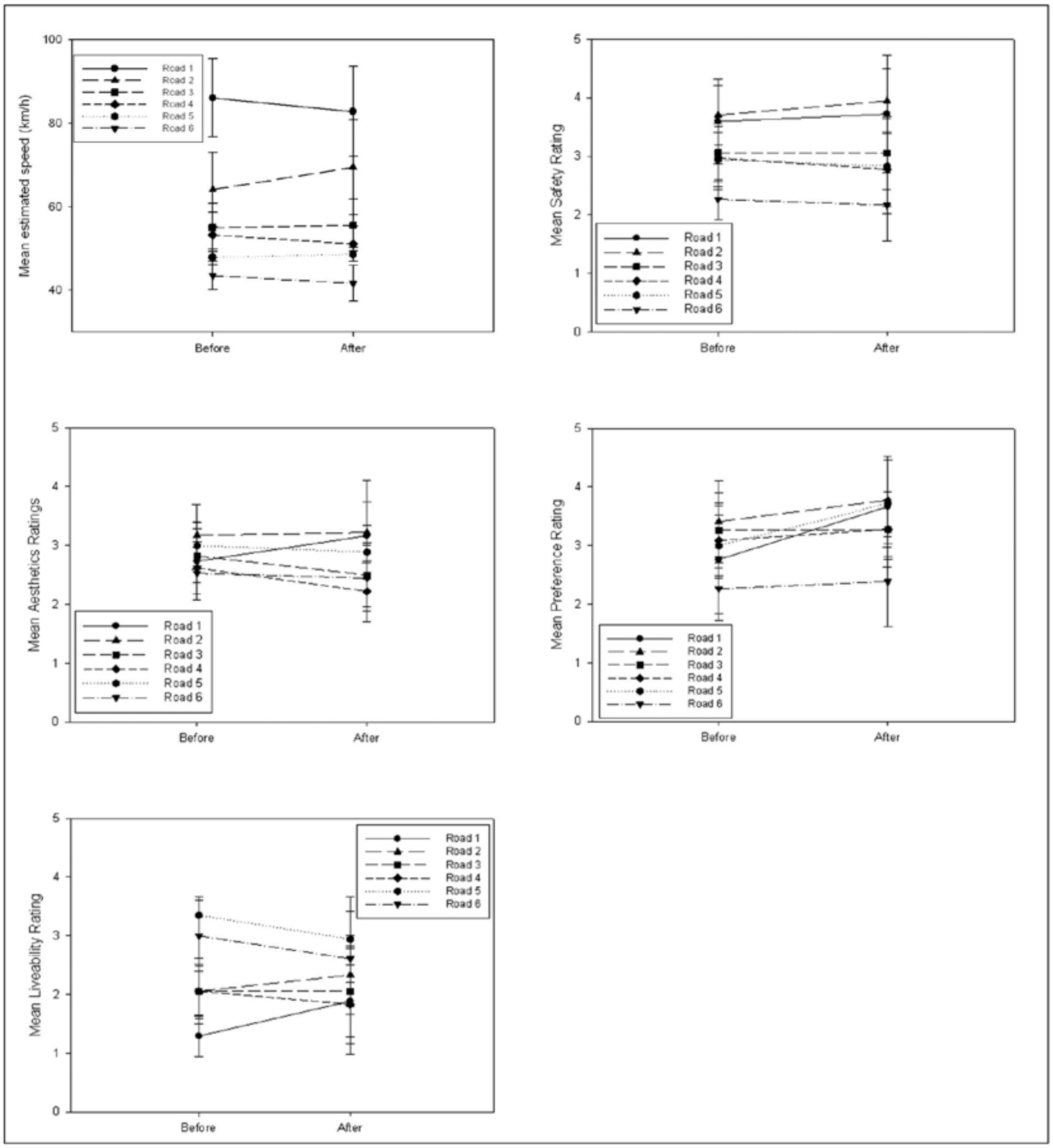

Figure 39: Estimated speed, safety, aesthetics, preference, and liveability ratings for control roads before and one month after the workshop (95% CI).

One month after the workshop, none of the ratings used changed significantly for any of the roads. There were differences between the roads both before and after the workshop for estimated speeds and safety ratings, and for liveability ratings before, but not after the workshop, $F(2.67, 42.69) = 36.52$, $p < .001$, $F(2.35, 18.79) = 27.23$, $p < .001$, $F(2.76, 38.61) = 5.97$, $p < .01$, $F(2.26, 18.06) = 6.01$, $p < .01$, and $F(2.76, 44.16) = 16.29$, $p < .001$ (all *F* values Greenhouse-Geisser adjusted). The graphs below show that estimated speed ratings varied substantially between roads.

Post hoc testing found that estimated speed ratings for Road 1 were significantly higher than all the other roads ($p < .001$). Estimated speeds for Road 2 were significantly faster than those for roads 3 ($p < .001$), 4 and 5($p < .01$), and 6 ($p < .001$). Ratings for Road 3 were significantly faster than those for Roads 5 ($p < .05$) and 6 ($p < .01$). Ratings for Road 4 were significantly faster than those of road 5 ($p < .05$) and road 6 ($p < .01$). Road ratings for road 5 were significantly faster than those for road 6 ($p < .05$).

For estimated speed ratings after the workshop post hoc testing revealed that estimated speed ratings for Road 1 were significantly higher than road 2 ($p < .05$) and roads 3-6 ($p < .001$). Estimated speeds for Road 2 were higher than those for roads 3-6 ($p < .01$). Ratings for Road 3 were significantly higher than 5 ($p < .05$) and 6 ($p < .01$). Ratings for road 4 were higher than those for Road 6 ($p < .05$). Road 5 had higher estimated speed ratings than those for road 6 ($p < .05$).

Safety ratings also varied substantially, with the roads with the highest speeds also having the highest safety ratings. Post hoc testing for safety ratings before the workshop revealed that Road 1 was rated as significantly safer than Road 6 ($p < .01$). Road 2 safety ratings were significantly higher than those for Road 3 ($p < .01$), Road 4 and road 5 ($p < .05$) and road 6 ($p < .001$). Road 3 and Road 5 were rated as significantly safer than road 6 ($p < .05$). After the workshop Road 1 was rated a significantly safer than road 6 ($p < .01$). Road 2 was rated as significantly safer than Road 3 ($p < .01$), Road 4 and Road 5 ($p < .05$) and Road 6 ($p < .001$). Road 5 was rated significantly safer than road 6 ($p < .05$).

Road 1 was rated as significantly less liveable than Road 2 and Road 3 ($p < .01$), Road 4 ($p < .05$) and Road 5 and Road 6 ($p < .001$). Road 2 and Road 3 were rated as significantly less liveable than Road 5 ($p < .001$) and Road 6 ($p < .05$). Road 4 was rated as significantly less liveable than Road 5 ($p < .001$) and Road 6 ($p < .01$).

Differences in Road Ratings Before the Workshop

Since this group of participants had a vested interested in roads that they redesigned, it was of interest to determine whether they were more critical in their ratings of the roads they were redesigning compared to the six control roads. Repeated measures ANOVAs were done on the variables, road safety, aesthetics, preference, liveability and speed.

Differences in Control Road Ratings Before the Workshop

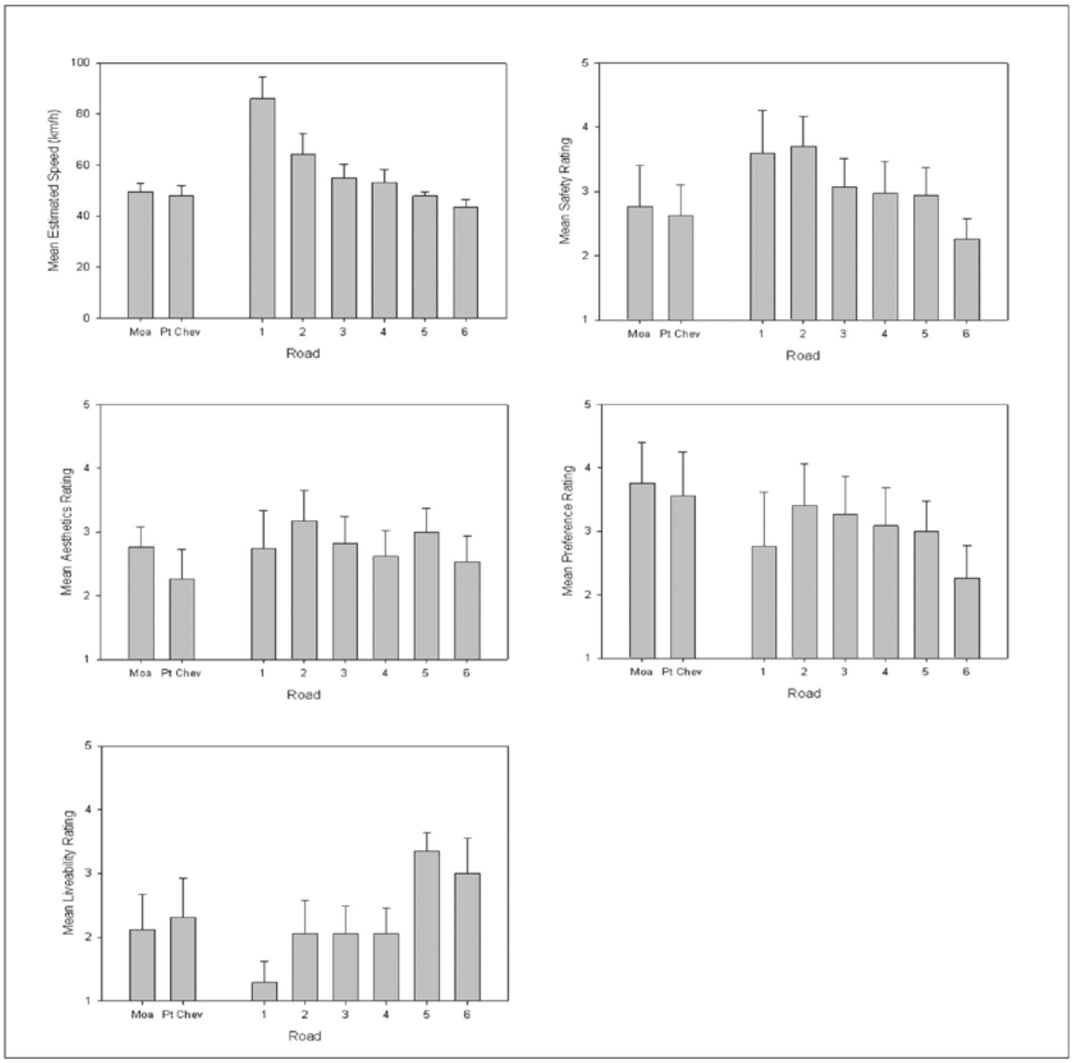

Figure 40: Differences in estimated speed, safety, aesthetics, preference, and liveability ratings for experiment and control roads (95% CI).

The estimated speeds on the control roads (Figure 40) were found to be significantly different, $F(2.67, 42.69)$ (Greenhouse-Geisser adjusted) = 36.52, $p < .001$. Road 1, with a mean estimated speed of 86.03km/h (SD 18.09) was rated as significantly faster than the other control roads ($p < .001$). Road 2 had a mean estimated speed of 64.12 km/h (SD 17.25), which was significantly faster than estimated speeds for roads 3-6 ($p < .01$, Road 6 $p < .001$). Road 3, with a mean estimated speed of 53.24 km/h (SD 10.45 km/h) was rated as significantly faster than Road 5 (p .05) and Road 6 ($p < .01$). Finally, Road 5, with a mean estimated speed of 47.94 km/h (SD 3.56) was rated as faster than Road 6, which had a mean estimated speed of 43.53km/h (SD 6.56).

Differences in safety ratings (Figure 40) between roads were also found, $F(2.76, 38.61)$ (Greenhouse-Geisser adjusted) = 5.97, $p < .01$. Road 1, with a mean rating of 3.59 (SD 1.36) was rated as significantly safer than road 6. Road 2 (mean 3.71, SD 0.99) was rated significantly safer than roads 3 to 6, ($p < .01$).Finally roads 3 and 5 (mean 3.06, SD 0.93 and mean 2.94, SD 0.90) were rated as significantly safer than road 6 ($p < .05$).

Preference ratings (Figure 40) were significantly different between roads $F(2.32, 37.18)$ (Greenhouse-Geisser adjusted) = 3.10, $p < .05$. Road 2 was the most preferred, with a mean rating of 3.41 (SD 1.37) and was significantly more preferred than Road 1 and Road 6, $p < .05$. Road 6, which had a mean rating of 2.27 (SD 1.06), was the least preferred road and was rated significantly lower than roads 2, 3, 4 and 5, ($p < .05$).

Liveability ratings (Figure 40) were also found to be significantly different between roads, $F(2.76, 46.49)$ (Greenhouse-Geisser adjusted) = 16.29, $p < .001$. Road 1 was rated as the least liveable with a mean rating of 1.29 (SD 0.69) and was rated as significantly less liveable than roads 2 to 6 ($p < .01$, $p < .01$, $p < .05$, $p < .001$, $p < .001$). Road 5 was rated as the most liveable, with a liveability rating of 3.35 (SD 0.61) and was rated as significantly more liveable than roads 1-4 ($p < .001$).

Aesthetics ratings between roads (Figure 40) were not significantly different $F(2.86, 45.82)$ (Greenhouse-Geisser adjusted) = 1.18, $p > .05$.

Differences Between Experimental Roads Before the Workshop

No significant differences between the two experimental roads, Moa Road and Point Chevalier Road, (Figure 40) were found for estimated speeds, safety, aesthetics, preference, or liveability ratings, $F(1. 15) = 0.03$, $p < .05$, $F(1. 15) = 0.16$, $p < .05$, $F(1. 15) = 2.22$, $p < .05$, $F(1. 15) = 0.48$, $p < .05$, $F(1. 15) = 0.23$, $p < .05$,

Differences Between Experimental and Control Roads Before the Workshop

The ANOVAs for road safety, preference, liveability, and estimated speed were significant. $F(7, 98) = 5.75$, $p < .001$, $F(3.42, 54.71) = 3.05$ (Greenhouse-Geisser adjusted), $p < .05$, $F(7, 105) = 9.41$, $p < .001$, and $F(7, 112)$, $p < .001$, $F(2.98, 47.63) = 35.09$ (Greenhouse-Geisser adjusted), $p < .001$ respectively.

Post hoc testing revealed that Moa road, with a mean rating of 2.77 (SD 1.35) was rated as significantly less safe than roads 1 and 2, mean 3.59 (SD 1.36) and mean 3.71 (SD .99) respectively. Point Chevalier road was rated as significantly less safe than roads 1, 2 and 3 (mean 3.06 (SD .93), $p < .01$, $p < .001$, $p < .01$ respectively (Figure 40).

Moa road (mean 2.13 SD 1.17) and Point Chevalier road (mean 2.31 SD 1.25) were rated as significantly more liveable than road 1 (mean 1.29 SD .69), $p < .05$ and less liveable than road 5 (mean 3.53 SD .61), $p < .01$. Point Chevalier road was also rated as less liveable than road 6 (mean 3.00 SD 1.17), $p < .05$ (see Figure 40).

In terms of estimated speed, both Moa road (mean 49.53km/h SD 6.74km/h) and Point Chevalier road (mean 48.09km/h SD 8.27km/h) had significantly lower estimated speeds than roads 1 (mean 86.03km/h, SD 18.09) 2 (mean 64.12km/h SD 17.25km/h) and 3 (mean 55 SD 11.18km/h), $p < .001$, $p < .01$, and $p < .05$ respectively. Point Chevalier Road had a lower estimated speed than road 4 (53.24 SD 10.45km/h), $p < .05$. Estimated speeds for both roads was higher than that of road 6 (mean 43.53 SD 6.56), $p < .05$ (see Figure 40).

The ANOVA for preference was significant, but, neither Moa road nor Point Chevalier road was rated significantly different than any of the control roads.

Differences in Road Ratings Between Groups in Experiments One, Two and Three

It was also of interest to determine whether participants rated the before roads differently due to their concern about and knowledge of the roads, when compared to those who were not directly concerned about the roads that they were redesigning. Road safety, aesthetics, preference, liveability (for the second experiment only) and speed were measured using a one-way ANOVA. Significant differences between ratings for safety, aesthetics, preference and estimated speed for the road used in experiment one (Tramway Road) were found, $F(2, 33.88) = 11.29$, $p < .001$, $F(2, 59) = 14.79$, $p < .001$, $F(2, 35.58) = 5.00$, $p < .05$, and $F(2, 59) = .004$. Post hoc testing revealed that Tramway road was rated as significantly safer ($p < .001$, $p < .001$), aesthetically pleasing ($p < .01$, $p < .001$) and more preferred ($p < .05$, $p < .01$) than both Moa and Point Chevalier roads.

Tramway road had a mean rating of 3.96 (SD 0.51) for safety, versus 2.76 (SD 1.35) and 2.62 (SD 1.02) for Moa and Point Chevalier roads. Aesthetically, Tramway road was rated 3.61 (SD .83) compared to 2.76 (SD .66) and 2.26 (SD 0.97) for Moa and Point Chevalier roads. Preference ratings for Tramway road were 4.64 (SD 0.56), while Moa and Point Chevalier roads had ratings of 3.76 (SD 1.35) and 3.56 (SD 1.46) respectively. Estimated speed for Tramway road was 55.64km/h (SD 8.10km/h) compared to 49.53km/h (SD 6.74km/h) for Moa road and 48.09km/h (SD 8.27km/h) for Point Chevalier road. These differences can be clearly seen in Figure 41 below.

Participants' before ratings from experiment two for River road and Church road were compared to those from experiment three to determine whether any differences existed. The ANOVA revealed significant differences between groups for road safety, aesthetics, and estimated speed ratings. $F(3, 83) = 8.44$, $p < .001$, $F(3, 83) = 20.29$, $p < .001$, and $F(3, 83) = 2.47$, $p < .001$. Post hoc testing revealed that both Moa (mean 2.76 SD 1.35) and Point Chevalier roads (mean 2.62 SD 1.02) were rated as significantly less safe than River road (mean 4.00 SD 69), $p < .001$. Aesthetically, Moa (mean 2.76 SD .66) and Point Chevalier (mean 2.62 SD 1.02) roads were rated significantly lower than River road (mean 3.97 SD .49), $p < .001$.

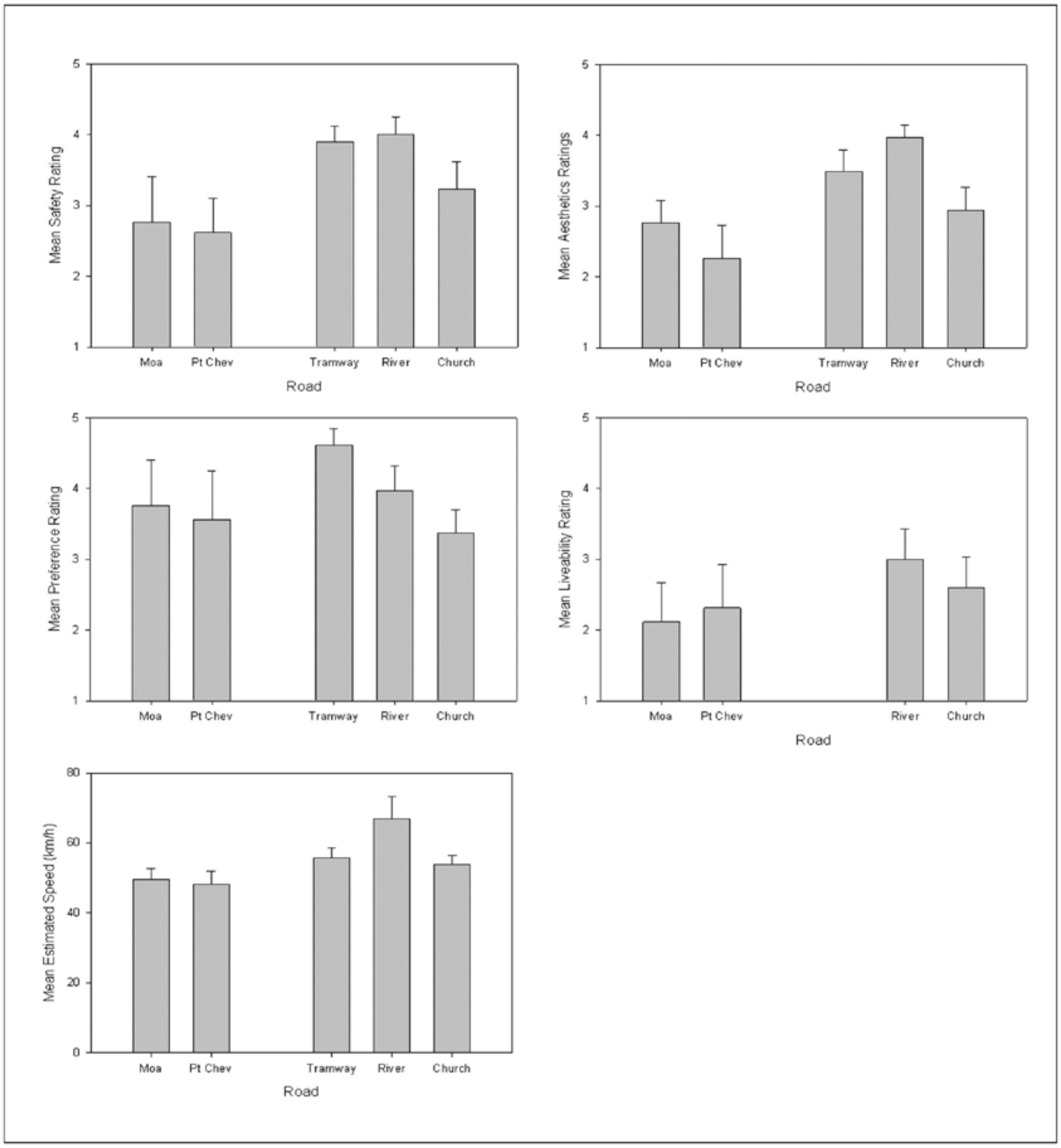

Figure 41: Safety, aesthetics, preference, liveability and estimated speed ratings for experimental roads from experiments one, two, and three.

Point Chevalier road was also rated significantly lower than Church road (mean 3.13 SD 1.00), $p < .01$. Estimated speeds were also significantly different. Moa road had a mean estimated speed of 49.53km/h (SD 6.74) and Point Chevalier road had an estimated speed of 48.09km/h (8.27), compared to River road which was rated as 66.92km/h (SD 17.90), $p < .001$.

Attitude Ratings

Three repeated measures MANOVAs were done to determine whether any changes in attitudes occurred when comparing measures before, immediately after and one month after the workshop. The three MANOVAs measured attitudes towards speed, the likelihood that participants would drive over the speed limit, and the speeding subsection of the DAQ respectively.

Attitudes Before and After the Workshop

No before and after differences were observed for the attitudes towards speed section (Wilks' Lambda = .70, $F(4, 11) = 1.18$). Nor for the intentions to drive over the speed limit section (Wilks' Lambda = .47, $F(6, 10) = 1.91$). When age was added as a co-varying factor, for MANOVA for the DAQ section, there were significant differences found, Wilks' Lambda = .17, $F(7, 7) = 4.93$, $p < .05$. Univariate testing showed that participants were happier to have speed limits more strictly enforced, with the mean score increasing from 4.03 (SD 1.15) to 4.44 (SD .81) and agreed more with the assertion that speed limits are set too low, mean = 2.27 (SD 1.32) to mean = 2.41 (SD 1.41). $F(1, 13) = 4.83$, $p < .05$ and $F(1, 13) = 4.86$, $p < .05$ respectively. Age was positively correlated with the question asking whether speed limits were set too low, $R = .66$, $p < .01$, with older people more likely to agree with the assertion.

Attitudes Before the Workshop Compared to Month After the Workshop

The speed subsection was measured before and after using a repeated measures MANOVA. The MANOVA was significant, Wilks' lambda = .07, $F(4, 3) = 10.07$, $p < .05$. Univariate tests showed that participants were less likely to say that they enjoyed driving fast on the open road, the mean score fell from 3.29 (SD .95) to 2.64 (SD 1.03). $F(1, 6) = 12.79$, $p < .05$. Other sections were not analysed due to a lack of degrees of freedom caused by an extremely low response rate.

Behavioural Change

As with experiment two, all those who took part in the experiment were given a survey regarding their driving behaviour, the DBQ, before the workshop and one month after the workshop. No significant differences in self reported behaviour were found when comparing behaviour prior to the workshop and after the workshop. However, there was a very poor response rate after the workshop, with only nine out of the seventeen participants who took part returning their one month follow up surveys.

Summary

Rather than being self-rated, the roads that were redesigned by the two teams in this experiment were rated by three independent road safety experts. A very positive finding in this experiment was that the independent judges felt that the group who redesigned Point Chevalier road had created a successful intervention. Their ratings of estimated speeds were reduced by approximately 10km/h, and aesthetic ratings were also improved. Ratings for Moa road remained unchanged. With this experiment there were some changes found in attitudes towards speed with participants reporting that they were happier with stricter enforcement and that speed limits were set too low. One month after the workshop participants these ratings were back to the same levels as prior to the workshop, but participants were less likely to report that they enjoyed driving fast on the open road. Unlike experiment two, no reliable changes in self-reported behaviour were found in this experiment. However, it must be noted that the one-month follow up survey had an extremely low response rate (9 out of 17 participants returned the survey).

Control roads were also rated by participants and these ratings varied widely, especially for estimated speeds. Despite all roads have a posted speed limit of 50km/h, ratings ranged from close to 90km/h down to around 40km/h. Unlike experiment two, these ratings did not alter 1 month after the workshop. Safety ratings were not as varied as estimated speed ratings, but there was a tendency for higher safety ratings to be associated (non-significantly) with higher estimated speed ratings. Liveability ratings varied between roads before the workshop, but not after the workshop. When safety, aesthetic, preference, liveability and estimated speed ratings for Point Chevalier and Moa roads were compared to ratings for control roads, it did not appear that ratings for Point Chevalier and Moa roads were significantly different than those for other roads overall. When ratings were compared to before ratings for roads from previous experiments, safety, aesthetic, and preference ratings for both Point Chevalier and Moa roads were lower than Tramway road (experiment one), but estimated speeds were also slower. When compared to roads from experiment two, Point Chevalier and Moa roads were rated as less safe and less aesthetically pleasing than river road, but only Point Chevalier road was rated a less aesthetically pleasing that Church road. Both roads had significantly lower estimated speed ratings than River road, but not for Church road.

It did appear that participants from this experiment had a tendency to rate their roads lower than participants from other experiments, but when examining the results from experiment two, River road was also rated significantly safer, aesthetically pleasing and was more preferred than Church road by participants in experiment two, but it also had higher estimated speed ratings than Church road. These findings are of interest as they again appear to point to a trend of lower safety, aesthetic and preference ratings associated with lower estimated speeds, rather than any bias towards roads. It is also of interest to note that in this experiment, estimated speed ratings were not above the posted speed limit for either Moa or Point Chevalier roads, indicating that participants were not concerned with speeds, but rather other aspects of the road design that may have been causing accidents, such as traffic volume or the potential for people to drive over the speed limit as there were no physical measures in place to prevent this from happening.

As in previous workshops, the process was rated highly by participants as a teaching and design tool and almost all participants felt that they were able to participate. This is an interesting finding, as several participants made up part of the audience, who did not fully participate in the actual design process. This demonstrates that having people take part as an audience could be a good way to increase the numbers who take part in a participatory design workshop without affecting people's views on whether or not they felt involved in the process.

Experiment three was a substantial departure from the methods used in experiments one and two. As a result, several advantages and disadvantages of the method were revealed. The new format of the workshop worked very well as a participatory design process. The design process was more unstructured, with audience members able to freely move about the room and observe the design teams redesigning the roads. Based on the ratings that were received for the workshop, people still felt they were highly involved in the process indicating that having the audience members as part of the participatory design workshop was successful. The unstructured approach also seemed to spur more creativity in the design teams, with one of the teams placing artwork in their redesigned road environment, something that was not seen in previous workshops. Furthermore, one of the expert judges commented on the aesthetics of the road designs being very good, which was also shown in the judges aesthetics ratings for Point Chevalier road. Not only were the designs creative, one of the groups also managed to reduce estimated speed ratings for their road, which were already low prior to the workshop, as rated by the expert judges. So the unstructured approach not only improved creativity, it still enabled participants to focus on designing a safer road as well.

Despite the fact that the unstructured approach has some very positive outcomes, the ability of audience members to move about freely amongst the design teams meant that most audience members continued to interact with design teams after their allotted time period. This had the potential to distract the design teams and also raised the possibility of conflict amongst design teams and audience members, since many more ideas and opinions were being put forth. So although it allowed for more participation, it made facilitation of the process more difficult.

The use of independent road safety experts as judges also appeared to be a good way of rating the redesigned roads without the potential of bias in the ratings. Unfortunately, participants were not able to rate their own designs, so it was not possible to compare judges' ratings with those of participants.

In this experiment, members of a community road safety group (SALT) were used as participants, and this was a valuable exercise, particularly since it involved liaising with the groups' leader to discuss the roads and the concerns which they had about them. However, the use of a community group also meant that there was more of an emphasis on outcomes and given that the workshop was part of an experiment, it is possible that the group may not have felt that their involvement led to any tangible outcomes. Furthermore, it was also important to ensure that the goals of the researcher and the goals of the community group were both achievable, which may not have been possible in the case of this experiment.

Finally, the road safety experts who took part in this experiment only took part as judges and not as active participants. Therefore they were able to remain more objective in judging the redesigned roads, but it would have been interesting to get them to take part as team members to help with the road redesign.

EXPERIMENT FOUR

Apart from the main goals of improving road design, driver behaviour and attitudes, experiment four also aimed to further refine the method of including an audience, investigate the inclusion of road safety experts as team members, and improve on how ratings were collected.

The rationale behind the refinement of the inclusion of an audience was that the way in which the audience interacted with team members in experiment three had the potential to create conflict and disrupt the participatory design process. This was done by changing the setting in which the workshop took place, with teams placed in front of the audience (Figure 44). The audience was seated in a lecture theatre so that they were able to view the teams working without having to walk around the tables where the teams worked (Figure 45). The overall process was also less relaxed than that used in experiment three. The audience was only involved for the five minute time limit and not beyond this. Teams also took questions from the audience after they had completed their redesigns outlining the logic of their design decisions.

For the design part of the experiment, two road safety experts took part, one in each team, to help guide participants with their designs. This was also to investigate how the inclusion of experts would affect the way that teams interacted with each other.

Roads were once again judged by the teams who designed the roads, but unlike previous experiments, the audience also judged the roads. Rather than two roads chosen by the community, this experiment used River Road as the road to be redesigned. The rationale behind this was that this particular road was problematic in terms of redesign, with a high traffic flow, high average speeds and several areas along the road where accidents tended to occur. A total of 8 control roads (Figure 42) were used to test participants' perceptions of roads before and after the experiment. River Road was included as a control road (road 2) to see whether participants' perceptions of the road would change one month after the experiment.

Figure 42: Control roads for experiment four.

Finally, ratings were collected using both written and online methods to attempt to improve the poor return rate that was experienced in experiment three.

Methods

Participants

Prior to beginning the research ethical approval was obtained from the Psychology Department Human Research Ethics Committee at the University of Waikato. Twenty eight participants, recruited via various community organisations and the University of Waikato, as well as two road safety experts, took part in the workshop. Where participants came from community organisations, $10 per participant was given to their organisation. Individual participants were given either $10 petrol or Warehouse vouchers. Ten of the participants were female and 18 of the participants were male. Their ages ranged from 15 to 76 (mean 40.18, *SD* 18.56), they drove between 0 and 120,000 kilometres per year (mean 27,569.57, SD 35,290.26), had between 0 and 60 years of driving experience (mean 23.48, SD 18.94), a mean of 0.04 infringements and 0 crashes.

Materials

Questionnaire

The questions used for experiment four were identical to that used in experiment three, apart from the control roads used to test participants' perception of roads. However, the layout of the questions was changed. There were three questionnaires given (Figure 43).

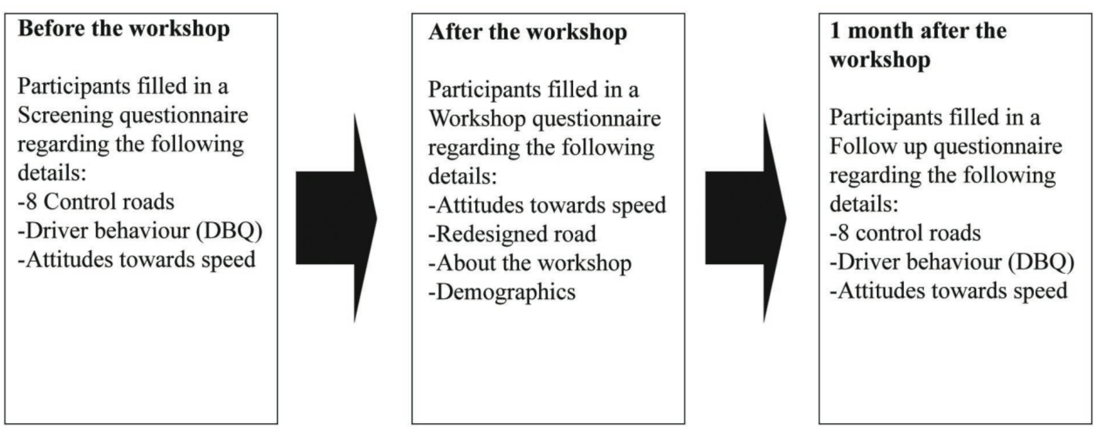

Figure 43: Questionnaires given for experiment four.

The Screening questionnaire was given prior to the workshop and included the following sections for rating roads, driver behaviour, attitudes towards speed and demographic information. The Workshop questionnaire was given after the design portion of the workshop and asked participants to rate the roads that had been redesigned during the workshop, their attitudes towards speed and the design workshop. The Follow up questionnaire asked participants to rate the control roads, driver behaviour one month following the workshop and about their attitudes towards speed. Pt Chevalier road was replaced with Tramway road. The questionnaire can be found in Appendix D.

Presentation

The 15 minute “participatory road design presentation” that was used in experiment three was used again in this experiment, the one change being that it included information regarding River road instead of the roads used in experiment three. This included road width, traffic flow and the safety and speed issues that the road had. The changes made to the presentation can be found in Appendix D and the original presentation can be found in Appendix C

Toolkit

The toolkit was identical to that used in experiments one and two, but in this experiment, as with experiment three, two toolkits were used.

Procedure

As mentioned above, recruitment of participants took place via various community organisations and the University of Waikato. A representative from the organisation took personal details of interested parties and personal contact by the researcher was made with them to arrange for them to take part in the workshop. At this time the first questionnaire was also sent out to participants to allow more time for the design process during the workshop. Questionnaires were also made available online. At the time of the workshop, participants were given a consent form and were told that participation in the research was voluntary and that they were allowed to leave at any stage of the experiment. Participants were also told that any information collected during the procedure was confidential and that no names or any other personally identifying information would be used in the experiment.

In this experiment teams were self selected and therefore, to ensure teams had a chance to familiarise themselves with the task, tools and layout, at the beginning of the workshop a request was made for 10 participants to make up two design teams of 5 people; each team also included one road engineer, making a total of 6 people per team. The presenter then gave the participatory road design presentation and described the toolkit and speed reduction measures booklet. Participants then began redesigning their roads, which took approximately one hour. Approximately half way through the process, the audience was able to interact directly with the teams more directly by observing the designs close up, asking questions and providing comments and inputs for approximately five minutes.

Figure 44: Room layout

Once the designs were completed, a representative from each of the teams gave an oral description of their designs and the rationale behind them. The audience was also allowed to ask questions regarding the designs that the teams had come up with. Once this was finished, the participants filled in the workshop questionnaire and rated the roads designed by each of the teams. Approximately one month after the workshop, the follow up questionnaire was sent out and collected.

Figure 45: Workshop in progress

Results

The results section is laid out in the following order:

- Experimental road ratings before and after the workshop
- Control road ratings before and one month after the workshop
- Attitudes towards speed before, after and one month after the workshop
- Changes in Driver behaviour one month after the workshop
- Analysis of differences between teams using sociometrics
- The two teams had quite different designs for river road as shown below in Figures Figure *46*Figure 47.

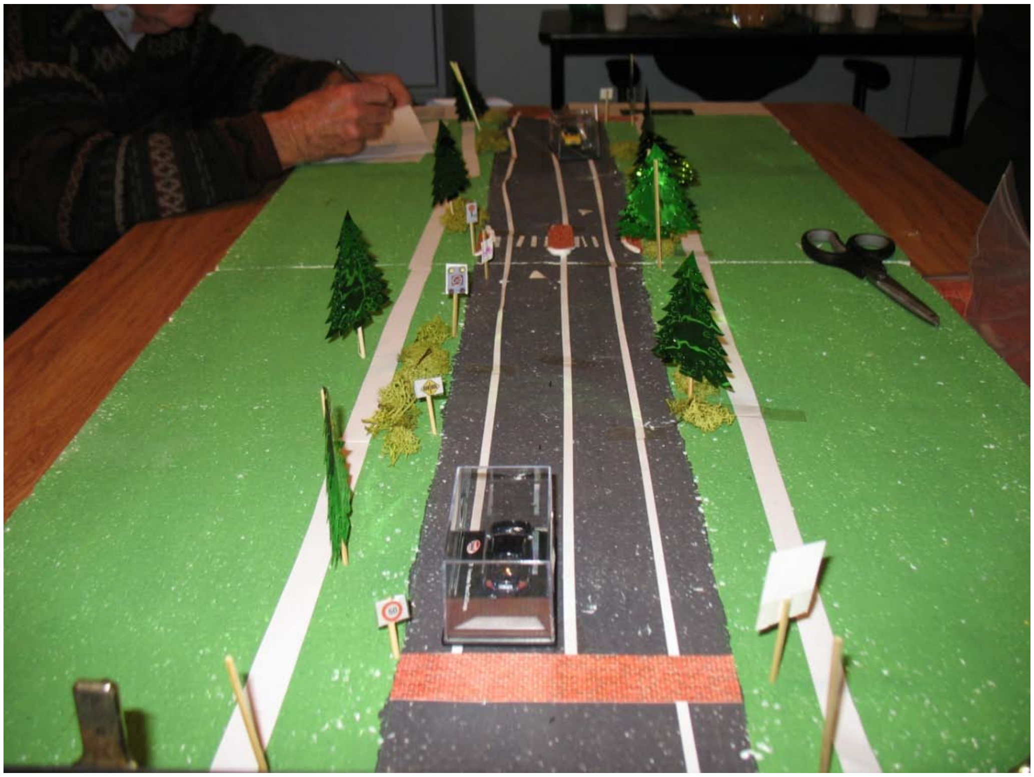

Figure 46: River Road as Redesigned by team one.

Figure 47: River Road as redesigned by team two.

Experimental Road Ratings

In order to determine whether any differences in road ratings existed before and after the workshop and between teams, a 2 X 2 mixed design MANOVA using the variables of road safety, aesthetics, preference, liveability and estimated speed was done The MANOVA was significant, Wilks' Lambda = .287, $F(10,12) = 2.98$, $p < .05$. Univariate tests revealed that both road safety ratings and estimated speed ratings were significantly different. $F(2, 42) = 3.3$, $p < .05$ and $F(1.32, 27.71) = 14.48$, $p < .001$. Estimated speed was found to be significantly different after the workshop (Figure 49), both teams managed to reduce estimated speed ratings with team one reducing estimated speed from an estimated 66.4km/h (SD 15.17) to 54.4km/h (SD 8.70) and team two to 52.22km/h (SD 9.34).

Post hoc tests revealed that safety ratings for the road between teams was different after the workshop, with team one (mean = 3.28, SD 0.82) having lower ratings than team two (mean = 3.83, SD 0.63), $p < .05$. Other ratings were not significantly different, although Figure 48 does show that both teams managed to improve liveability ratings. Interestingly, team one's ratings for aesthetics and preference were both (non-significantly) lower than team two as well as the before ratings. Ratings did not differ between teams and audience, nor did they differ between males and females.

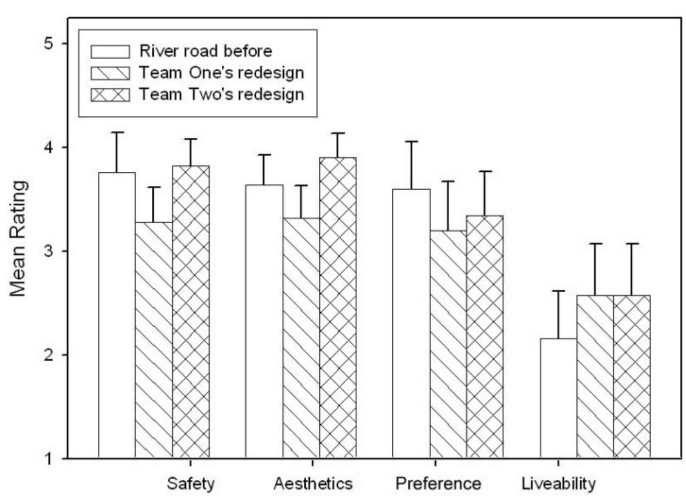

Figure 48: Mean road safety, aesthetics, preference, and liveability ratings for river road before the workshop and for teams one and two after the workshop (95% CI).

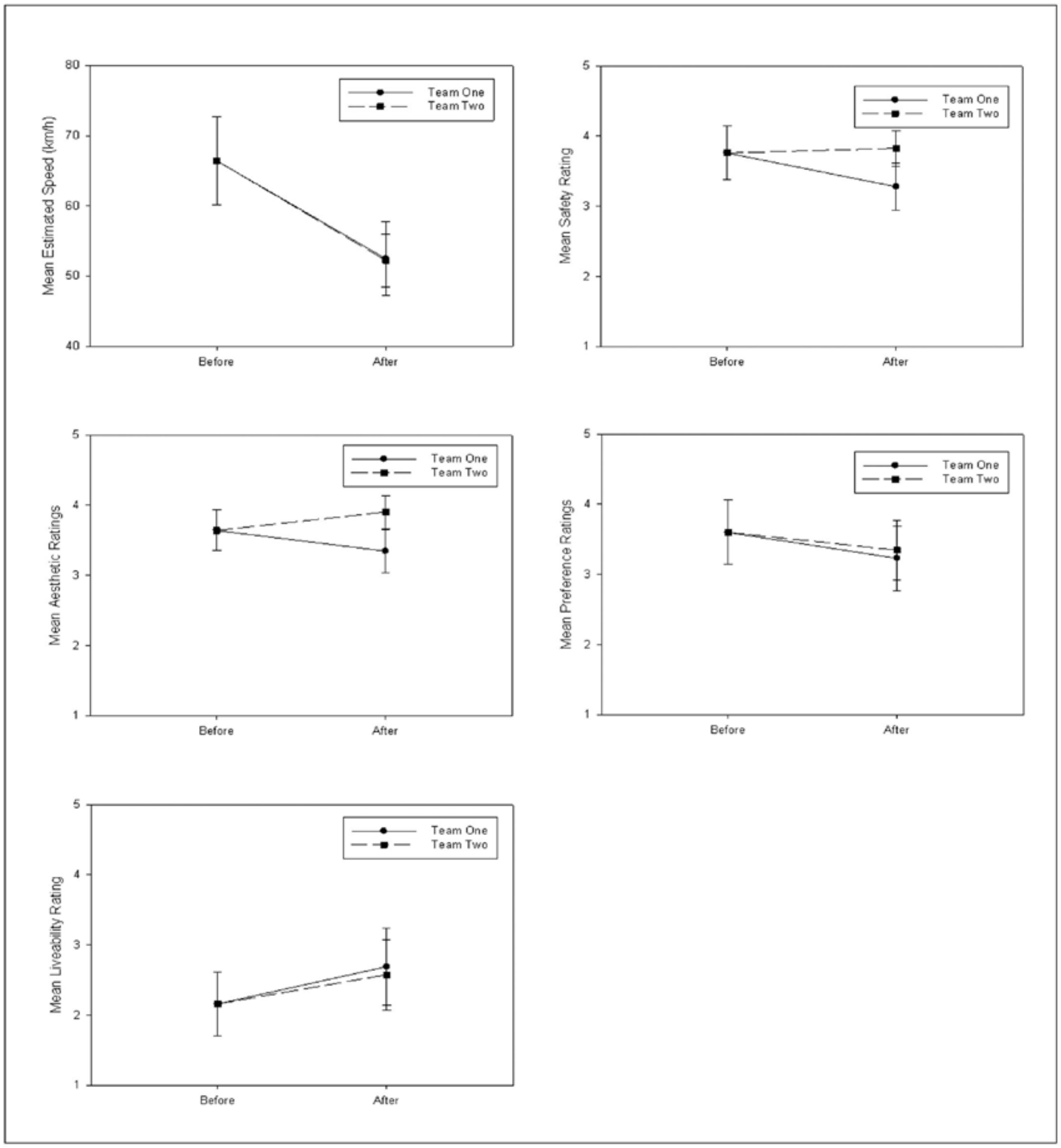

Figure 49: Changes in estimated speed, safety, aesthetics, preference and liveability ratings generated by teams one and two (95% CI).

Control Road Ratings

Participants also rated eight control roads for safety, aesthetics, preference, liveability and estimated speed one month after the workshop. Each of the roads rated by participants was analysed separately using a repeated measures MANOVA with five dependent variables.

Out of the eight roads, two were significantly different in their ratings, road two and road three (Figure 50), Wilks' Lambda = .36, $F(5, 12) = 4.22$, $p < .05$, Wilks' Lambda = .40, $F(5, 12) = 3.58$, $p < .05$. Road two had a significant drop in estimated speed ratings from an average of 62.35km/h (SD 11.34km/h) to 56.94km/h (SD 9.73) and road three had a drop significant drop in mean aesthetics and liveability ratings, 3 (SD .87) to 2.53 (SD .87) and 2.51 (SD 1.33) to 2.18 (SD 1.19) respectively. Figure 50 below shows that ratings for roads with an already low estimated speed rating remained stable. Safety, preference, and liveability ratings remained unchanged.

Attitudes Towards Speed

The attitude section was split into three separate sections, with each section analysed by a separate repeated measures MANOVA. The first section asked questions regarding attitudes to speed and enforcement and had four dependent variables, the second section asked more specific questions regarding participants' intentions to break the speed limit and had six dependent variables.

The third and final section asked questions from the speeding subsection of the Driver Attitude Questionnaire (DAQ) and had seven dependent variables. Repeated measures MANOVAs were done on each of the three sections to find out whether any differences existed in attitude before and directly after the workshop. No significant differences in attitude were found. The addition of age and team membership as covariate also yielded no significant results.

Participants were also asked directly whether they felt the workshop had changed their attitudes and whether they felt that everyone was able to take part in the workshop. Twenty-four out of 28 (85.7%) participants said they felt that everyone was able to participate in the workshop and 11 out of 28 (39.3%) felt that their attitude towards driving had changed as a result of the workshop.

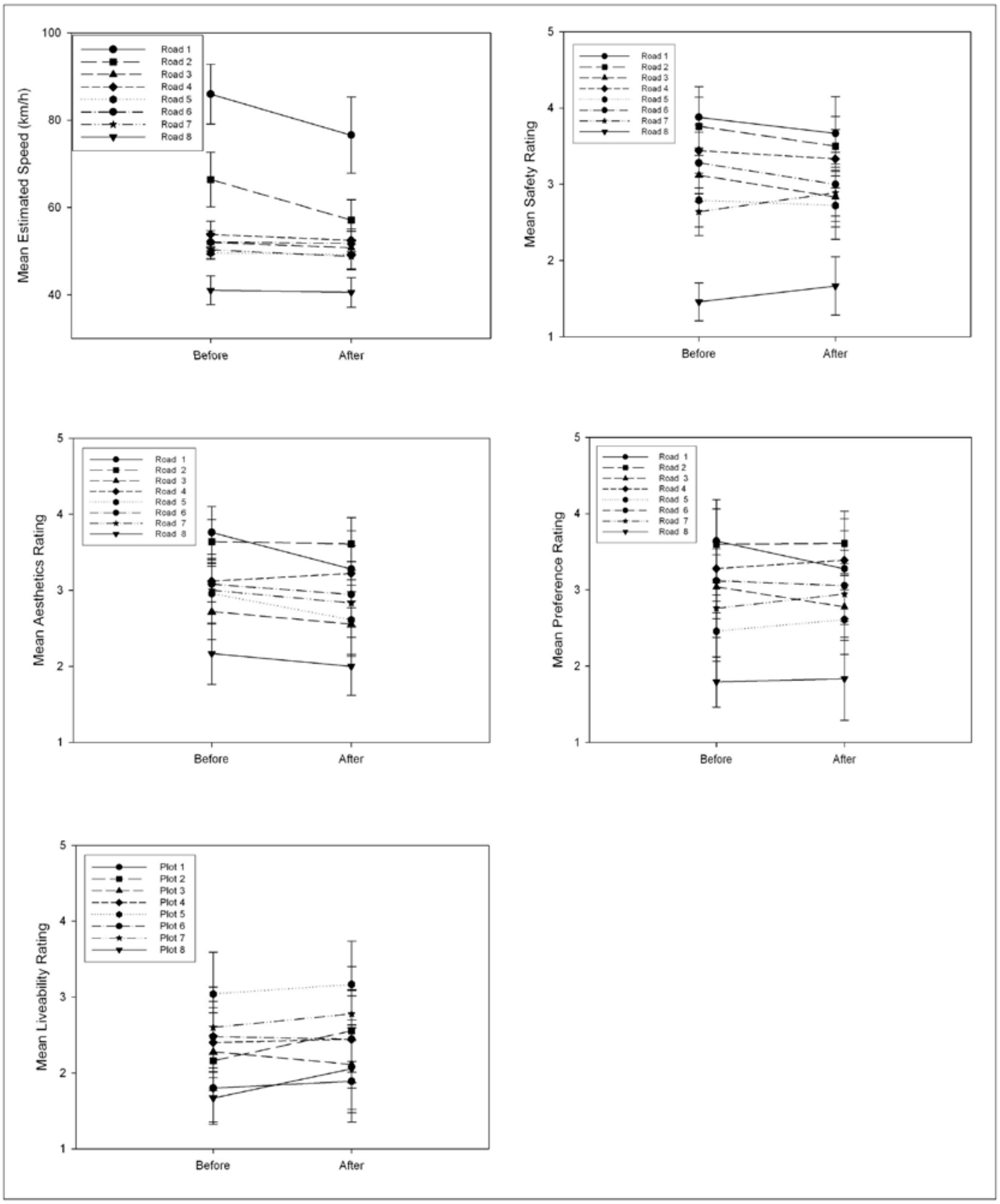

Figure 50: Estimated speed, safety, aesthetics, preference, and liveability ratings for control roads before and one month after the workshop.

A Mann-Whitney test revealed that differences in attitude ratings existed between team members and audience members. One person reported an attitude change and 10 reported no change for team members, whereas 10 audience members reported an attitude change and 6 did not, $U = 44$, $p < .01$.

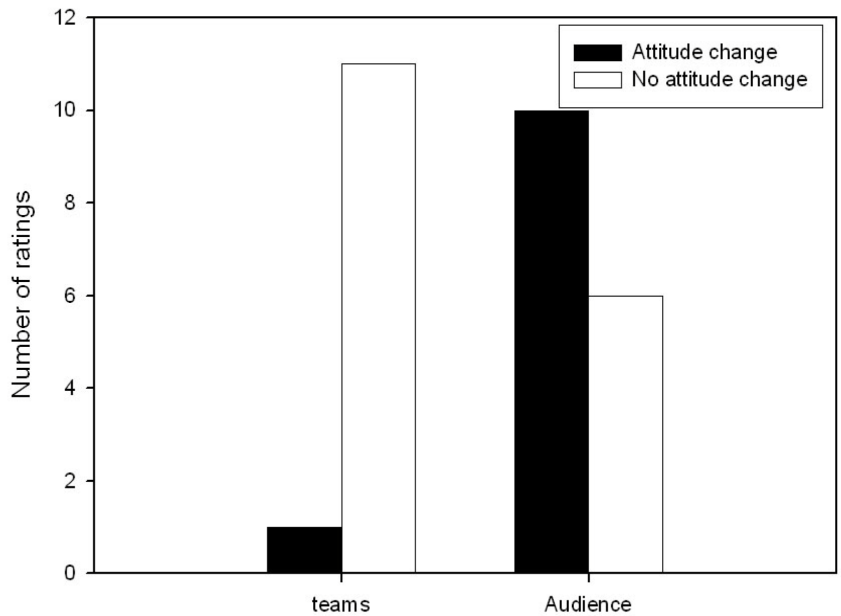

Figure 51: Graph showing those who reported an attitude change and those who didn't separated by team or audience membership.

One Month Follow up Survey

Attitudes towards speed and driver behaviour ratings were collected one month after the workshop and are shown below. Unfortunately, due to the name field not being validated in the one month follow up survey, many participants did not enter their names, making it impossible to differentiate between team and audience members for this analysis. Hence, all participants' data was analysed as one group.

The measures and analyses used were the same as in the before and after study mentioned above and the DAQ speeding subsection had a significant MANOVA result and a univariate analysis revealed that participants were less likely to report that they knew exactly how fast they could drive and still drive safely. Prior to the workshop the average score for this question was 4.00 (SD .82) and one month after the workshop the average score was 2.87 (SD 1.31). Wilks' Lambda = 0.22, $F(7, 9) = 4.61$, $p < .05$ and $F(1, 15) = 13.97$, $p < .01$. The first two sections did not yield any significant results.

Participants were also asked to rate the workshop as a way to improve road design and as a teaching tool. The workshop was rated a mean of 3.80 out of 5 (SD 1) as a design tool and 4.04 out of 5 (SD 1) as a teaching tool. It was also of interest to determine whether being a team member or an audience member had any effect on these ratings. A Mann-Whitney test was done to determine whether any differences existed between audience and team members. No significant differences were found for either rating. The same test was conducted to determine whether any gender differences existed and once again, no significant differences were found indicating that all participants rated the workshop equally highly.

Changes in Driver Behaviour

Driver behaviour was rated before and one month after the workshop. A repeated measures MANOVA with four dependent variables (violations, aggressive violations, lapse and errors) was done to determine whether any changes in participants' self reported driving behaviour took place within 1 month after the workshop. The MANOVA revealed significant changes in self reported driving behaviour. Wilks' Lambda = .22, $F(4, 14) = 12.34$, $p < .05$. Univariate analyses found that self reported violations and lapses both fell significantly, with violations falling from an average score of 6.11 (SD 4.89) to 4.56 (SD 5.09) and lapses from a mean of 8.56 (SD 3.69) to 4.78 (SD 3.69). $F(1, 17) = 4.50$, $p < .05$ and $F(1, 17) = 14.60$, $p < .01$. The graph below shows that, although non-significant, reports of aggressive violations and errors also fell substantially in the month following the workshop.

Analysis of Differences Between Teams

In an effort to determine why ratings were different between teams, further analysis of team structure was conducted. First individual team members' participation was analysed by counting the number of comments and interactions that each team member had. These were then compared to how individual participants rated the roads for safety, aesthetics, preference and liveability. Interactions and comments and road ratings were not correlated, which can be clearly seen in Figures 53and 54 below.

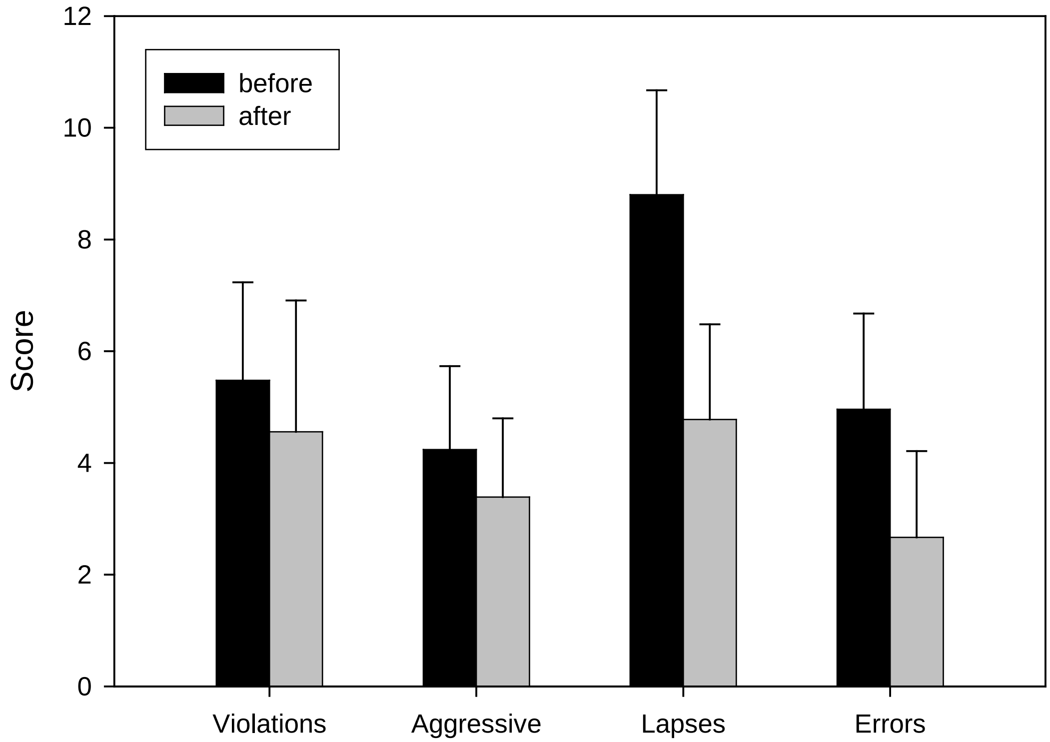

Figure 52: DBQ measures before and one month after the workshop (95% CI).

Due to the lack of correlation between comments, interactions and road ratings, sociograms (Figure 55) were then used to determine the structure of the groups' interactions. Sociograms are used to determine in-group and out-group members based on the number of interactions they have with others. They stem from the study of sociometry and psychodrama (Moreno, 1953). Sociograms are part of social network analysis and give a visual representation of how people interact with each other and allow a visualisation of any asymmetries in a social network (Scott, 2000). They have been used in the analysis of social networks of children in classrooms, in particular those with disabilities (e.g. Tan and Cheung, 2008), the analysis of teamwork in software development (Yang and Tang, 2004) amongst others. For this experiment, they were adapted to show how well a group functioned by showing the links between participants through their interactions with each other and the number of comments made to the entire group. Team members were given numbers, those that started with "M" were male and "F" were female, "FA" was the facilitator, in all cases, the facilitator was the experimenter. The numbers in brackets indicate the number of comments or points that were made to the entire group and the numbers along the lines indicate number of interactions that were held between two individual group members without involving the other team members.

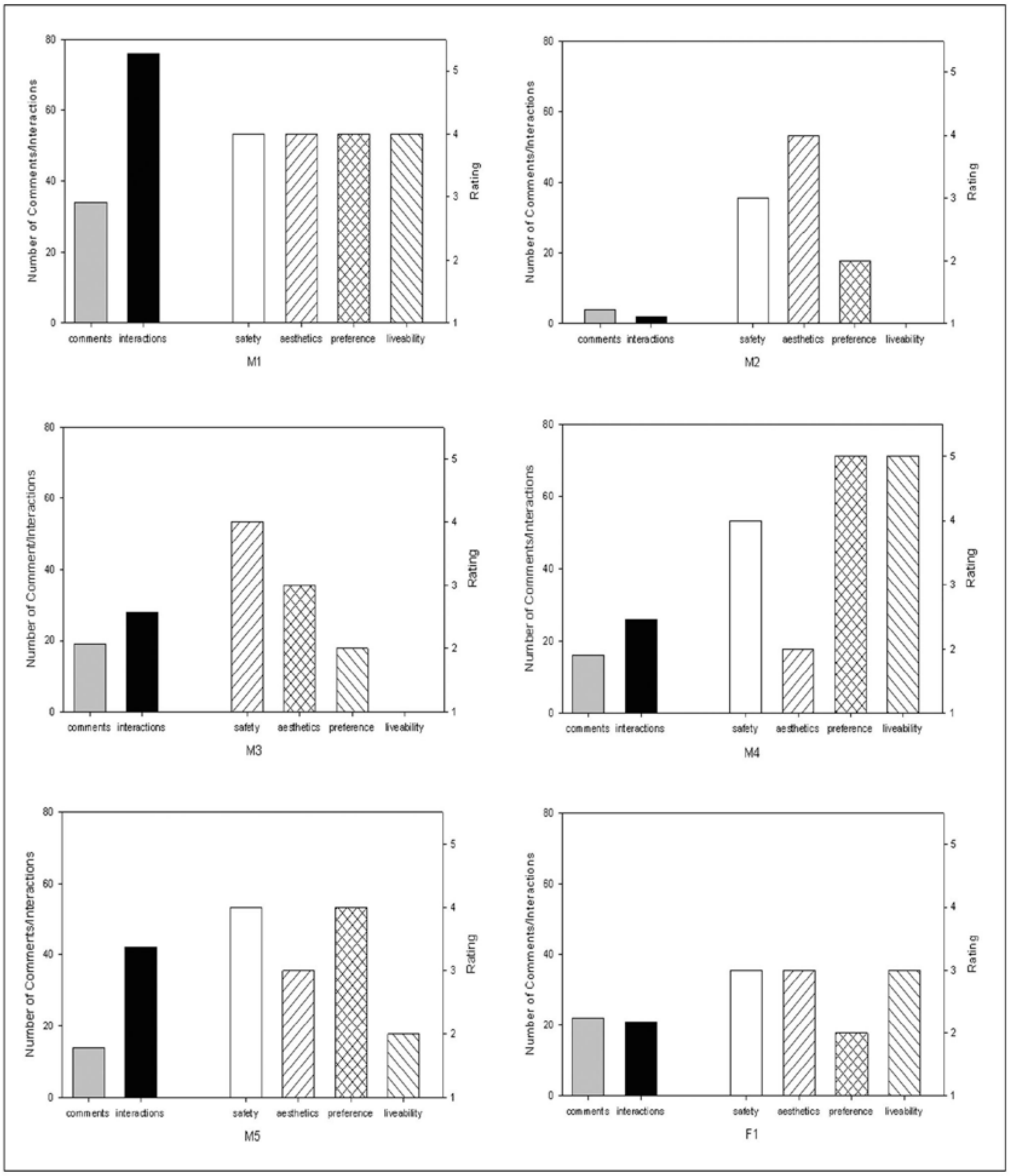

Figure 53: Comments, interactions and road ratings for team one members.

The sociograms clearly show that interactions and comments were more balanced for team two, with each of the team members interacting at least once with each other. In contrast, the sociogram for team one shows that M2 was largely excluded from the group and there was a largely exclusive set of interactions between M1 and M4.

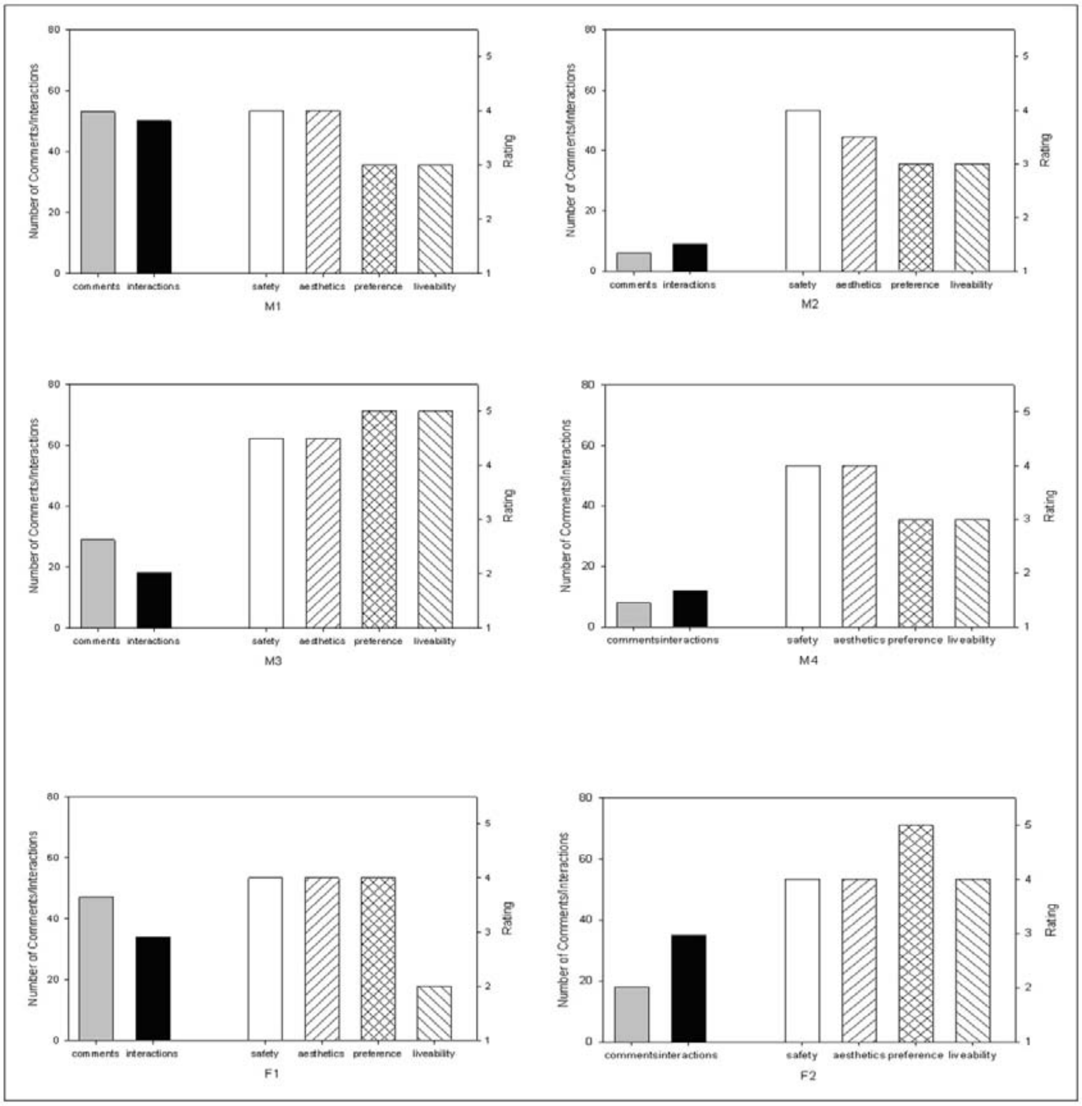

Figure 54: Comments, interactions and road ratings for team two members.

Interestingly comments from two of the team members commented on some issues with participants, e.g. “older participants had very narrow and unbending views that ignored other’s perspectives.” And “…dominating personalities can drown out others.” These types of comments were absent from team two’s feedback.

The road engineers were M4 for team one and M1 for team two. The road engineer was the “star” in team one, with the most comments and interactions out of all of the team members. However, interactions were well balanced, with the comments and interactions spread well between the road safety engineer and other participants. In team one, the road engineer was not the star in the group, but his time was dominated by the “star” in the team. The number of backwards and forwards interactions show that M1 made 47 statements to the road safety expert, with 28 replies to M1 from the road safety expert.

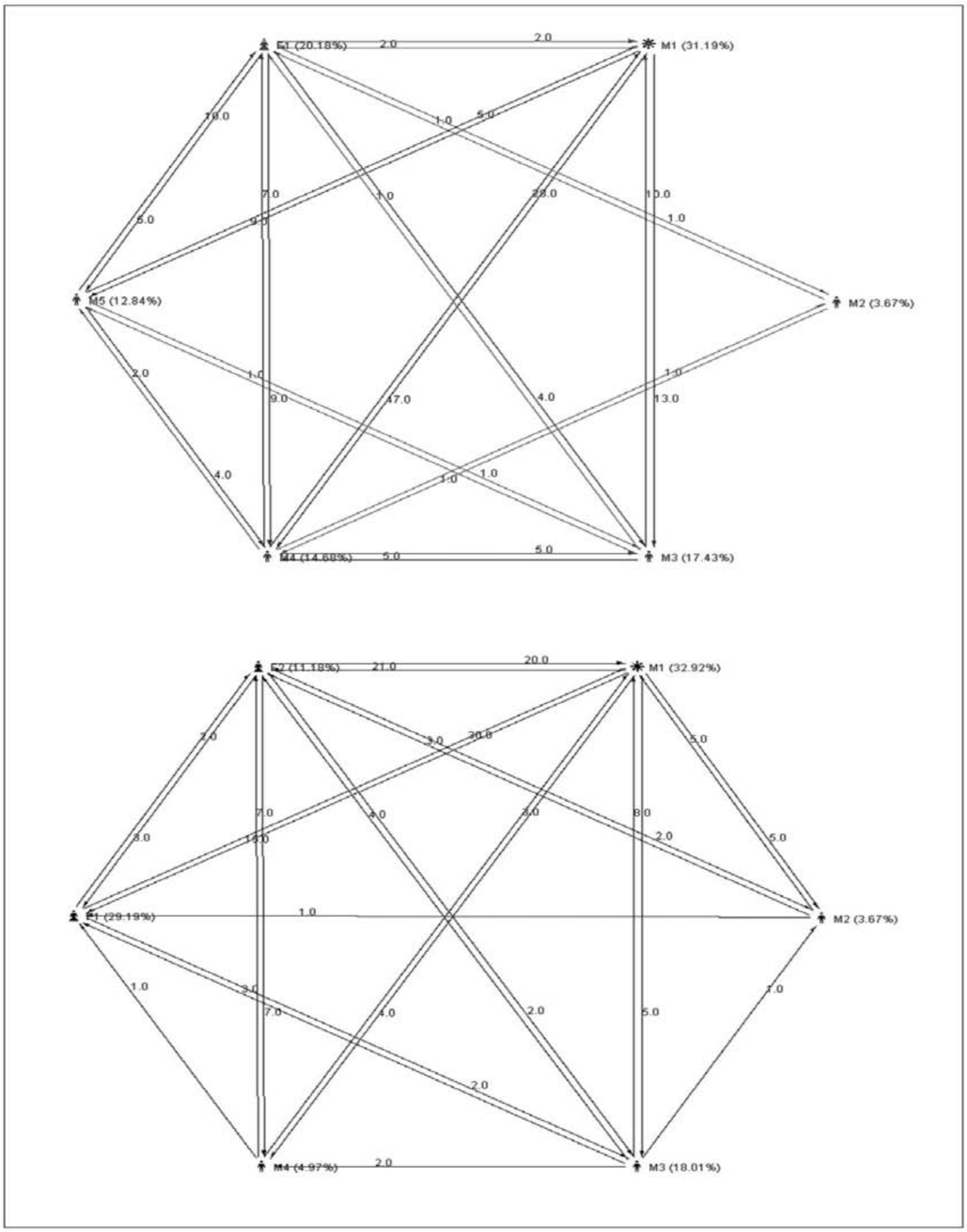

Figure 55: Sociograms for team one (top) and team two (bottom) in experiment four.

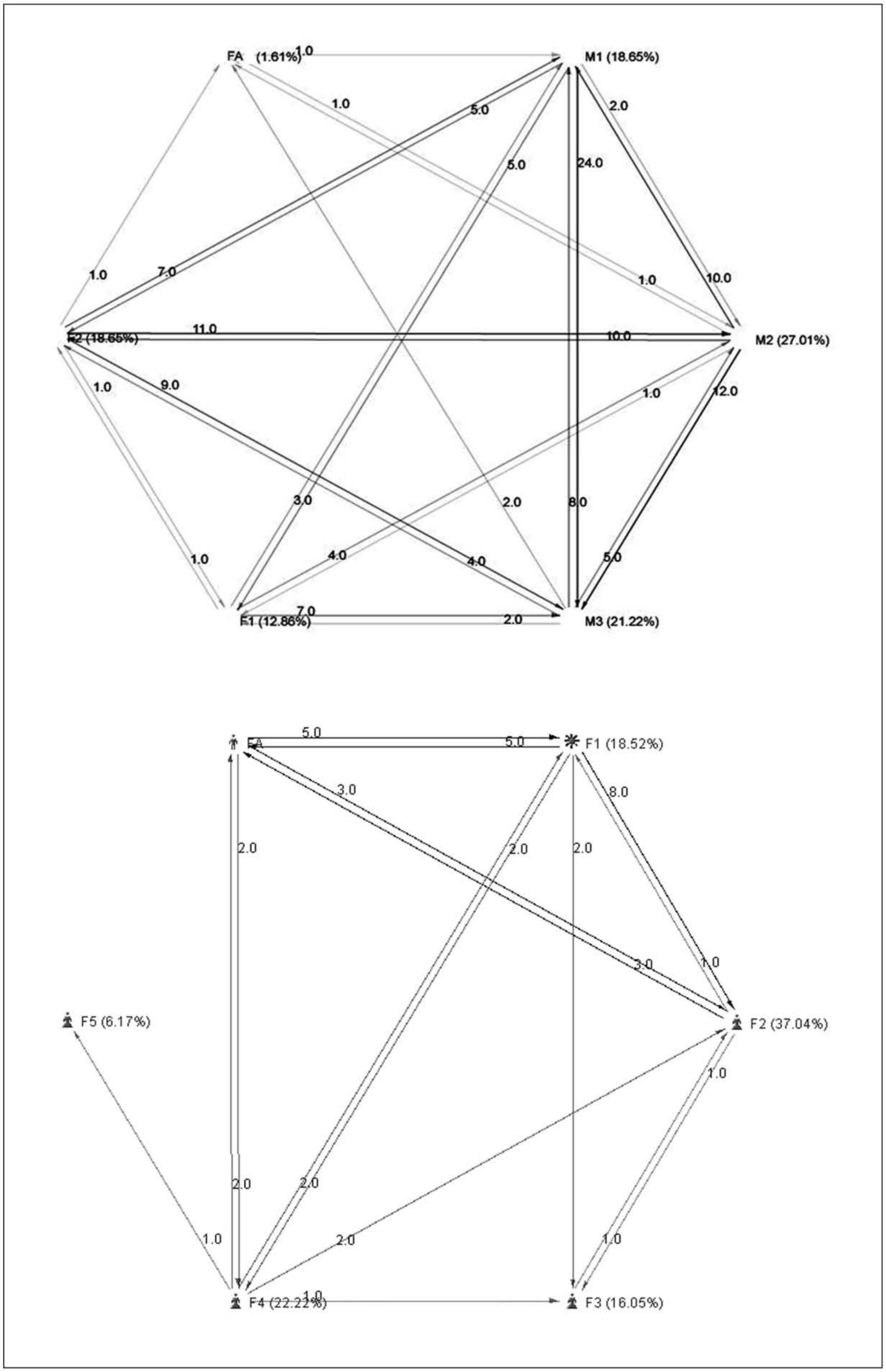

Figure 56: Sociograms for groups 1 (top) and 4 (bottom) from experiment one.

To test the validity of the finding that group structure appeared to affect the ability of teams to generate effective designs, a second set of sociograms were created for the groups that created the lowest and highest rated roads in experiment one as rated by participants from experiment two (Figure 56). Group 1 from experiment one created the highest rated road, and group 4 created the lowest rated road, as rated by participants from experiment two.

These sociograms also appear to indicate that group structure and communication is important for a successful workshop. As with the sociograms from teams 1 and 2, the sociogram for group 1 shows a cohesive structure with a good balance of comments made for each team member and more interactions between team members. Conversely, the sociogram from group 4 shows a lack of cohesiveness and also limited interactions with some participants, in particular F5.

Summary

As with previous experiments, both teams were able to reduce estimated speeds on the roads that they redesigned, in this case by approximately 10km/h. However, neither team was able to improve safety, aesthetic, preference or liveability ratings. No differences were found between audience and team members for these ratings. Safety ratings were different between teams; with team two's safety ratings higher than those for team one. Team one's ratings were also general, although not significantly lower, than team two's. Participants also rated control roads, and some differences were found. As with experiment two, the roads with higher estimated estimated speeds had speed reductions, one of them, road two, was significant. This is interesting, as this was also the road which participants redesigned. It is possible that they had more awareness of the speed limit on this road after redesigning it. Other roads' estimated speed ratings remained stable.

One month after the workshop, participants were significantly less likely to report that they knew exactly how fast they could drive and still drive safely. When asked directly whether they felt that their attitudes had changed as a result of participating in the workshop, there was a significant difference between those who took part as team members and those who took part as audience members. Substantially more audience members reported that they felt their attitudes had changed. Unlike the previous experiment, self-reported behaviour improved significantly, with violations and lapses falling significantly and aggressive violations and errors also showing decreases. As with all other previous workshops, participants rated the workshop highly as a design and teaching tool. These ratings were the same for both audience and team members.

With differences in ratings apparent between the two teams, comments and interactions were measured to see whether these correlated with road ratings, there were no correlations evident, and so sociograms were used to determine whether group structure may have affected the outcomes of the workshop. It appeared that a more cohesive structure was linked to a better result. The same was found when sociograms were used to analyse team structure for the lowest and highest rated roads designed by participants from the first experiment when rated by participants from the second experiment. The team with the highest rated roads had a more cohesive team structure than the team with the lowest rated road. The addition of an expert in the teams yielded some interesting results, with one of the experts the "star" in the team and the other having a large amounts of statements directed at him. Clearly, having an expert in the teams affected the structure of the teams, but it did not appear that the experts placed themselves in a position of power, it seem more like participants placed them there instead. This is an interesting dilemma for those facilitating participatory design workshops, rather than having to ensure experts allow others to participate, it may be more to do with reminding other participants in the group to treat the expert as an equal participant.

Experiment four ran well, with several lessons learnt from the previous three experiments incorporated into the design. Data collection was an issue, with the name field in the online survey not being validated. This meant that it was not possible to separate audience and team members' data for the one month survey. Facilitation also proved to be an issue in this experiment. Clearly, the involvement of experts in the teams affected the structure of the teams and it is likely that more direct involvement from the workshop facilitator was necessary to ensure better balanced team interaction.

DISCUSSION

This thesis investigates the use of participatory design in improving road design, drivers' attitudes, and driver behaviour. The discussion section will begin with outlining the efficacy of the participatory design process in improving road design, attitudes, and behaviour. This will be followed by its implications for enforcement, engineering, education. Finally limitations and recommendations for future research will be discussed.

The Efficacy of Participatory Design

Participatory Design as a Design Tool

To determine whether participatory design could be used in improving road design, all roads were measured using safety, aesthetics, preference, liveability and estimated speed ratings. Participants who took part in the experiments were asked to work in groups of 3-6 people and reduce estimated speeds and make general improvements on a variety of roads. In terms of estimated speed reduction, the use of participatory design was a success. Almost all groups were able to significantly reduce estimated speed ratings on the roads that they redesigned. Reductions in estimated speed ratings ranged from approximately 4km/h to more than 10km/h and standard deviations in estimated speed also fell. It should be noted that roads were self-rated in most experiments, redesigned roads from experiment one were also rated by participants in experiment two and no difference in the reductions in estimated speed ratings were found. Given the consistency of the reductions in estimated speed achieved when self-rated and rated by others by designs generated in the workshop, it appears that participants were at least capable of designing a road that can elicit the correct estimated speed by design by using their tacit knowledge. This lends support to the idea that using drivers to aid in the design of SER via participatory design would be a beneficial way to enhance the ability of SER to improve speed management.

As in previous participatory design and participatory ergonomics projects participants were given some background information to aid in the design process (Fontalvo-Herazo et al., 2007; Hess et al., 2004; Loisel et al., 2001; Pehkonen et al., 2008; Thursky et al., 2006; Thursky and Mahemoff, 2007). Participants were given an outline of currently used speed management techniques to ensure they had enough background knowledge to complete their tasks, but were also told that they were not restricted to these methods alone and they were free to design their own methods of speed management. As in the adaptation of the skid plate used to transport a concrete hose (Hess et al., 2004), participants often used innovative methods in order achieve their reductions in estimated speed. One of the most successful roads in terms of estimated speed reduction and other ratings used an innovative design that involved the adaptation of delineation methods. Participants developed a colour coding system for road markings. The colour of the centre line indicated the speed limit. This can be seen Figure 57 below.

Figure 57: A successful road redesign.

Experiment three, perhaps the most interesting in terms of process, really seemed to bring forth participants' creativity, with artwork and other innovations incorporated into the designs (Figure 36, p. 119). It also allowed participation of more than just the design teams in the design process with the addition of audience members, who were able to watch the designs being created, as well as interact with the designers. Not only was the process innovative, one of the designs generated was also rated as successful in reducing estimated speeds and improving the aesthetics of the road by independent road safety experts.

Other groups used roundabouts in unusual, but practical places, while another used a raised VMS sign to allow traffic coming over a hill to see that the speed limit had changed (Figure 58). This use of innovation was a demonstration that participants used knowledge gained from the introduction of the workshop and integrated it with their own ideas.

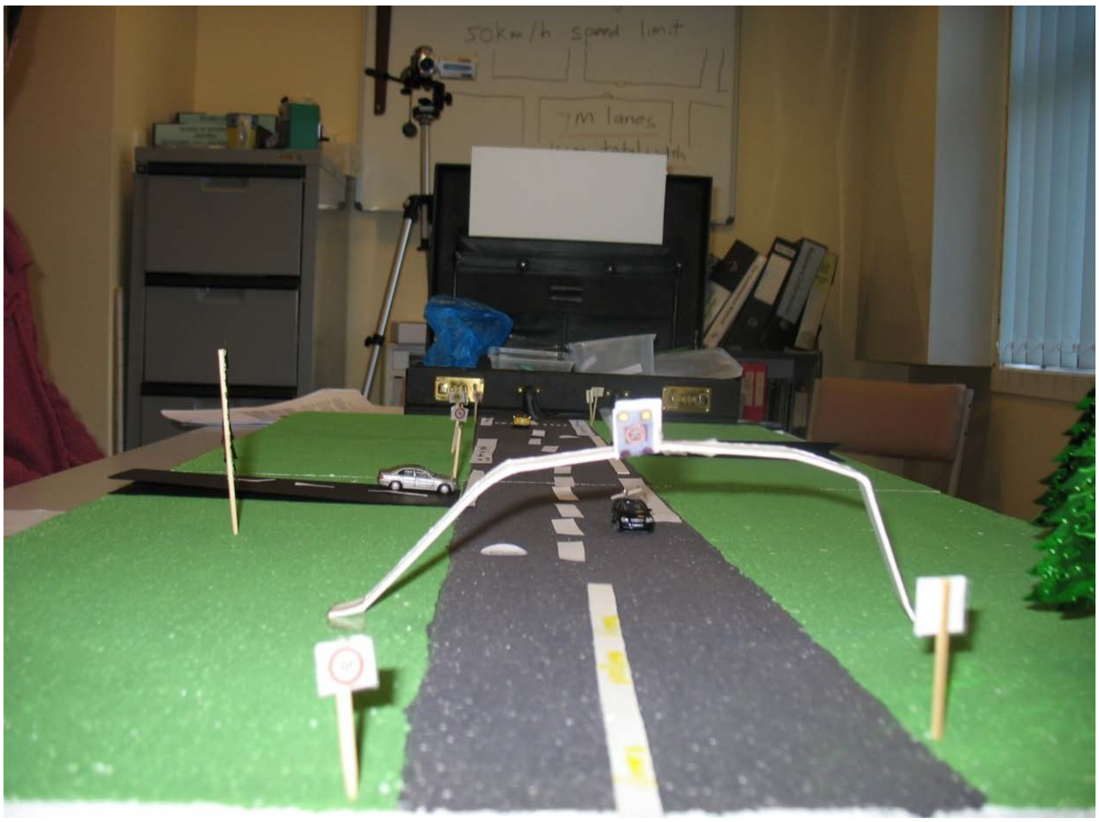

Figure 58: An innovative placement of a VMS sign.

The other ratings used were safety, aesthetics, preference and liveability. Unfortunately, improvements in these ratings were not as consistent, with many remaining unchanged. This is surprising, as participants rated the experimental roads on safety, aesthetics, preference, and liveability prior to the workshop and worked on improving the roads, one would have expected consistent increases in these ratings. Moreover, when these variables were rated by those not involved in the design process, there was a tendency for the objective ratings to be lower than the self-ratings. However, it must be noted that participants were told to focus on speed reduction as their primary goal, and given that the workshops were relatively short, it may not have been possible for them to think too far beyond reducing speeds. Despite this, none of the other ratings fell significantly after participants had redesigned the road. Given more time, it is likely that participants would have come up with more ideas for improving these ratings.

The lack in changes for these ratings did give some insights into participants' tacit knowledge about and perceptions of roads. When these ratings were used as predictors of estimated speeds for experimental roads in the first two experiments, almost none of these ratings predicted estimated speed choice. The same was found when these ratings were used to predict estimated speed choice for control roads in experiment two. Ratings given to roads designed by participants in experiment one by participants in experiment two indicated that lower safety ratings were associated with lower estimated speeds (e.g. Figure 23, p. 83). Ratings for control roads in experiment three showed the same, although not statistically significant, tendency for control roads, with lower safety ratings associated with lower estimated speeds (Figure 39, p. 121). River road was rated as one of the safest roads in the experiment prior to redesign and also had some of the highest estimated speed ratings, the highest of which were 100km/h. These findings support literature surrounding delineation, which states that roads perceived as less safe tend to have lower operating speeds and vice versa (Elliott et al., 2003; Fitzpatrick et al., 1997). The fact that participants tend to have higher estimated speed ratings associated with perceptually safer roads may explain why a lack of involvement in the planning and design of speed management schemes can lead to a perception that the scheme is somehow unsuccessful or that it is causing other problems such as increased noise or pollution (Wheeler and Taylor, 1999). It may be that the perception is based on the idea that a wide straight road is a safe road and a narrow more restrictive road is seen as unsafe.

In contrast, after participants had redesigned their roads their safety ratings for the experimental roads did not reduce, and increased in some cases, even though estimated speeds had decreased. Given this was only true for roads which they had been involved in designing and not roads designed by others or control roads, this demonstrates that involvement in road design and planning through participatory design could be very useful in reducing resistance to and poor perception of traffic calming schemes. This improved perception of new technology and practices due to involvement has been reported in several participatory design and participatory ergonomics projects (Demirbilek and Demirkan, 2004; Hess et al., 2004; Loisel et al., 2001; Pehkonen et al., 2008; Sundin et al., 2004; Thursky and Mahemoff, 2007). It was unfortunate that safety ratings did not change for control roads after being involved in the process, which would have indicated that participants' perception of what constitutes a safe road would have been significantly altered. However, perceived safety does not mean the same as appropriate speed, especially since increases in perceived safety often lead to excessive speeds. Furthermore, in many cases, safety ratings did not fall but estimated speeds did, so participants were still able to reduce estimated speeds without affecting safety ratings.

Interestingly, other participatory design and participatory ergonomics research does not report on whether user/worker involvement in design has any flow on effects on participants' perceptions of artefacts created by others. This is a potential problem, as the improvements found by some participatory design projects may simply be due to improved in a process. Indeed, Loisel (2001) who reported on a participatory ergonomics intervention with workers suffering from back pain speculated that some of the workers may have returned to work early as a result of simply being involved in their own treatment, rather than any objectively measured improvements in their situation. On an individual level this is beneficial, but for road design, which could affect thousands of people, this is a potential problem that should be addressed by continual objective analysis of any prototype using appropriate measures (e.g. estimated speed).

Despite some short-comings, as a design exercise the participatory design process can be deemed a success, with almost all groups able to significantly reduce estimated speed ratings. Furthermore, although there were not as many improvements made to other aspects of the roads, the majority of ratings remained unchanged and some improved demonstrating that participants reduced estimated speeds without negatively affecting the perception of the road. This is important as often empirical findings contradict public perception, especially when the public is not involved to a satisfactory level. The process also gave insights into participants' tacit knowledge regarding how they make their speed choices which could prove useful in future road design and speed management strategies.

Process of the Participatory Design Workshops

Although there is no all encompassing description of participatory design methodology, participatory design does tend to follow a certain set of tenets and it does have an underlying philosophy (Spinuzzi, 2005). The participatory design workshops undertaken for this thesis attempted to work within these tenets and to the underlying philosophy of participatory design. The process used in the workshops aimed to ensure that the tenets of exploration, communication and prototyping outlined by Spinuzzi (2005) were followed for each of the workshops. Exploration involved the researcher using various resources (such as crash databases and local government information regarding traffic flows) in order to determine which roads were suitable for redesign. The communication stage consisted of participants being given a presentation regarding road safety that outline the impacts of accidents and gave details about current speed management and traffic calming strategies. Prototyping consisted of participants working to redesign roads in order to reduce estimated speeds and make general improvements to the roads. Due to time constraints, the amount of time spent on each of the stages was relatively short and more interaction between the researcher and the participants may have been beneficial. However, participatory design processes do vary in length and previous research has found that the time frame used in the workshops run in this thesis (approximately 1.5 hours) is sufficient to generate successful prototypes (Olsson, 2004).

One of the more innovative aspects of two of the workshops was the inclusion of an audience. This was done to determine whether they would still be able to benefit from involvement in the participatory design process and it proved to be successful. Previous research from Brazil also used large numbers of people (406) from various villages in a participatory design process and this was also successful in generating a useable indicator system for coastal management (Fontalvo-Herazo et al., 2007). This has implications for the use of participatory design as an alternative to consultation for roading projects, as there may be more people attending the meetings than could be placed in a participatory design group. Experiments three and four attempted to bring more people into the participatory design process using the "audience" concept. They observed the design teams and were not directly involved in the design process, but they were given the same information as the design teams and were also allowed to provide input into the designs for a brief period of time during the process. The inclusion of an audience was successful as they reported that they felt fully involved in the process and that others were also able to contribute. Additionally, they were also able to ask teams about their designs and provide feedback. Although limited by time, the use of an audience in participatory design processes has the potential to provide additional objective information regarding any flaws in designs that may have been overlooked by the teams. The inclusion of an audience also provided a way to allow somewhat more objective ratings of the redesigned roads without having to recruit additional participants to rate the roads independently.

The Toolkit

A paper on participatory house design presented at the 2008 Participatory Design Conference in Bloomington (Lee et al., 2008) noted that the toolkit that they used affected the power relationship between the architects and the clients, with tools too close to the ones used by architects reducing the ability of the clients to have inputs into the design of the houses. By simplifying the toolkits, they found that clients were able to have more input into the designs. The toolkit used for the workshops in this thesis did not seem to suffer from these issues. Participants were all able to use the toolkit without difficulty.

The Inclusion of the Road Safety Experts as Team Members

Several participatory design papers discuss issues of power in the participatory design process (Kensing and Blomberg, 1998; Mankin et al., 1997; Olsson, 2004). Power is a particular issue when experts are involved in a participatory design process as they can take over the design process. Experiment four involved road safety experts in the design teams and it was therefore important to determine whether the participation of these experts would affect the design process. Sociometric analysis of the team structure revealed that the road safety expert in team two was the “star” of the team, meaning that he had the most interactions with other team members (Figure 55, p. 149). However, closer inspection of the sociogram shows that participants tended to interact with the expert more often that with each other in most cases, but that the interactions were balanced, with a tendency for participants to speak more to the expert than vice versa. Furthermore, the expert made a total of 32.92% of the comments to the entire team and the next closest participant made 29.19% of the comments. This analysis showed that although the expert was the “star” of the team, it did not appear that the expert placed himself in a position of power; it appeared more likely that the other team members placed him in this position. Sociometric analysis of the structure of team one showed that the road safety expert (M4) was not the “star” of the group. However, the “star” of the group (M1) spoke to the expert a total of 47 times compared with 28 replies from the expert. Given these numbers, it is possible that the road safety expert was overwhelmed by the number of statements directed at him. As mentioned previously, this type of interaction had an effect on the group, as it disrupted the ability to work together as a cohesive unit.

In the case of this experiment, there did appear to be some issues regarding power, but not in ways previously described. Judging by the direction of the interactions in both teams, the experts were placed in a position of power, at least in terms of interactions, by participants and not the other way around. This is interesting as it has not been reported in this way before, as the papers discussing issues of power tend to focus more on how users are overridden by experts. Unless this type of situation is carefully managed, with the iterative process of participatory design, it is quite possible that any experts involved would eventually assume the role of leader.

Based on the fact that engineers were spoken to more than other team members, it is likely that the creative process would have been led more by the engineer rather than the team members themselves, but when comparing designs across experiments, there appeared to be little difference in the amount of creativity displayed. It would have been of interest to show the designs to more road engineers to determine whether placement of objects (such as pedestrian crossings, median barriers, plantings etc.) was more accurate for the groups who had an engineer present than for those who did not. In terms of the costs of the designs, if budget constraints had been placed on the teams' designs, it is likely that the designs would have been simplified on the advice of the engineers who had more of an idea regarding the costs involved when redesigning a road.

The Workshop Participants

The underlying philosophy of participatory design as outlined by Spinuzzi (2005) indicates that tacit knowledge can be brought forth and used ethically in order to created artefacts and systems, as well as enhance the understanding of the activity that participants are taking part in. Clearly, the participatory design workshops run for this experiment were successful in keeping to the underlying philosophy of participatory design. Firstly, the workshops were rated highly by participants (e.g. Table 4, p. 62) and the designs created were innovative and successful in achieving their goal of reducing estimated speeds. The researcher also observed that participants interacted well with each other and tended to discuss the designs they came up with amongst themselves. The workshops also created a space for those with special interests, such as motorcycle enthusiasts and cyclists, to have their issues, concerns and suggestions raised in a positive environment without causing conflict. Secondly, although these findings were not as conclusive as the reductions in estimated speeds generated by the redesigned roads, there were positive behavioural changes found as a result of taking part in the workshop. If the workshops had not been successful in bringing forth participants' tacit knowledge, it is unlikely that there would have been such a variety of designs and it is unlikely that any changes in behaviour would have been found.

It has been reported that some participatory design projects have issues with people unwilling to participate either due to a perceived lack of knowledge (Clement and van den Besselaar, 1993), or a lack of time (Pilemalm et al., 2007). In this process, participants did not appear to be unwilling to participate in the workshops; the high ratings given to the workshops (e.g. Table 4, p. 21) show that participants clearly felt they and their colleagues were able to participate. However, time may have been an issue for all of the experiments. Most workshops took place in a relatively short time period and in some cases participants had to leave early due to other commitments.

Participant's attitudes and personalities can also affect the process (Dinka and Lundberg, 2006; Mankin et al., 1997). In smaller scale participatory design projects, it is possible to select participants in such a way that the chances of conflict arising from these factors is minimised, but when dealing with larger groups of people from varying backgrounds, this is not possible.

Participants in the experiments run for this thesis were from a wide cross-section of the community, with varying interests and opinions, but despite this, most groups worked well together. Nevertheless, not all groups worked well together. In experiment four, despite the fact that both groups worked in the same environment, one of the groups rated their road lower than the road prior to redesign (Figure 48, 140). Sociometric analysis of group structures revealed that one of the group members in the group with lower ratings dominated the attention of one of the team members and this appeared to cause a disruption of group communication and affected cohesiveness. When comparing sociograms for both groups this is clear to see (Figure 55, p. 149). Sociometric analysis on the lowest objectively rated group also showed the same pattern (Figure 56, p. 150), with the lowest rated group (group 4, Figure 19, p. 80) having a poor group structure and one or two dominating personalities. In contrast, as with experiment four, the highest objectively rated group had a much more cohesive structure with much more balanced communication between participants. This is unsurprising as previous literature on participatory design project also points out that attitudes and personalities can have a detrimental effect on the ability of the participatory design process to produce successful results (Dinka and Lundberg, 2006; Garrigou et al., 1995; Spinuzzi, 2005). In some cases, the only way to effectively solve these issues, intervention from the facilitator is required (Dinka and Lundberg, 2006; Luck, 2003). In all of the experiments, the facilitator was not heavily involved in the design process, leaving participants to work on the designs by themselves. It appears that sometimes intervention is necessary to ensure a successful participatory design process. In the case of dominant personalities, the person may simply need a chance to have their issue heard and discussed by all group members so that the group can then continue with the activity. In other cases, the facilitator may have to guide the discussion to allow other group members to speak and ensure that all relevant topics are discussed in a balanced manner.

Application of Participatory Design in the Real World

Despite the success of the workshops used in the experiments, it must be noted that the workshops took place in a somewhat sheltered environment outside many of the constraints, such as budgets and project time frames, which may have been placed on them if the workshops would be used in the development of an actual road, rather than a prototype. As such it is important to discuss how this process might fare if it was used within the constraints mentioned above.

Aside from the actual design aspect of participatory design, one key element of the participatory design process is that the artefacts produced by the process are used. As this was a study to determine whether participatory design could be successfully applied to road design, unfortunately only prototypical roads were created. Even with this in mind, one of the participants in experiment three commented that they felt it was unlikely that anything useful would come from the process. Concerns about the participatory design process failing to produce outcomes were also highlighted in a paper at the recent Participatory Design Conference. Ehn (2008) noted that in some cases participatory design processes and projects end up sitting on designer's shelves once the researcher has left. This would be a challenge for future research using participatory design for road safety. Any project would require buy in from all parties involved and the researcher would have to remain with the project from beginning to end to ensure that the process can produce tangible outcomes and that all stakeholders involved continue to have the opportunity to remain as co-designers in the project.

As it is important for any participatory design project to be able to achieve success outside a sheltered environment (Kensing and Blomberg, 1998), it is essential to discuss how this process might have fared with the various issues that are often faced by participatory design projects.

The first things to consider if participatory design were to be used in a roading project consultation process would be the time and costs involved in running participatory design workshops. Transit NZ for example, has to consult with several bodies during the course of any roading project (Transit New Zealand, 2006), so it is crucial that any participatory design project is capable of being done efficiently and cost effectively. For this experiment, the participatory design workshops were able to generate road designs that achieved their main objective of reducing estimated speed ratings within approximately 1.5 hours. However it must be noted that further iterations would most likely be needed to achieve optimal solutions, especially if the problems being addressed go beyond that of speed management. Iteration is a crucial aspect of most participatory design projects (Bødker and Iversen, 2002; Spinuzzi, 2005) and can lead to the discovery of unforeseen issues (Bèguin, 2003). In terms of cost, the equipment required for the construction of the toolkits was purchased at local retailers, with most items costing less than $3 each. Additionally, the toolkits were reused several times with only minimal replacement of equipment required. As can be seen from the workshops in practice (Figure 6, p. 56) the workshops can also be run in a variety of environments from classrooms to office meeting rooms.

Several participatory design and participatory ergonomics projects comment on the commitment of management being a crucial component of any successful participatory design or participatory ergonomics project (de Jong and Vink, 2002; de Looze et al., 2001; Vink and van Eijik, 2007). Unfortunately, as the participatory design workshops done for the experiments were focused more on discovering whether participatory design could be used for road design, it is not possible to say whether these projects would receive supporting from the various bodies involved with road design. However, road safety experts and engineers were willing to take part in the workshops indicating that they did at least receive some support from those working within governing bodies.

The use of participatory design in complex projects has also been advocated, especially in computer software development, which went through several decades of usability crisis until the advent of user centred design (Carroll and Rosson, 2007). Road engineering and the design of transport systems is probably equal in terms of complexity, especially given the goals that traffic engineers have to achieve (Canadian Council of Motor Transport Administrators, 2006; Department for Transport, 2007a; Federal Highway Administration, 2006; Transit New Zealand, 2007), yet public involvement is often ignored (Bickerstaff et al., 2002). The use of participatory design for road design in this thesis lead to several interesting findings, all of which appear to be relevant to road design. Surveys given to participants found that the way in which drivers chose their estimated speeds for any given road varied substantially and that several of the roads rated by drivers elicited estimated speed ratings well in excess of their posted speed limits. In addition, the designs that the participants came up with were often better than those they replaced, especially in eliciting the correct speeds by design, without the use of speed limit signs. This also indicates that SER could also benefit from the use of drivers' knowledge via a participatory process. Furthermore, when rating their own roads, participants generally rated them highly, demonstrating a sense of ownership and perhaps pride in their work. Given that traffic calming schemes can suffer from poor public perception without sufficient public consultation (Department for Transport, 1994, 2007b; Taylor and Tight, 1997), the sense of ownership generated by this participatory design project, supports findings from other participatory design projects (Fontalvo-Herazo et al., 2007; Lindgaard and Caple, 2001; Pehkonen et al., 2008; Thursky and Mahemoff, 2007; Weng et al., 2007) is another potentially useful finding that could contribute to the efficiency of engineering solutions.

Often, when traffic calming or speed management schemes are implemented, they can bring about unexpected and sometimes unwanted results (Department for Transport, 1994, 2007b). Often proper consultation can help to minimise the chances of this happening and also minimise the effects they do have by ensuring that people are aware of the implications of the newly installed schemes. Literature from participatory design supports the idea that involvement helps to speed up the uptake of new systems (Thursky et al., 2006; Thursky and Mahemoff, 2007; Weng et al., 2007) and literature regarding traffic calming also indicates that public involvement helps to improve the acceptability and efficacy of these schemes (Taylor and Tight, 1997). Although the roads designed in the participatory design workshops run for this thesis were only prototypes, the positive ratings participants gave to their own designs demonstrates that the participatory design process fostered a sense of ownership for their designs. Nevertheless, not all participants rated their road designs highly and this may have been due to issues with the participatory design process.

Summary

The participatory design workshops run for the experiments, adhered to the philosophies of participatory design, with the exception of iteration due to time constraints. The also appeared to efficient in terms of both time and costs. Those working in the field of road safety expressed an interest in the workshops and the workshops had benefits for road engineering, providing insights into drivers' behaviour and generating a number of innovative designs for a variety of road environments. The workshops were also highly rated by participants and appeared to generate a sense of ownership of the roads that were redesigned. Finally, for the most part, the workshops provided an excellent environment for bringing forth drivers' knowledge and fostering cooperation between people from various backgrounds and ranges of interests. However, it is clear that care must be taken to ensure that participants interact with each other as each equals, and that no-one is placed in a position of power, as this can affect the workshop process in a negative way.

Participatory Design as a Means of Consultation

In contrast to consultation or informing practices which are often seen as tokenistic and are often ineffective (Arnstein, 1969; Bickerstaff et al., 2002), participants overwhelmingly saw using participatory design as a way to redesign roads as positive. Ratings for participatory design as a design tool were very high (an average of approximately 4/5 for most experiments) and participants not only reported that they felt involved, but also that others around them were involved as well. This supports findings from other participatory design and participatory ergonomics research which consistently reports overwhelming support for a participatory approach (Fontalvo-Herazo et al., 2007; Hess et al., 2004; Loisel et al., 2001; Olsson and Jansson, 2005; Pehkonen et al., 2008; Thursky et al., 2006; Thursky and Mahemoff, 2007; Weng et al., 2007). Out of all the workshops that were run, only one of the groups had major issues with group structure and communication. Considering that groups were made up of people of different ages, nationalities, backgrounds and varying interests, including motorcycle club members, students, teachers, cyclists, marathon runners and engineers, this is a very positive finding. Not only did people see the process as successful, the designs that they created also achieved their main aim of reducing speeds (estimated). Arguably, these findings indicate that rather than increased public involvement potentially causing conflict; the involvement of drivers using a participatory design process fostered a cooperative, positive environment, which generated many potentially successful and innovative road designs in less than two hours.

Summary

As a means of consultation, participatory design appears to be a potentially successful way of designing roads by using drivers' tacit knowledge. It also has the potential to eliminate several of the pitfalls associated with implementing traffic calming and speed management strategies. However, it must be stressed that the process is not just a "feel good" process for everyone involved. It is crucial that those involved see their ideas implemented as this will lead to a sense of ownership of the design (Thursky and Mahemoff, 2007; Weng et al., 2007). To ensure success, empirical methods must also be used throughout the process, including self and objective ratings of the designs using appropriate measures. In some cases, open ended questions should also be used to further elicit drivers' tacit knowledge, which can then be used to further enhance and improve roads in the future.

Mutual Learning from the participatory design process

As participatory design brings together people with different viewpoints, agendas, backgrounds and areas of expertise in an environment that fosters cooperation, it is also opens up opportunities for mutual learning. There were several lessons learnt from the participatory design process by the participants, engineers, and the researcher. The following sections describe the lessons learnt by each of these groups/people over the four experiments.

Participants and Researcher.

The researcher found that it was crucial to listen to participants from the beginning. In experiment 3 in particular, the researcher's motivations for the process appeared to be somewhat different from those of the participants as they had a vested interest in the road that was being redesigned in the workshop. Although the process allowed participants to express their ideas, it may have been even more successful with better communication in regards to outcomes prior to the workshop.

Participants appeared to feel good about the process, as was reflected in the ratings of the workshops. In addition, during the process they reported a greater awareness of the road design process and of their own behaviour. This increased awareness was possibly involved in the cooperative attitude shown in all of the workshops. Workshops in the second experiment often bought together people with differing viewpoints and agendas regarding road use (i.e. cyclists, runners, and drivers). The researcher also fostered cooperation and cooperative conflict resolution of differing viewpoints by reminding participants that they would all use roads and the surrounding environment in different ways at different times.

An important aspect of participatory design as a research exercise was that both the researcher and the participants became aware that research does not have to be tightly controlled in order to yield positive results. Research can be truly participatory and participants' knowledge can therefore be shared in a safe and positive environment. However, the researcher did find that occasionally participants had a tendency to take over a workshop, thereby disrupting the design process. This indicated to the researcher that in order to allow the participator design process to function smoothly, planning the process must include provision for what to do if issues such as disruptive participants or conflict arise.

Road safety experts, participants, and researcher.

Where road safety experts were involved, more lessons were learnt during the participatory design processes. Participants found road safety experts accessible and were able to collaborate with them well. They also gained insights into how road safety experts worked to redesign roads. Aspects such as budget constraints, traffic, and the types of tools available to engineers were able to be observed by participants, increasing their understanding of how engineers work. For their part, engineers were able to see how those outside the profession view road design. Furthermore, engineers also had a chance to access participants' knowledge about road design in a mutually beneficial environment. This allowed engineers to see that participants' had good ideas and knowledge about roads that they may not otherwise have shared.

Seeing how the road safety experts interacted with participants, as well as looking at comments given by the experts allowed the researcher valuable insights into the difficulties faced by road safety experts during consultation, as well as the tools that they have at their disposal when designing or redesigning roads. It was also evident that the road safety experts involved in the participatory design process had not had positive experiences with consultation processes on the whole, as they voiced concerns over trying to please everyone as well as budget constraints which they worked under. Finally, the researcher was also made aware of power issues faced by both participants and experts in these exercises. It appears that this is something that must be managed not only from the side of participants, but also from the side of experts.

Attitudes and Behaviour

Previous research on driver attitudes has found that although attitudes towards certain types of driver behaviour do have predictive value, other factors also influence drivers' behaviour (Fildes et al., 1991; Goldenbeld et al., 2000). The TPB (Ajzen, 1991) has been used to determine the predictive value of attitude (Parker et al., 1998, 1992) and found that factors such as subjective norms and perceived behavioural control are also strong predictors of driver behaviour. Attempting to change driver attitudes using the TPB has also been done by Parker (1996), but failed to do so as it was just one intervention.

Participatory design research does not report on attitudinal changes found after taking part in a participatory design project, but research on message framing and involvement indicates that high levels of involvement make people more aware of the issues at hand and that they produce more cognitions about the issues (Maheswaran and Meyers-Levy, 1990; Millar and Millar, 2000). This indicates that it is possible that participatory design may be able to affect attitudes as well. The current research attempted to find out whether being involved in a participatory design project could affect driver's attitudes towards speed. Unfortunately, although some changes were found in attitudes towards speed and enforcement, there were not enough to say the process had any significant effect on drivers' attitudes towards speed for any of the experiments. A possible reason for this lack of change in attitudes may be that as in Parker's (1996) research, participants were only involved in one participatory design project for 1.5 hours. Furthermore, research regarding schemata also notes that the deeper a schema is entrenched, the more difficult it is to alter (Anderson, 1977).

However, as mentioned in previous sections, significant decreases in estimated speeds as well as improvements in self-reported behaviour were found. To determine what may have been causing these changes in behaviour, linkages between attitudes, estimated speed ratings, changes in estimated speed, and driver behaviour were investigated for the first two experiments.

In the first experiment an attempt was made to determine whether attitudes could be used to predict estimated speed. Unfortunately in this case, none of the attitudinal ratings used in the regression could predict estimated speed ratings before or after the workshop, nor could they account for estimated speed changes found. Furthermore, DBQ ratings were also not able to predict estimated speed ratings before or after the workshop, nor could they predict estimated speed change. In the first experiment, gender was the most powerful predictor of estimated speeds before the workshop (Table 4, p. 62). Kilometres driven and gender also predicted changes in estimated speed. In terms of other behaviour, the DBQ scores of violations and aggressive violations were correlated with attitudinal variables regarding enforcement (Table 5, p. 64), with negative attitudes towards enforcement correlating with higher violation and aggressive violation scores.

In the second experiment, more experimental roads as well as a set of control roads were used and rather than using regression analyses, correlations were used to determine whether attitudes towards speed could account for estimated speed ratings and changes in estimated speed. For both experimental and control roads used in this experiment there was a strong trend towards higher estimated speeds being correlated with more negative attitudes towards enforcement (Table 22, p. 105 and Table 23, p. 106). However, for Newell road, these negative attitudes were correlated with a larger decrease in estimated speeds (Table 22, p. 105). In this experiment violation, aggressive violation, and lapse scores from the DBQ predicted estimated speed choice for Newell road prior to the workshop (Table 17, p. 100), violation scores predicted estimated speed choice for River Road after the workshop (Table 18, p. 101), and Violation and aggressive violation scores predicted estimated speeds for

Church road after the workshop(Table 19, p. 101). In the case of violations and aggressive violations, higher scores predicted higher estimated speed choices and higher lapse scores predicted lower speed choices. Interestingly, as with the correlation for speed change and attitudes for Newell road, Violation, aggressive violation and lapse scores predicted an impressive 61% of the variance in change in estimated speed, with higher violation and aggressive violation scores predicting larger decreases in estimated speeds and lapses predicting smaller changes in estimated speeds (Table 16, p. 100).

Previous literature on attitudes and behaviour has indicated that attitudes are not the only factor predicting driver behaviour (Haglund and Aberg, 2002; Parker et al., 1998; Parker and Stradling, 1996; Trafimow and Finlay, 1996; Ulleberg and Rundmo, 2003), but this literature has also been criticized for ignoring the road environment (Rothengatter, 2002). In experiments one and two, it appeared that age, gender, driver behaviour and attitudes played a role in predicting drivers' estimated speed ratings, but these ratings varied depending on the road which was being rated, making it clear that the road environment should be taken into account when attempting to predict estimated speed choice. The fact that factors predicting estimated speed choice were not stable for these experiments supports previous literature that looking only at attitudes and behaviour is not always a reliable way to predict speed choice (Haglund and Aberg, 2002; Trafimow and Finlay, 1996). When looking at these findings it is also important to remember that despite higher violation and aggressive violation scores being associated with higher estimated speeds, estimated speeds fell for all experimental roads in both experiments one and two as well as two out of the four control roads in experiment two. Furthermore, the largest decreases in estimated speed ratings were found to come from those participants who had high aggressive violation and violation scores and correlated with negative attitudes towards enforcement.

These rather inconsistent findings also provide support for SER, which attempts to affect driver behaviour by altering the road environment using psychological principles, as it is clear that the road environment affects drivers' speed choice. However, considering that estimated speed ratings for almost none of the roads used in experiment one or two could be predicted by any of other road ratings (safety, aesthetics, preference and liveability) makes it rather difficult to determine exactly what it was about the roads that participants were using in order to make their estimated speed choices, especially considering that none of the roads used in the experiments had any visible signage and that not all of the roads could have been known to participants. Although the trend found in experiment three for higher safety ratings to be associated with higher estimated speed ratings (Figure 39, p. 123) gives some clue as to what drivers were using to rate estimated speeds, the inclusion of an open-ended question regarding what aspects of the roads participants were using to make their estimated speed choices may have been able to answer this question.

Summary

In summary, it appears that the participatory design projects undertaken in this thesis were not successful in changing participants' attitudes towards speed. However, findings from the first two experiments show that the link between attitudes and behaviour is by no means clear-cut. The inconsistency of findings regarding what was actually predicting estimated speed choice for the various roads in the first two experiments indicates that the road environment, age, gender and past behaviour must be taken into account when studying the predictive value of attitudes regarding estimated speed choice. In addition, the fact that all of the experiments reported decreases in estimated speed for experimental as well as some control roads also indicates that the participatory design process is a valuable tool for speed management, both as an adjunct to current engineering practice and as a way to improve driver behaviour.

Enforcement

Previous research on enforcement has found that enforcement is a successful speed management and road safety improvement strategy, but that it suffers from issues stemming from the fact that it does little to affect driver behaviour and attitudes at an individual level, aside from improving behaviour with the increased threat of apprehension (Hakkert et al., 2000). The first issue arising from this lack of change in attitudes and behaviour is that enforcement is only effective over relatively short distances beyond its physical presence (Chen et al., 2002; Ha et al., 2003; Hauer et al., 1982; Teed et al., 1993) and loses effectiveness anywhere between 0 and 6 weeks after its removal (Champness et al., 2005; Hauer et al., 1982; Vaa, 1997). Finally, public views of enforcement appear to be somewhat mixed (Berry, 2004; Demirbilek and Demirkan, 2004; Kontogiannis et al., 2002; Land Transport Safety Authority, 2004; "Speed police get out", 2005; "Speed tickets at 1000", 2005).

Although this thesis was not directly focused on affecting perception of and attitudes towards enforcement as a speed management strategy, participants were given the option to use enforcement in their designs and were questioned regarding their attitudes towards enforcement before and after their participatory design workshops to see whether involvement in the designing of speed management strategies would positively impact their attitudes towards enforcement. Although some findings from the questionnaires given before and after the workshop indicated that there were some changes towards enforcement found, they were few and inconsistent. Some variables showed that participants had a more positive attitude towards enforcement and others showed that they had a more negative attitude towards enforcement after taking part in a workshop. These mixed attitudes are unsurprising given the above examples from the literature showing that people have a mixed attitude towards enforcement. The lack of change in attitudes toward enforcement is also unsurprising, given firstly that the workshops were short and previous research on attempting to change drivers' attitudes towards speeding was also deemed unsuccessful in part due the short length of time (Parker and Stradling, 1996). The lack of change in attitudes towards enforcement may have also been due to the fact that workshops were not aimed directly at developing enforcement strategies. Literature from previous participatory design and participatory ergonomics projects also does not report on the impacts that taking part in a participatory design or participatory ergonomics project may or may not have on participants' attitudes to indirectly related issues.

However, it does appear that development of speed management strategies using a participatory approach does have some implications for enforcement in that it does offer possible solutions to some of the short-comings faced by enforcement. First of all, although many did use speed cameras as an adjunct to their designs, almost all of the speed management strategies used by participants in the workshops tended to focus more on road redesign and did not rely heavily on enforcement as a method of speed reduction, and almost all designs still had significant decreases in estimated speed ratings. This is interesting considering enforcement is a very widely known speed management strategy and was given as an option to participants. If participants were as positive about enforcement as would appear to be the case in the literature mentioned above, one would have expected far more reliance on enforcement as a strategy, giving further support to previous literature showing the mixed attitude towards enforcement found in drivers.

Participants also significantly reduced their estimated speed ratings for several of the control roads used in the experiments one month after being involved in the workshop. Aside from the decreases in estimated speed, the finding with the most impact for enforcement was the behavioural changes found in two out of the three workshops where behaviour was measured. Previous participatory design and participatory ergonomics research has found that involvement in a participatory process can have a positive effect on behaviour related to the subject of the workshop (e.g. the ergonomic qualities of kitchen implements and appliances) (Pehkonen et al., 2008). For this workshop, there was an improvement found in self-reported driver behaviour one month after the workshop, with participants reporting significant decreases in lapses after experiment two and significant decreases in violations and lapses reported by participants after experiment four. This finding indicates that a more participatory approach to speed management and road design has the potential to improve the driving behaviour of those taking part in a positive way, addressing one of the major short-comings of enforcement.

An increase in public involvement in speed management and road design, along with increased awareness of the participatory practices being used through advertising may have flow on effects for those not directly involved in the process. First it may help to foster a sense of ownership, which has been found to improve acceptance and uptake of new systems (Fontalvo-Herazo et al., 2007; Thursky et al., 2006; Thursky and Mahemoff, 2007; Weng et al., 2007), and it may also help to develop a positive framework in which to deliver road safety messages. This positive framing along with increased awareness may lead to increased involvement and cognitions surrounding driver behaviour, allowing people to become aware of their own tacit schemata regarding roads and driving (Fischbein, 1994; Maheswaran and Meyers-Levy, 1990; Millar and Millar, 2000).

In terms of drivers who tend to have negative attitudes towards enforcement and more cavalier attitudes towards speed, participatory design. Findings from the first experiment indicated that those with a negative attitude towards enforcement tended to be happier with the designs that they had created than those that had a more positive attitude towards enforcement. In experiment two, there was also a tendency for those with a negative attitude towards enforcement to have larger decreases in estimated speeds than those with more positive attitudes towards enforcement. These correlations were found for one of the experimental roads and one of the control roads, indicating that the correlations were not confined to just due to being involved in the design of particular road.

In summary, participatory design bought forward people's attitudes towards enforcement, which were somewhat mixed, but the process did little to change these attitudes. However, the results show that a more participatory approach to speed management and road design has the potential to reduce reliance on enforcement by positively affecting driver behaviour, reducing estimated speeds and improving road design. There also appears to be some evidence that, although attitudes towards enforcement were not changed by the process, drivers with a more cavalier attitude towards speed and negative attitudes towards enforcement were more still benefited from the process by reducing their estimated speeds and that they were happier with their designs than group members with a more positive attitude towards enforcement, indicating that involving these types of drivers in a participatory process may be more beneficial for them than issuing fines or demerit points, which do little to affect attitudes or behaviour (de Waard and Rooijers, 1994; Hakkert et al., 2000; Holland and Conner, 1996).

Engineering

The goals of traffic engineering vary from country to country, but the main goal for most roading authorities appears to be the development of a safe and efficient transport system (Canadian Council of Motor Transport Administrators, 2006;

Department for Transport, 2007a; Federal Highway Administration, 2006; Transit New Zealand, 2007). Unfortunately the combination of safety and efficiency can and does lead to roads that are over-engineered with safety margins that are too large, which in turn leads to difficulties in managing speeds. Indeed, many roads have the issue that the posted speed limit is often below what the road was engineered for (Fitzpatrick et al., 1997). When engineering is used to manage speeds, traffic calming is one of the most widely used methods in urban areas (Bunn et al., 2003; Ewing et al., 1998; Kjemtrup and Herrstedt, 1992; Wheeler and Taylor, 1999; Womble and Bretherton, 2003). Other methods include delineation (Carsten et al., 1995; Denton, 1980; Godley et al., 1999, 2004, 2002) and signage (Charlton, 2006; Johansson and Rumar, 1966; Luoma et al., 2000; Martens, 2000; Rämä and Kulmala, 2000; Winnet and Wheeler, 2002). Despite the success of these methods in managing speeds and reducing accidents, as with enforcement, drivers and the general public are often left out of the design process, and even when involved, their input is seldom used (Bickerstaff et al., 2002). This despite evidence showing that public involvement in the implementation of speed management strategies, especially traffic calming, is a crucial element in the creating of successful strategies (Department for Transport, 1994, 2007b; Taylor and Tight, 1997; Wheeler and Taylor, 1999).

Furthermore, as with enforcement, most speed management strategies, such as delineation, work to reduce speeds via implicit measures, such as reducing perceived road safety, or simply by forcing speeds to come down with physically restrictive methods, as in traffic calming. Given that participatory design processes have shown that involving workers and users in the design process can lead to successful and cost-effective solutions to a wide variety of problems (Fontalvo-Herazo et al., 2007; Hess et al., 2004; Loisel et al., 2001; Pehkonen et al., 2008; Thursky et al., 2006; Thursky and Mahemoff, 2007), it is surprising that it is not used in road design. Findings reported earlier in this section clearly demonstrate that both as a design and consultation tool, participatory design appears to be a useful for dealing with the issues faced by traffic engineering.

Education

Out of all of the 3 Es, education has the most questions surrounding its efficacy, with several large scale studies casting doubt on the ability of driver training and education programs to improve driver behaviour and attitudes (Christie, 2001; Engström et al., 2003; Hatakka et al., 2002; Vernick et al., 1999). Hakkert and colleagues (2000) postulate that increased teaching of the higher levels of the GDE (i.e. improving awareness of trip goals and behaviour in life in general) would help to improve the efficacy of driver education and training. Participatory design has the elements required to potentially improve the efficacy of driver education. By involving drivers in road design it allows them to become more aware of the road environment and perhaps their own attitudes, however previous participatory design research has not focused on the possibility of participatory design to be used as a teaching medium. The current thesis attempted to address the ability of participatory design to be used as a teaching medium. It did this by asking participants taking part in the workshops several questions regarding the process, their attitudes towards speed, their driving behaviour and asked to comment on what effect they felt the participatory design workshop had on their attitudes towards speed and any other general feedback or comments.

Participants were asked directly how they rated participatory design as a way to teach people about speed and as with ratings on design, these ratings were consistently high. As with the design ratings, these findings once again support previous findings that those who participate in participatory design and participatory ergonomics projects rate them very highly (de Looze et al., 2001; Demirbilek and Demirkan, 2004; Pehkonen et al., 2008; Thursky and Mahemoff, 2007; Weng et al., 2007). Despite these high ratings it was important to ensure that these were further supported by more objective findings, such as changes in behaviour and attitudes, as some participatory design projects are rated highly, but do very little in terms of making actual improvements (Lindgaard and Caple, 2001).

Behaviourally, significant improvements were found in two out of the three workshops where driver behaviour was measured. In experiment two, significant reductions in reported lapses were found and in experiment four, significant decreases in violations and lapses were found. Furthermore, Figure 52 (p. 146) shows that aggressive violations and lapses also fell. As the main aim of the workshop was to redesign a road, rather than improve driver behaviour per say, it is important to determine what may have caused the changes in driver behaviour. The answer appeared to lie in the comments gathered from participants in the workshops. Several participants commented that they now understood the complexity of road design and others commented that they were more aware of their surroundings when driving. This enhanced awareness may be the reason why they changed their behaviour. A recent participatory ergonomics project on ergonomic interventions in kitchens also reported that staff involved now took ergonomic factors into account when purchasing new kitchen equipment (Pehkonen et al., 2008).

It was also hoped that the participatory design process would lead to improvements in drivers' attitudes towards speed. Unfortunately, despite the use of several scales used to measure drivers' attitudes, no reliable changes in attitude were found as a result of the workshop. This was somewhat disappointing, as changes in behaviour were found. However, the workshops were relatively short (approximately 1.5 hours) and they were not directly focused on changing attitudes towards speed. Furthermore, attempts to change drivers' attitudes towards speed using the TPB in a short workshop, also failed to produce significant results (Parker and Stradling, 1996) and the authors also comment that that the relatively short time used for the workshop was the most likely reason why did not find any changes in attitudes. Furthermore, research on schemata has also demonstrated that when a schema is deeply embedded it is difficult to change them (Anderson, 1977). It is likely that the attitudes participants held towards speed were probably built up over a considerable period of time, especially considering that the mean age for most workshops was around 40 years old. Although age was used as a co-varying factor to determine whether this was the case, it was seldom the case that age impacted attitudinal change findings. However, this may have been due to the relatively small sample size.

Summary

In summary, despite the workshop not being directly aimed at educating drivers, there were positive improvements found in terms of both behavioural and estimated speed ratings. This shows that participatory design at least has the potential to be used as a driver education tool. Even when not directly focused on education drivers, involvement in the road design process clearly showed behavioural improvements in drivers. Unfortunately there was no associated change in attitudes. Despite these findings, further research is clearly required to more clearly identify which aspects of participatory design are the most powerful in terms of affecting behaviour and attitudes in order to improve its efficacy as an educational tool.

Limitations and Issues

Despite several positive findings from the participatory design workshops, this thesis suffers from several limitations. Perhaps the most significant is that all the findings are based surveys rather than observed behaviour. However, in terms of driver behaviour, several studies show a high level of correspondence between self-reports and observed behaviour, particularly in terms of the DBQ (Lajunen and Summala, 2003; Özkan et al., 2006).

The scales used to measure attitudes were somewhat more problematic. The LTSA attitudes towards speed subsection does not appear in the literature and the DAQ appear to have been not been widely reported in the literature (Davey et al., 2006). Futhermore, although variables from the LTSA attitudes towards speed subsection were used, it was not clear from the variables how to analyse them as a single scale, as they were only analysed as individual items by the LTSA themselves. However, over the four experiments, there were no reliable changes in attitudes found, and when asked directly whether participants felt that their attitudes had changed, many reported that they felt their attitudes had not changed.

Sample sizes were small for all of the experiments, meaning that the findings must be treated with caution. This was a particularly large problem with the third experiment where only 17 participants took part and an even lower number returned their one month follow up surveys. Despite these shortcomings, findings across workshops were fairly consistent, particularly regarding changes in estimated speeds. Furthermore, none of the participatory design or participatory ergonomics studies reviewed in the literature took behaviour or attitudes into account and so this thesis was in many ways a first attempt at trying to gather information regarding these factors.

The sheer volume of data that the participatory design workshops generated was also a limiting factor. Most participatory design projects report on just one small group of participants taking part in a participatory design project and this project attempted to report on 15 participatory design workshops. As a result, a decision was made by the researcher to focus on the quantitative aspects of the data. This was also in part based on previous participatory design projects being rather limited in providing concrete statistical data on their successes or failures. Nevertheless, deeper qualitative analysis of the workshops would no doubt have been useful in getting more information about the people who participated in the workshops.

As a participatory design process, the workshops all suffered from one major limitation, time. All of the workshops took place in 1.5 hours or less. This caused issues with the number of questions that could be asked of participants regarding the process and did not allow participants to fine tune their designs. Considering that iteration is a large part of participatory design (Bèguin, 2003; Spinuzzi, 2005; Thursky and Mahemoff, 2007), this lack of time was a major drawback. One might argue that participants should have been asked back to do a second workshop, but organising even one group of participants to take part in one workshop constituted a major effort by the researcher due to the fact that participants were gathered from the community and had commitments at varying times and on varying days. That being said, participatory design research projects vary greatly in terms of length (Olsson, 2004; Timpka et al., 1995) and longer periods of time do not always lead to successful outcomes. The shortest participatory design workshop found in the literature was held in the course of an afternoon (Olsson, 2004; Timpka et al., 1995) and participatory design process used still generated a successful prototype. In this thesis, the workshops also consistently delivered road designs that reduced estimated speed ratings.

Recommendations for Future Research

Given the limitations of the research mentioned above several recommendations for future research into the use of participatory design in the field of road safety can be made. As a road development exercise, any future participatory design project should allow more time for design iterations and be run over the course of two or more design sessions. This would be to allow further refinement of any design solutions arrived at in the first session. The road designs should also be rated by a wide range of people using both rating scales and open ended questions. This could be done using a virtual environment once the initial prototype has been developed. This would also allow access to the prototypes by any interested party, and even provide a way for them to participate and offer feedback for the design via forums, online chat sessions and other interactive online methods. In this way, the participatory design meetings would still be able to receive input from a wide range of sources, without the disruptions that this might cause if the workshops were held with too many people attending. Furthermore, those directly taking part in the design workshops could log any potentially useful ideas they may have had outside the workshop on the forums for future reference.

Future research into the potential of participatory design as an educational tool should be done by changing the focus of the participatory design workshops to education. This may involve drivers working together with education professionals in the development of new participatory driver education tools, or simply allowing the workshops to use drivers' tacit knowledge about their own attitudes and behaviours regarding driving to develop other types of artefacts that would aid in improving driver attitudes and behaviour. Measuring the effectiveness of these workshops as an educational tool should use a wide range of both qualitative and quantitative measures over an extended period of time, across a wide range of participants. This is largely because it appears that driving behaviour is influenced by a larger number of variables and any educational program should take as many of these into account as possible. Therefore either using participatory design to develop an educational tool or using as participatory design as an educational tool should be considered a far longer term process than using participatory design as a road design tool. Finally, and perhaps most importantly, future participatory design research in road safety needs to achieve buy in from governing bodies to allow real world testing of the efficacy of the participatory design process in road design and education.

Finally, in terms of the current research, a more detailed qualitative analysis of the actual workshop processes would provide further insights into what was occurring for the participants and road safety experts in terms of group interaction, how ideas were developed and negotiated, what contributions participants and road safety experts made to the design, and how decisions were made. These could be used to further enhance any future workshops.

CONCLUSION

Involving drivers in the development of roads using a participatory design approach has the potential to improve the efficiency of the 3 Es and SER by; reducing reliance on enforcement via improved road design and improvements in behaviour, providing a useful alternative to current consultation processes, generating a sense of ownership and acceptance, and allowing for the creation of innovative and functional designs using drivers' tacit knowledge. Education may benefit from a participatory design approach as it creates a positive environment in which participants are able to access implicit knowledge and attitudes regarding their own driving and road awareness. As a tool for changing attitudes the workshops run in this thesis proved ineffective, but further research is clearly needed to determine whether a participatory design process focused more on behaviour and attitude change might be able to achieve this.

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APPENDICES

Appendix A: Materials for Experiment One

Questionnaire

Section 1

Demographic Data

Age:	
Ethnicity:	
Gender:	
Years that you have held a full driving license:	
Number of years of driving experience:	
Annual amount of kilometres driven:	

Section 2

The following section asks questions regarding your driving habits and experience:

Manchester Driver Behaviour Questionnaire

How often do you do each of the following?

For each item, you are asked to indicate how often this kind of thing has happened to you, using the following key. Base your judgements on what you remember of your driving over, say, the past year.

0 = never 1 = hardly ever 2 = occasionally 3 = quite often 4 = frequently 5 = all the time

never all the time

please tick the most appropriate column for EACH item	0	1	2	3	4	5
Hit something when reversing that you had not previously seen						
Intending to drive to destination A, you "wake up" to find yourself heading for destination B, maybe because the latter is a more usual destination						
Drive when you suspect you might be over the legal blood alcohol limit						
Get into the wrong lane approaching a roundabout or an intersection						
Queuing to turn left onto a main road, you pay such close attention to the main stream of traffic that you nearly hit the car in front						
Fail to notice that pedestrians are crossing when turning into a side street from a main road						
Sound your horn to indicate your annoyance at another road user						
Fail to check your rear-view mirror before pulling out, changing lanes, etc.						
Brake too quickly on a slippery road, or steer the wrong way in a skid						
Pull out of an intersection so far that the driver with right of way has to stop and let you out						
Disregard the speed limit on a residential road						

please continue over

	never					all the time
Switch on one thing, such as the headlights, when you meant to switch on something else, such as the wipers						
On turning left, nearly hit a cyclist who has come up on your inside						
Miss "Give Way" signs, and narrowly avoid colliding with traffic having right of way						
Attempt to drive away from the traffic lights in third gear						
Attempt to overtake someone that you hadn't noticed to be signalling a right turn						
Become angered by another driver and give chase with the intention of giving him/her a piece of your mind						
Stay in a motorway lane that you know will be closed ahead until the last minute before forcing yourself into another lane						
Forget where you left your car in a car park						
Overtake a slow driver on the inside						
Race away from traffic lights with the intention of beating the driver next to you						
Misread the signs and exit from a roundabout on the wrong road						
Drive so close to the car in front that it would be difficult to stop in an emergency						
	0	**1**	**2**	**3**	**4**	**5**

please continue over

never all the time

(continued)	0	1	2	3	4	5
Cross an intersection knowing that the traffic lights have already turned against you						
Become angered by a certain type of driver and indicate your hostility by whatever means you can						
Realise that you have no clear recollection of the road along which you have just been travelling						
Underestimate the speed of an oncoming vehicle when overtaking						
Disregard the speed limit on the open road						
	0	**1**	**2**	**3**	**4**	**5**

Section 3

The next section asks some questions regarding your attitudes towards speed:

Do you enjoy driving fast on the open road	Like very much	Like	Neutral	Dislike	Strongly dislike
The risk of being caught speeding is small	Strongly agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly disagree
The penalties for speeding are not very severe	Strongly agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly disagree
Most people who get caught speeding are just unlucky	Strongly agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly disagree
Enforcing speed limits helps lower the road toll	Strongly agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly disagree
Speed limits on the roads I normally use are:	Too high		About right		Too low
Should the 100km/h limit be raised, lowered or left as is?	Raised		Left as is		Lowered
Should 50km/h limit be raised, lowered or left as is?	Raised		Left as is		Lowered
Automatic loss of license for speeding at 150km/h on the open road would be…	Very fair	Somewhat fair	Neutral	Somewhat unfair	Very unfair
Automatic loss of license for speeding at 100km/h in a 50km/h zone would be…	Very fair	Somewhat fair	Neutral	Somewhat fair	Very unfair
Automatic loss of license for 3 speeding tickets in 12 months would be…	Very fair	Somewhat fair	Neutral	Somewhat fair	Very unfair
The likelihood that you will drive above 55km/h on a 50km/h road in the next twelve months	Very likely	Somewhat likely	Uncertain	Somewhat unlikely	Very unlikely

Section 4

Please rate the following scenario:

Please rate the following:

How fast would you drive down this road?

________________ km/h

The road safety

–	1	2	3	4	5	6	7	+
very poor								very good

The road aesthetics

–	1	2	3	4	5	6	7	+
very poor								very good

Would you drive down this road?

–	1	2	3	4	5	6	7	+
very unlikely								very likely

Comments:

PLEASE STOP HERE AND DO NOT TURN OVER UNTIL THE COMPLETION OF YOUR SPEED REDUCTION METHODS

Section 1

Some questions regarding your attitudes towards speed:

Do you enjoy driving fast on the open road	Like very much	Like	Neutral	Dislike	Strongly dislike
The risk of being caught speeding is small	Strongly agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly disagree
The penalties for speeding are not very severe	Strongly agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly disagree
Most people who get caught speeding are just unlucky	Strongly agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly disagree
Enforcing speed limits helps lower the road toll	Strongly agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly disagree
Speed limits on the roads I normally use are:	Too high		About right		Too low
Should the 100km/h limit be raised, lowered or left as is?	Raised		Left as is		Lowered
Should 50km/h limit be raised, lowered or left as is?	Raised		Left as is		Lowered
Automatic loss of license for speeding at 150km/h on the open road would be…	Very fair	Somewhat fair	Neutral	Somewhat unfair	Very unfair
Automatic loss of license for speeding at 100km/h in a 50km/h zone would be…	Very fair	Somewhat fair	Neutral	Somewhat fair	Very unfair
Automatic loss of license for 3 speeding tickets in 12 months would be…	Very fair	Somewhat fair	Neutral	Somewhat fair	Very unfair
The likelihood that you will drive above 55km/h on a 50km/h road in the next twelve months	Very likely	Somewhat likely	Uncertain	Somewhat unlikely	Very unlikely

Section 2

Please rate the countermeasures that you have created:

Compared to the "before" scenario please rate the following:

How fast would you drive down this road?

_________________km/h

Would you say your opinion of the countermeasure is:

–	1	2	3	4	5	6	7	+
very unfavourable								very favourable

I would drive this road section

–	1	2	3	4	5	6	7	+
much slower								much faster

The road safety

–	1	2	3	4	5	6	7	+
very poor								very good

The road aesthetics

–	1	2	3	4	5	6	7	+
very poor								very good

Would you drive down this road?

–	1	2	3	4	5	6	7	+
very unlikely								very likely

Comments:

Section 3

Please answer the following questions regarding the participatory design process:

Was the introduction to the workshop clear?	very easy – 1 2 3 4 5 + very difficult
Was the process of the workshop easy to follow?	very unclear – 1 2 3 4 5 + very clear
Do you feel that you were able to fully participate in the design process during the workshop?	not at all – 1 2 3 4 5 + fully
Do you feel that everyone was able to contribute to the design process?	no – 1 2 3 4 5 + yes
Are you happy with the speed reduction methods that your group came up with?	very unhappy – 1 2 3 4 5 + very happy
Has this process changed your attitude towards speed?	no change – 1 2 3 4 5 + change
How would you rate participatory design as a way to design speed reduction countermeasures?	very bad – 1 2 3 4 5 + very good
How would you rate the effectiveness of participatory workshops as a tool to teach people about speed and speeding?	very bad – 1 2 3 4 5 + very good

Regarding the “before” scenario, has this workshop changed your estimate of the saftey of this example road?

much less safe	less safe	no change	more safe	much more safe

Did you understand the information presented to you in the booklet and the PowerPoint presentation?

Yes / No

Comments:

Did you understand the goals of the workshop?

Yes / No

Comments:

Did you feel as though you were participating in the design process during this workshop?

Yes / No

Comments:

Do you now feel that you have a better understanding of the design process when it comes to speed reduction?

Yes / No

Comments:

Consent

- Some or all of this experiment may be recorded
- Please be sure to fill in the consent form before beginning the experiment
- No identifying information will be collected during this experiment
- You have to right to leave the experiment at any time

Experiment Goals

- Define speeding and some of the impacts
- Gain some understanding of attitudes towards speed
- Introduce various speed reduction techniques
- Define participatory design
- Use participatory design to develop a set of speed reduction techniques and rate them in terms of effectiveness and acceptability

Speed: What is it and what are its impacts?

- Speeding is defined by the Ministry of Transport as: Driving too fast for conditions (MOT, 2005)
- In 2004, speeding was a factor in 138 fatal crashes (36.7%) and 1632 injury crashes (16.3%) (MOT, 2005)
- Speeding is a major contributing factor to vehicle crashes around the world

Attitudes towards speed

- Around 33% of New Zealanders (42% male, 31% female) say they enjoy driving fast on the open road (LTSA, 2004)
- However, 84% of New Zealanders think that speeds limits on the road are about right (LTSA, 2004)
- Overall, research regarding the links between attitudes towards speed and actual behaviour is mixed, as other factors such as the environment and self-justification, tend to have more impact on speed choice (e.g. Rothengatter, 2002)

Speed Reduction Techniques

- Traffic calming.
  - Traffic calming is defined as: "The combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behaviour and improve conditions for non -motorised street users." (Lockwood, 1997, p.22)
  - Methods include speed humps, medians, road narrowing, mini roundabouts, chicanes and chokers. These are usually used in combination

Speed Humps


Median


Road narrowing
Amcal
DOLLAR SHOPPE


Speed Reduction techniques
• Perceptual countermeasures
– These measures work by using methods that influence our perception of the road environment
– They can influence our perception of speed or risk
– Examples include transverse lines and perceptual road narrowing

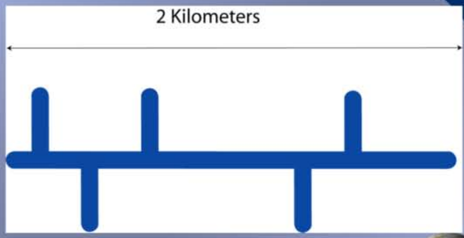

Speed Reduction Techniques
• Enforcement
– This involves the use of a deterrent, such as fines or loss of license to reduce speeding
– Methods include fixed speed cameras, mobile speed cameras and patrol cars


Fixed Speed camera


Patrol Car
POLICE
HIGHWAY PATROL

The scenario

- The road is a straight 2 km straight suburban arterial route with an average traffic flow of 8600 cars per day. At one end it meets a rural road with a speed limit of 80km/h and vehicles from this zone frequently enter this road. It ends on the other side with a sharp 90-degree corner to another 50km/h suburban arterial route. It has 5 other 50km/h roads that intersect it via T intersections.
- The road is 14 meters wide (two 7 meter lanes) from curb to curb. Most of the road is suburban.
- Various types of vehicles use the road including passenger cars, trucks, bicycles and buses.



Your Task

- In this workshop you will be using a scale model of a 100 meter section of this road to develop a set of speed reduction measures that will be used along the length of the road
- The booklet you have been provided outlines various commonly used speed reduction methods. It is meant only as a guide, there are no restrictions regarding the ideas you come up with

Your Task (recommended)

- You will begin by discussing some ideas and writing them down
- Once your ideas become more concrete and agreement amongst you has been reached you will then develop a paper prototype
- The final model will be constructed using the materials provided in this kit

Your Task

- Once you are satisfied with your model, it will be photographed and you will be given a brief questionnaire regarding your model etc
- I will be available to answer any questions as best I can. However, I will not take part in the design process directly as this model will be developed using your ideas and knowledge
- The estimated time for this workshop is approximately 1~1.5 hours

Appendix B: Materials For Experiment Two

Screening Questionnaire

SECTION 1

Demographic Data

Age:	
Gender:	
Years that you have held a full driving license:	
Number of years of driving experience:	
Annual amount of kilometres driven:	
Number of infringements (including speed camera fines) in the past year:	
Crashes (including minor) in the past year:	

The following section asks questions regarding your driving habits and experience:

How often do you do each of the following?

For each item, you are asked to indicate how often this kind of thing has happened to you, using the following key. Base your judgements on what you remember of your driving over, say, the past year.

0 = never 1 = hardly ever 2 = occasionally 3 = quite often 4 = frequently 5 = all the time	
please circle the most appropriate number for EACH item	never All the time
Hit something when reversing that you had not previously seen	0 1 2 3 4 5
Intending to drive to destination A, you “wake up” to find yourself heading for destination B, maybe because the latter is a more usual destination	0 1 2 3 4 5
Drive when you suspect you might be over the legal blood alcohol limit	0 1 2 3 4 5

	Never … All the time
Get into the wrong lane approaching a roundabout or an intersection	0 1 2 3 4 5
Queuing to turn left onto a main road, you pay such close attention to the main stream of traffic that you nearly hit the car in front	0 1 2 3 4 5
Fail to notice that pedestrians are crossing when turning into a side street from a main road	0 1 2 3 4 5
Sound your horn to indicate your annoyance at another road user	0 1 2 3 4 5
Fail to check your rear-view mirror before pulling out, changing lanes, etc.	0 1 2 3 4 5
Brake too quickly on a slippery road, or steer the wrong way in a skid	0 1 2 3 4 5
Pull out of an intersection so far that the driver with right of way has to stop and let you out	0 1 2 3 4 5
Disregard the speed limit on a residential road	0 1 2 3 4 5
Switch on one thing, such as the headlights, when you meant to switch on something else, such as the wipers	0 1 2 3 4 5
On turning left, nearly hit a cyclist who has come up on your inside	0 1 2 3 4 5
Miss “Give Way” signs, and narrowly avoid colliding with traffic having right of way	0 1 2 3 4 5
Attempt to drive away from the traffic lights in third gear	0 1 2 3 4 5
Attempt to overtake someone that you hadn’t noticed to be signalling a right turn	0 1 2 3 4 5
Become angered by another driver and give chase with the intention of giving him/her a piece of your mind	0 1 2 3 4 5
Stay in a motorway lane that you know will be closed ahead until the last minute before forcing yourself into another lane	0 1 2 3 4 5

	Never — All the time
Forget where you left your car in a car park	0 1 2 3 4 5
Overtake a slow driver on the inside	0 1 2 3 4 5
Race away from traffic lights with the intention of beating the driver next to you	0 1 2 3 4 5
Misread the signs and exit from a roundabout on the wrong road	0 1 2 3 4 5
Drive so close to the car in front that it would be difficult to stop in an emergency	0 1 2 3 4 5
Cross an intersection knowing that the traffic lights have already turned against you	0 1 2 3 4 5
Become angered by a certain type of driver and indicate your hostility by whatever means you can	0 1 2 3 4 5
Realise that you have no clear recollection of the road along which you have just been travelling	0 1 2 3 4 5
Underestimate the speed of an oncoming vehicle when overtaking	0 1 2 3 4 5
Disregard the speed limit on the open road	0 1 2 3 4 5

Section 3

This section regards your attitudes towards speeding.

For each item please circle the appropriate number.

1 = Strongly dislike 2 = Dislike 3 = Neutral 4 = Like 5 = Like very much	
Do you enjoy driving fast on the open road	1 2 3 4 5

1 = Strongly disagree 2 = Somewhat Disagree 3 = Neutral 4 = Somewhat Agree 5 = Strongly agree	
The risk of being caught speeding is small	1 2 3 4 5
The penalties for speeding are not very severe	1 2 3 4 5
Most people who get caught speeding are just unlucky	1 2 3 4 5
Enforcing speed limits helps lower the road toll	1 2 3 4 5

1 = Very unfair 2 = Somewhat unfair 3 = Neutral 4 = Somewhat fair 5 = Very fair	
Demerit points only for 70km/h in a 50km/h zone	1 2 3 4 5
Fine only for 70km/h in a 50km/h zone	1 2 3 4 5
Demerit points and a fine for 70km/h in a 50km/h zone	1 2 3 4 5
Demerit points only for 120km/h in a 100km/h zone	1 2 3 4 5
Fine only for 120km/h in a 100km/h zone	1 2 3 4 5
Demerit points and a fine for 120km/h in a 100km/h zone	1 2 3 4 5
Automatic loss of license for speeding at 100km/h in a 50km/h zone would be…	1 2 3 4 5
Automatic loss of license for 3 speeding tickets in 12 months would be…	1 2 3 4 5

1 = Very unlikely 2 = Somewhat unlikely 3 = Uncertain 4 = Somewhat likely 5 = Very likely	
The likelihood that you will drive above 55km/h on a 50km/h road in the next twelve months	1 2 3 4 5

1 = Strongly disagree 2 = Somewhat disagree 3 = Neutral 4 = Somewhat agree 5 = Strongly agree	
I would be happier if speed limits were more strictly enforced.	1 2 3 4 5
People stopped for speeding are unlucky because lots of people do it.	1 2 3 4 5
Stricter enforcement of speed limits 50km/h roads would be effective in reducing the occurrence of accidents.	1 2 3 4 5
It's okay to drive faster than the speed limit as long as you drive carefully.	1 2 3 4 5
Speed limits are often set too low, with the result that many drivers ignore them.	1 2 3 4 5
Speeding is one of the main causes of road accidents.	1 2 3 4 5
I know exactly how fast I can drive and still drive safely.	1 2 3 4 5
I would favour stricter enforcement of the speed limit on 50km/h roads.	1 2 3 4 5
Sometimes you have to drive in excess of the speed limit in order to keep up with the traffic flow.	1 2 3 4 5
Even driving slightly faster than the speed limit makes you less safe as a driver.	1 2 3 4 5

Workshop Questionnaire

Section 1

Please rate the following scenarios constructed by another group:

Please rate the following: **1A**

The road safety — 1 2 3 4 5 (very poor … very good)

The road aesthetics — 1 2 3 4 5 (very poor … very good)

Would you use this road as a regular route towork or school? — 1 2 3 4 5 (very unlikely … very likely)

Would you choose to live on this road? — 1 2 3 4 5 (very unlikely … very likely)

How fast would you drive down this road?

____________ km/h

Please rate the following: **1B**

The road safety — 1 2 3 4 5 (very poor … very good)

The road aesthetics — 1 2 3 4 5 (very poor … very good)

Would you use this road as a regular route towork or school? — 1 2 3 4 5 (very unlikely … very likely)

Would you choose to live on this road? — 1 2 3 4 5 (very unlikely … very likely)

How fast would you drive down this road?

____________ km/h

Please rate the following: 1C

The road safety — 1 2 3 4 5 — very poor / very good

The road aesthetics — 1 2 3 4 5 — very poor / very good

Would you use this road as a regular route towork or school? — 1 2 3 4 5 — very unlikely / very likely

Would you choose to live on this road? — 1 2 3 4 5 — very unlikely / very likely

How fast would you drive down this road?

______________ km/h

Please rate the following: 1D

The road safety — 1 2 3 4 5 — very poor / very good

The road aesthetics — 1 2 3 4 5 — very poor / very good

Would you use this road as a regular route towork or school? — 1 2 3 4 5 — very unlikely / very likely

Would you choose to live on this road? — 1 2 3 4 5 — very unlikely / very likely

How fast would you drive down this road?

______________ km/h

Please rate the following: **1E**

The road safety

1 2 3 4 5
very poor — very good

The road aesthetics

1 2 3 4 5
very poor — very good

Would you use this road as a regular route towork or school?

1 2 3 4 5
very unlikely — very likely

Would you choose to live on this road?

1 2 3 4 5
very unlikely — very likely

How fast would you drive down this road?

__________ km/h

Please rate the following: **1F**

The road safety

1 2 3 4 5
very poor — very good

The road aesthetics

1 2 3 4 5
very poor — very good

Would you use this road as a regular route towork or school?

1 2 3 4 5
very unlikely — very likely

Would you choose to live on this road?

1 2 3 4 5
very unlikely — very likely

How fast would you drive down this road?

__________ km/h

Please rate the following real world scenarios:

2A

Please rate the following:

The road safety

1 2 3 4 5

very poor — very good

The road aesthetics

1 2 3 4 5

very poor — very good

Would you use this road as a regular route towork or school?

1 2 3 4 5

very unlikely — very likely

Would you choose to live on this road?

1 2 3 4 5

very unlikely — very likely

How fast would you drive down this road?

__________ km/h

2B

Please rate the following:

The road safety

1 2 3 4 5

very poor — very good

The road aesthetics

1 2 3 4 5

very poor — very good

Would you use this road as a regular route towork or school?

1 2 3 4 5

very unlikely — very likely

Would you choose to live on this road?

1 2 3 4 5

very unlikely — very likely

How fast would you drive down this road?

__________ km/h

Please rate the following:

2C

The road safety

1 2 3 4 5

very poor — very good

The road aesthetics

1 2 3 4 5

very poor — very good

Would you use this road as a regular route towork or school?

1 2 3 4 5

very unlikely — very likely

Would you choose to live on this road?

1 2 3 4 5

very unlikely — very likely

How fast would you drive down this road?

________________ km/h

Please rate the following:

2D

The road safety

1 2 3 4 5

very poor — very good

The road aesthetics

1 2 3 4 5

very poor — very good

Would you use this road as a regular route towork or school?

1 2 3 4 5

very unlikely — very likely

Would you choose to live on this road?

1 2 3 4 5

very unlikely — very likely

How fast would you drive down this road?

________________ km/h

Please rate the following:

3A

The road safety

1 2 3 4 5

very poor | very good

The road aesthetics

1 2 3 4 5

very poor | very good

Would you use this road as a regular route towork or school?

1 2 3 4 5

very unlikely | very likely

Would you choose to live on this road?

1 2 3 4 5

very unlikely | very likely

How fast would you drive down this road?

______________ km/h

3B

Please rate the following:

The road safety

1 2 3 4 5

very poor | very good

The road aesthetics

1 2 3 4 5

very poor | very good

Would you use this road as a regular route towork or school?

1 2 3 4 5

very unlikely | very likely

Would you choose to live on this road?

1 2 3 4 5

very unlikely | very likely

How fast would you drive down this road?

______________ km/h

Please rate the following: 3C

The road safety — 1 2 3 4 5 (very poor … very good)

The road aesthetics — 1 2 3 4 5 (very poor … very good)

Would you use this road as a regular route towork or school? — 1 2 3 4 5 (very unlikely … very likely)

Would you choose to live on this road? — 1 2 3 4 5 (very unlikely … very likely)

How fast would you drive down this road?

_______________ km/h

Please rate the following: 3D

The road safety — 1 2 3 4 5 (very poor … very good)

The road aesthetics — 1 2 3 4 5 (very poor … very good)

Would you use this road as a regular route towork or school? — 1 2 3 4 5 (very unlikely … very likely)

Would you choose to live on this road? — 1 2 3 4 5 (very unlikely … very likely)

How fast would you drive down this road?

_______________ km/h

PLEASE STOP HERE AND DO NOT TURN OVER UNTIL THE COMPLETION OF THE DESIGN PHASE

Section 2

This section asks some questions regarding your attitudes towards speed.

For each item please circle the appropriate number.

1 = Strongly dislike 2 = Dislike 3 = Neutral 4 = Like 5 = Like very much	
Do you enjoy driving fast on the open road	1 2 3 4 5

1 = Strongly disagree 2 = Somewhat Disagree 3 = Neutral 4 = Somewhat Agree 5 = Strongly agree	
The risk of being caught speeding is small	1 2 3 4 5
The penalties for speeding are not very severe	1 2 3 4 5
Most people who get caught speeding are just unlucky	1 2 3 4 5
Enforcing speed limits helps lower the road toll	1 2 3 4 5

1 = Very unfair 2 = Somewhat unfair 3 = Neutral 4 = Somewhat fair 5 = Very fair	
Demerit points only for 70km/h in a 50km/h zone	1 2 3 4 5
Fine only for 70km/h in a 50km/h zone	1 2 3 4 5
Demerit points and a fine for 70km/h in a 50km/h zone	1 2 3 4 5
Demerit points only for 120km/h in a 100km/h zone	1 2 3 4 5
Fine only for 120km/h in a 100km/h zone	1 2 3 4 5
Demerit points and a fine for 120km/h in a 100km/h zone	1 2 3 4 5
Automatic loss of license for speeding at 100km/h in a 50km/h zone would be…	1 2 3 4 5
Automatic loss of license for 3 speeding tickets in 12 months would be…	1 2 3 4 5

1 = Very unlikely 2 = Somewhat unlikely 3 = Uncertain 4 = Somewhat likely 5 = Very likely	
The likelihood that you will drive above 55km/h on a 50km/h road in the next twelve months	1 2 3 4 5

1 = Strongly disagree 2 = Somewhat disagree 3 = Neutral 4 = Somewhat agree 5 = Strongly agree	
I would be happier if speed limits were more strictly enforced.	1 2 3 4 5
People stopped for speeding are unlucky because lots of people do it.	1 2 3 4 5
Stricter enforcement of speed limits 50km/h roads would be effective in reducing the occurrence of accidents.	1 2 3 4 5
It's okay to drive faster than the speed limit as long as you drive carefully.	1 2 3 4 5
Speed limits are often set too low, with the result that many drivers ignore them.	1 2 3 4 5
Speeding is one of the main causes of road accidents.	1 2 3 4 5
I know exactly how fast I can drive and still drive safely.	1 2 3 4 5
I would favour stricter enforcement of the speed limit on 50km/h roads.	1 2 3 4 5
Sometimes you have to drive in excess of the speed limit in order to keep up with the traffic flow.	1 2 3 4 5
Even driving slightly faster than the speed limit makes you less safe as a driver.	1 2 3 4 5

Section 3

Please rate the countermeasures that you have created:

.Scenario 1

Following the changes you have made to the scenario:

Would you use this road as a regular route to work or school?

1 2 3 4 5

very unlikely — very likely

Would you choose to live on this road?

1 2 3 4 5

very unlikely — very likely

The road safety

1 2 3 4 5

very poor — very good

The road aesthetics

1 2 3 4 5

very poor — very good

Would you say your opinion of the changes made by your group is:

1 2 3 4 5

very unfavourable — very favourable

How do you feel the changes you have made have affected road safety

-2 -1 0 1 2

worse — no change — better

How do you feel the changes you have made have affected road aesthetics

-2 -1 0 1 2

worse — no change — better

How fast would you drive down this road?

_______________km/h

Scenario 2

Following the changes you have made to the scenario:

Would you use this road as a regular route to work or school?

1 2 3 4 5
very unlikely — very likely

Would you choose to live on this road?

1 2 3 4 5
very unlikely — very likely

The road safety

1 2 3 4 5
very poor — very good

The road aesthetics

1 2 3 4 5
very poor — very good

Would you say your opinion of the changes made by your group is:

1 2 3 4 5
very unfavourable — very favourable

How do you feel the changes you have made have affected road safety

-2 -1 0 1 2
worse — no change — better

How do you feel the changes you have made have affected road aesthetics

-2 -1 0 1 2
worse — no change — better

How fast would you drive down this road?

________________km/h

Scenario 3

Following the changes you have made to the scenario:

Would you use this road as a regular route to work or school?

1 2 3 4 5

very unlikely — very likely

Would you choose to live on this road?

1 2 3 4 5

very unlikely — very likely

The road safety

1 2 3 4 5

very poor — very good

The road aesthetics

1 2 3 4 5

very poor — very good

Would you say your opinion of the changes made by your group is:

1 2 3 4 5

very unfavourable — very favourable

How do you feel the changes you have made have affected road safety

-2 -1 0 1 2

worse — no change — better

How do you feel the changes you have made have affected road aesthetics

-2 -1 0 1 2

worse — no change — better

How fast would you drive down this road?

_________________km/h

SECTION 4

Please answer the following questions regarding the participatory design workshop:

Was the introduction to the workshop clear?	very difficult 1 2 3 4 5 very easy
Was the process of the workshop easy to follow?	very unclear 1 2 3 4 5 very clear
Do you feel that you were able to fully participate in the design process during the workshop?	not at all 1 2 3 4 5 fully
Do you feel that everyone was able to contribute to the design process?	no 1 2 3 4 5 yes
Are you happy with the speed reduction methods that your group came up with?	very unhappy 1 2 3 4 5 very happy
Has this process changed your attitude towards speed?	worse 1 2 no change 3 4 5 better
How would you rate participatory design as a way to design speed reduction countermeasures?	very bad 1 2 3 4 5 very good
How would you rate the effectiveness of participatory workshops as a tool to teach people about speed and speeding?	very bad 1 2 3 4 5 very good

Did you understand the information presented to you in the booklet and the PowerPoint presentation?

Yes / No

Comments:

Did you understand the goals of the workshop?

Yes / No

Comments:

Did you feel as though you were participating in the design process during this workshop?

Yes / No

Comments:

Do you now feel that you have a better understanding of the design process when it comes to speed reduction?

Yes / No

Comments:

Please write your name here: ______________________________

Section 1

This section asks some questions regarding your attitudes towards speed.

For each item please circle the appropriate number.

1 = Strongly dislike 2 = Dislike 3 = Neutral 4 = Like 5 = Like very much	
Do you enjoy driving fast on the open road	1 2 3 4 5

1 = Strongly disagree 2 = Somewhat Disagree 3 = Neutral 4 = Somewhat Agree 5 = Strongly agree	
The risk of being caught speeding is small	1 2 3 4 5
The penalties for speeding are not very severe	1 2 3 4 5
Most people who get caught speeding are just unlucky	1 2 3 4 5
Enforcing speed limits helps lower the road toll	1 2 3 4 5

1 = Very unfair 2 = Somewhat unfair 3 = Neutral 4 = Somewhat fair 5 = Very fair	
Demerit points only for 70km/h in a 50km/h zone	1 2 3 4 5
Fine only for 70km/h in a 50km/h zone	1 2 3 4 5
Demerit points and a fine for 70km/h in a 50km/h zone	1 2 3 4 5
Demerit points only for 120km/h in a 100km/h zone	1 2 3 4 5
Fine only for 120km/h in a 100km/h zone	1 2 3 4 5
Demerit points and a fine for 120km/h in a 100km/h zone	1 2 3 4 5
Automatic loss of license for speeding at 100km/h in a 50km/h zone would be…	1 2 3 4 5
Automatic loss of license for 3 speeding tickets in 12 months would be…	1 2 3 4 5

1 = Very unlikely 2 = Somewhat unlikely 3 = Uncertain 4 = Somewhat likely 5 = Very likely	
The likelihood that you will drive above 55km/h on a 50km/h road in the next twelve months	1 2 3 4 5

1 = Strongly disagree 2 = Somewhat disagree 3 = Neutral 4 = Somewhat agree 5 = Strongly agree	
I would be happier if speed limits were more strictly enforced.	1 2 3 4 5
People stopped for speeding are unlucky because lots of people do it.	1 2 3 4 5
Stricter enforcement of speed limits 50km/h roads would be effective in reducing the occurrence of accidents.	1 2 3 4 5
It's okay to drive faster than the speed limit as long as you drive carefully.	1 2 3 4 5
Speed limits are often set too low, with the result that many drivers ignore them.	1 2 3 4 5
Speeding is one of the main causes of road accidents.	1 2 3 4 5
I know exactly how fast I can drive and still drive safely.	1 2 3 4 5
I would favour stricter enforcement of the speed limit on 50km/h roads.	1 2 3 4 5
Sometimes you have to drive in excess of the speed limit in order to keep up with the traffic flow.	1 2 3 4 5
Even driving slightly faster than the speed limit makes you less safe as a driver.	1 2 3 4 5

Section 2

Please rate the following scenarios:

Please rate the following:

2A

The road safety

1 2 3 4 5

very poor — very good

The road aesthetics

1 2 3 4 5

very poor — very good

Would you use this road as a regular route towork or school?

1 2 3 4 5

very unlikely — very likely

Would you choose to live on this road?

1 2 3 4 5

very unlikely — very likely

How fast would you drive down this road?

____________ km/h

Please rate the following:

2B

The road safety

1 2 3 4 5

very poor — very good

The road aesthetics

1 2 3 4 5

very poor — very good

Would you use this road as a regular route towork or school?

1 2 3 4 5

very unlikely — very likely

Would you choose to live on this road?

1 2 3 4 5

very unlikely — very likely

How fast would you drive down this road?

____________ km/h

Please rate the following:

2C

The road safety — 1 2 3 4 5 (very poor … very good)

The road aesthetics — 1 2 3 4 5 (very poor … very good)

Would you use this road as a regular route towork or school? — 1 2 3 4 5 (very unlikely … very likely)

Would you choose to live on this road? — 1 2 3 4 5 (very unlikely … very likely)

How fast would you drive down this road?

________ km/h

Please rate the following:

2D

The road safety — 1 2 3 4 5 (very poor … very good)

The road aesthetics — 1 2 3 4 5 (very poor … very good)

Would you use this road as a regular route towork or school? — 1 2 3 4 5 (very unlikely … very likely)

Would you choose to live on this road? — 1 2 3 4 5 (very unlikely … very likely)

How fast would you drive down this road?

________ km/h

The following section asks questions regarding your driving habits and experience:

How often do you do each of the following?

For each item, you are asked to indicate how often this kind of thing has happened to you, using the following key. Base your judgements on what you remember of your driving over the past ***month since the workshop***

0 = never 1 = hardly ever 2 = occasionally 3 = quite often 4 = frequently 5 = all the time	
please circle the most appropriate number for EACH item	never All the time
Hit something when reversing that you had not previously seen	0 1 2 3 4 5
Intending to drive to destination A, you "wake up" to find yourself heading for destination B, maybe because the latter is a more usual destination	0 1 2 3 4 5
Drive when you suspect you might be over the legal blood alcohol limit	0 1 2 3 4 5
Get into the wrong lane approaching a roundabout or an intersection	0 1 2 3 4 5
Queuing to turn left onto a main road, you pay such close attention to the main stream of traffic that you nearly hit the car in front	0 1 2 3 4 5
Fail to notice that pedestrians are crossing when turning into a side street from a main road	0 1 2 3 4 5
Sound your horn to indicate your annoyance at another road user	0 1 2 3 4 5
Fail to check your rear-view mirror before pulling out, changing lanes, etc.	0 1 2 3 4 5
Brake too quickly on a slippery road, or steer the wrong way in a skid	0 1 2 3 4 5
Pull out of an intersection so far that the driver with right of way has to stop and let you out	0 1 2 3 4 5
Disregard the speed limit on a residential road	0 1 2 3 4 5
Switch on one thing, such as the headlights, when you meant to switch on something else, such as the wipers	0 1 2 3 4 5
On turning left, nearly hit a cyclist who has come up on your inside	0 1 2 3 4 5

	never		All the time
Miss "Give Way" signs, and narrowly avoid colliding with traffic having right of way	0 1 2 3 4 5		
Attempt to drive away from the traffic lights in third gear	0 1 2 3 4 5		
Attempt to overtake someone that you hadn't noticed to be signalling a right turn	0 1 2 3 4 5		
Become angered by another driver and give chase with the intention of giving him/her a piece of your mind	0 1 2 3 4 5		
Stay in a motorway lane that you know will be closed ahead until the last minute before forcing yourself into another lane	0 1 2 3 4 5		
Forget where you left your car in a car park	0 1 2 3 4 5		
Overtake a slow driver on the inside	0 1 2 3 4 5		
Race away from traffic lights with the intention of beating the driver next to you	0 1 2 3 4 5		
Misread the signs and exit from a roundabout on the wrong road	0 1 2 3 4 5		
Drive so close to the car in front that it would be difficult to stop in an emergency	0 1 2 3 4 5		
Cross an intersection knowing that the traffic lights have already turned against you	0 1 2 3 4 5		
Become angered by a certain type of driver and indicate your hostility by whatever means you can	0 1 2 3 4 5		
Realise that you have no clear recollection of the road along which you have just been travelling	0 1 2 3 4 5		
Underestimate the speed of an oncoming vehicle when overtaking	0 1 2 3 4 5		
Disregard the speed limit on the open road	0 1 2 3 4 5		

Roads redesigned by participants from the first experiment

Figure 1: Group one redesign

Figure 2: Group two redesign

Figure 3: Group three redesign

Figure 4: Group four redesign

Figure 5: Group five redesign

Figure 6: Group six redesign

Figure 7: Newell Road

Figure 8: River Road

Figure 9: Church Road

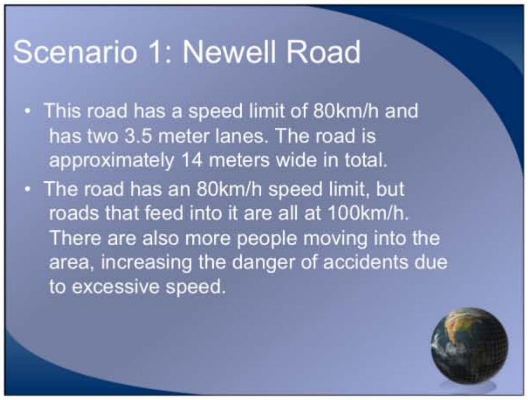
Figure 10: Spring Street

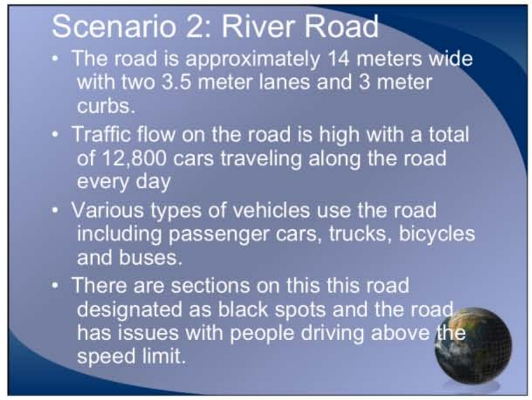
Figure 11: Moffat Road

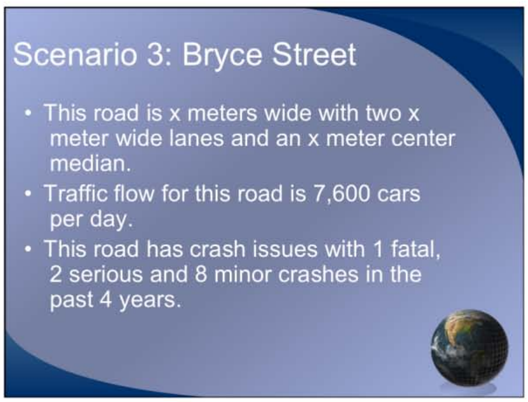
Figure 12: Cameron Road

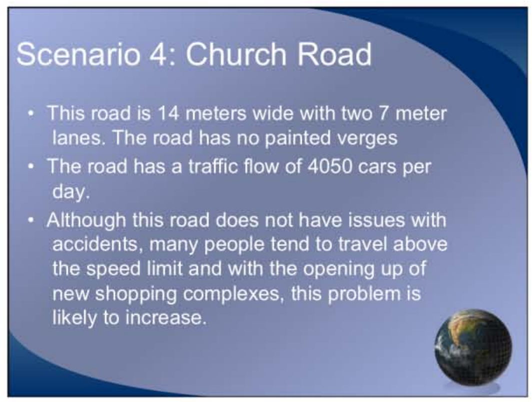
Figure 13: Central Road

Additional slides for the presentation









Questionnaire one

Questionnaire

SECTION 1A: Road Ratings

Please tell us what you think about these two Point Chevalier Roads:

Moa Road

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	________ km/h

Pt Chevalier Road

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	______________ km/h

SECTION 1B: Road Ratings

Please tell us what you think about these roads from around New Zealand:

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	____________ km/h

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	______________ km/h

The road safety	1 (very poor) — 2 — 3 — 4 — 5 (very good)
The road aesthetics	1 (very poor) — 2 — 3 — 4 — 5 (very good)
Would you use this road as a regular route to work or school?	1 (very unlikely) — 2 — 3 — 4 — 5 (very likely)
Would you choose to live on this road?	1 (very unlikely) — 2 — 3 — 4 — 5 (very likely)
How fast would you drive down this road?	____________ km/h

The road safety	1 (very poor) – 2 – 3 – 4 – 5 (very good)
The road aesthetics	1 (very poor) – 2 – 3 – 4 – 5 (very good)
Would you use this road as a regular route to work or school?	1 (very unlikely) – 2 – 3 – 4 – 5 (very likely)
Would you choose to live on this road?	1 (very unlikely) – 2 – 3 – 4 – 5 (very likely)
How fast would you drive down this road?	________ km/h

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	____________ km/h

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	____________ km/h

SECTION 2: Driving Habits and Experience

The following section asks questions regarding your driving habits and experience:

How often do you do each of the following?

For each item, you are asked to indicate how often this kind of thing has happened to you, using the following key. Base your judgements on what you remember of your driving over, say, the past year.

0 = never 1 = hardly ever 2 = occasionally 3 = quite often 4 = frequently 5 = all the time	
please circle the most appropriate number for EACH item	never ... All the time
Hit something when reversing that you had not previously seen	1 2 3 4 5
Intending to drive to destination A, you "wake up" to find yourself heading for destination B, maybe because the latter is a more usual destination	1 2 3 4 5
Drive when you suspect you might be over the legal blood alcohol limit	1 2 3 4 5
Get into the wrong lane approaching a roundabout or an intersection	1 2 3 4 5
Queuing to turn left onto a main road, you pay such close attention to the main stream of traffic that you nearly hit the car in front	1 2 3 4 5
Fail to notice that pedestrians are crossing when turning into a side street from a main road	1 2 3 4 5
Sound your horn to indicate your annoyance at another road user	1 2 3 4 5
Fail to check your rear-view mirror before pulling out, changing lanes, etc.	1 2 3 4 5
Brake too quickly on a slippery road, or steer the wrong way in a skid	1 2 3 4 5
Pull out of an intersection so far that the driver with right of way has to stop and let you out	1 2 3 4 5

0 = never 1 = hardly ever 2 = occasionally 3 = quite often 4 = frequently 5 = all the time	
please circle the most appropriate number for EACH item	never All the time
Disregard the speed limit on a residential road	1 2 3 4 5
Switch on one thing, such as the headlights, when you meant to switch on something else, such as the wipers	1 2 3 4 5
On turning left, nearly hit a cyclist who has come up on your inside	1 2 3 4 5
Miss “Give Way” signs, and narrowly avoid colliding with traffic having right of way	1 2 3 4 5
Attempt to drive away from the traffic lights in third gear	1 2 3 4 5
Attempt to overtake someone that you hadn’t noticed to be signalling a right turn	1 2 3 4 5
Become angered by another driver and give chase with the intention of giving him/her a piece of your mind	1 2 3 4 5
Stay in a motorway lane that you know will be closed ahead until the last minute before forcing yourself into another lane	1 2 3 4 5
Forget where you left your car in a car park	1 2 3 4 5
Overtake a slow driver on the inside	1 2 3 4 5
Race away from traffic lights with the intention of beating the driver next to you	1 2 3 4 5
Misread the signs and exit from a roundabout on the wrong road	1 2 3 4 5
Drive so close to the car in front that it would be difficult to stop in an emergency	1 2 3 4 5

0 = never 1 = hardly ever 2 = occasionally 3 = quite often 4 = frequently 5 = all the time	
please circle the most appropriate number for EACH item	never All the time
Cross an intersection knowing that the traffic lights have already turned against you	1 2 3 4 5
Become angered by a certain type of driver and indicate your hostility by whatever means you can	1 2 3 4 5
Realise that you have no clear recollection of the road along which you have just been travelling	1 2 3 4 5
Underestimate the speed of an oncoming vehicle when overtaking	1 2 3 4 5
Disregard the speed limit on the open road	1 2 3 4 5

SECTION 3: Driver Attitudes

This section asks some questions about your attitudes towards driving.

For each item please circle the appropriate number.

1 = Strongly dislike 2 = Dislike 3 = Neutral 4 = Like 5 = Like very much	
Do you enjoy driving fast on the open road	1 2 3 4 5

1 = Strongly disagree 2 = Somewhat Disagree 3 = Neutral 4 = Somewhat Agree 5 = Strongly agree	
The risk of being caught speeding is small	1 2 3 4 5
Most people who get caught speeding are just unlucky	1 2 3 4 5
Enforcing speed limits helps lower the road toll	1 2 3 4 5

1 = Very unlikely 2 = Somewhat unlikely 3 = Uncertain 4 = Somewhat likely 5 = Very likely	
The likelihood that you will drive more than 50km/h on a 50km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 60km/h on a 50km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 70km/h on a 70km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 80km/h on a 70km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 100km/h on a 100km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 110km/h on a 100km/h road in the next twelve months	1 2 3 4 5

1 = Strongly disagree 2 = Somewhat disagree 3 = Neutral 4 = Somewhat agree 5 = Strongly agree	
I would be happier if speed limits were more strictly enforced.	1 2 3 4 5
People stopped for speeding are unlucky because lots of people do it.	1 2 3 4 5
It's okay to drive faster than the speed limit as long as you drive carefully.	1 2 3 4 5
Speed limits are often set too low, with the result that many drivers ignore them.	1 2 3 4 5
Speeding is one of the main causes of road accidents.	1 2 3 4 5
I know exactly how fast I can drive and still drive safely.	1 2 3 4 5
Sometimes you have to drive in excess of the speed limit in order to keep up with the traffic flow.	1 2 3 4 5

SECTION 4: Personal Details

Please tell us a bit about yourself.

Age:	
Gender:	
Years that you have held a full driving license:	
Number of years of driving experience:	
Annual amount of kilometres driven:	
Number of infringements (including speed camera fines) in the past year:	
Crashes (including minor) in the past year:	

PLEASE STOP HERE AND DO NOT TURN OVER UNTIL THE COMPLETION OF THE DESIGN PHASE

SECTION 5:

This section asks some questions about your attitudes towards driving.

For each item please circle the appropriate number.

1 = Strongly dislike 2 = Dislike 3 = Neutral 4 = Like 5 = Like very much	
Do you enjoy driving fast on the open road	1 2 3 4 5

1 = Strongly disagree 2 = Somewhat Disagree 3 = Neutral 4 = Somewhat Agree 5 = Strongly agree	
The risk of being caught speeding is small	1 2 3 4 5
Most people who get caught speeding are just unlucky	1 2 3 4 5
Enforcing speed limits helps lower the road toll	1 2 3 4 5

1 = Very unlikely 2 = Somewhat unlikely 3 = Uncertain 4 = Somewhat likely 5 = Very likely	
The likelihood that you will drive more than 50km/h on a 50km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 60km/h on a 50km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 70km/h on a 70km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 80km/h on a 70km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 100km/h on a 100km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 110km/h on a 100km/h road in the next twelve months	1 2 3 4 5

1 = Strongly disagree 2 = Somewhat disagree 3 = Neutral 4 = Somewhat agree 5 = Strongly agree	
I would be happier if speed limits were more strictly enforced.	1 2 3 4 5
People stopped for speeding are unlucky because lots of people do it.	1 2 3 4 5
It's okay to drive faster than the speed limit as long as you drive carefully.	1 2 3 4 5
Speed limits are often set too low, with the result that many drivers ignore them.	1 2 3 4 5
Speeding is one of the main causes of road accidents.	1 2 3 4 5
I know exactly how fast I can drive and still drive safely.	1 2 3 4 5
Sometimes you have to drive in excess of the speed limit in order to keep up with the traffic flow.	1 2 3 4 5

SECTION 6: The Road Safety Design Challenge

Please give us some feedback on the road safety design challenge:

Do you feel that everyone was able to contribute to the design process? YES/NO

How would you rate participatory design as a way to improve road design?

How would you rate the effectiveness of participatory design as a tool to teach people about roads and road safety?

Has this process changed your attitude towards driving? YES/NO

If yes, what do you feel has changed?

General feedback/comments:

Follow up Questionnaire

SECTION 1A: Road Ratings

Please tell us what you think about these two Point Chevalier Roads:

Moa Road

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	____________ km/h

Pt Chevalier Road

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	____________ km/h

SECTION 1B: Road Ratings

Please tell us what you think about these roads from around New Zealand:

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	____________ km/h

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	____________ km/h

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	________________ km/h

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	________ km/h

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	____________ km/h

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	____________ km/h

SECTION 2: Driving Habits and Experience

The following section asks questions regarding your driving habits and experience:

How often do you do each of the following?

For each item, you are asked to indicate how often this kind of thing has happened to you, using the following key. Base your judgements on what you remember of your driving over **THE PAST MONTH** since the workshop.

0 = never 1 = hardly ever 2 = occasionally 3 = quite often 4 = frequently 5 = all the time	
please circle the most appropriate number for EACH item	never All the time
Hit something when reversing that you had not previously seen	1 2 3 4 5
Intending to drive to destination A, you "wake up" to find yourself heading for destination B, maybe because the latter is a more usual destination	1 2 3 4 5
Drive when you suspect you might be over the legal blood alcohol limit	1 2 3 4 5
Get into the wrong lane approaching a roundabout or an intersection	1 2 3 4 5
Queuing to turn left onto a main road, you pay such close attention to the main stream of traffic that you nearly hit the car in front	1 2 3 4 5
Fail to notice that pedestrians are crossing when turning into a side street from a main road	1 2 3 4 5
Sound your horn to indicate your annoyance at another road user	1 2 3 4 5
Fail to check your rear-view mirror before pulling out, changing lanes, etc.	1 2 3 4 5
Brake too quickly on a slippery road, or steer the wrong way in a skid	1 2 3 4 5
Pull out of an intersection so far that the driver with right of way has to stop and let you out	1 2 3 4 5

0 = never 1 = hardly ever 2 = occasionally 3 = quite often 4 = frequently 5 = all the time	
please circle the most appropriate number for EACH item	never All the time
Disregard the speed limit on a residential road	1 2 3 4 5
Switch on one thing, such as the headlights, when you meant to switch on something else, such as the wipers	1 2 3 4 5
On turning left, nearly hit a cyclist who has come up on your inside	1 2 3 4 5
Miss “Give Way” signs, and narrowly avoid colliding with traffic having right of way	1 2 3 4 5
Attempt to drive away from the traffic lights in third gear	1 2 3 4 5
Attempt to overtake someone that you hadn’t noticed to be signalling a right turn	1 2 3 4 5
Become angered by another driver and give chase with the intention of giving him/her a piece of your mind	1 2 3 4 5
Stay in a motorway lane that you know will be closed ahead until the last minute before forcing yourself into another lane	1 2 3 4 5
Forget where you left your car in a car park	1 2 3 4 5
Overtake a slow driver on the inside	1 2 3 4 5
Race away from traffic lights with the intention of beating the driver next to you	1 2 3 4 5
Misread the signs and exit from a roundabout on the wrong road	1 2 3 4 5
Drive so close to the car in front that it would be difficult to stop in an emergency	1 2 3 4 5

0 = never 1 = hardly ever 2 = occasionally 3 = quite often 4 = frequently 5 = all the time	
please circle the most appropriate number for EACH item	never All the time
Cross an intersection knowing that the traffic lights have already turned against you	1 2 3 4 5
Become angered by a certain type of driver and indicate your hostility by whatever means you can	1 2 3 4 5
Realise that you have no clear recollection of the road along which you have just been travelling	1 2 3 4 5
Underestimate the speed of an oncoming vehicle when overtaking	1 2 3 4 5
Disregard the speed limit on the open road	1 2 3 4 5

SECTION 3: Driver Attitudes

This section asks some questions about your attitudes towards driving.

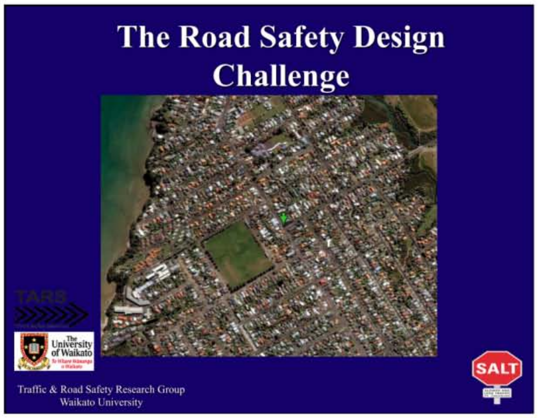
For each item please circle the appropriate number.

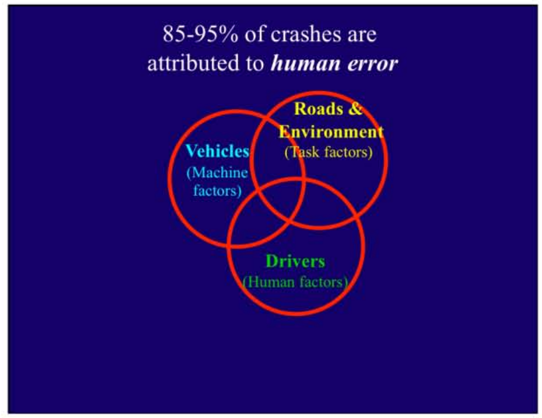
1 = Strongly dislike 2 = Dislike 3 = Neutral 4 = Like 5 = Like very much	
Do you enjoy driving fast on the open road	1 2 3 4 5

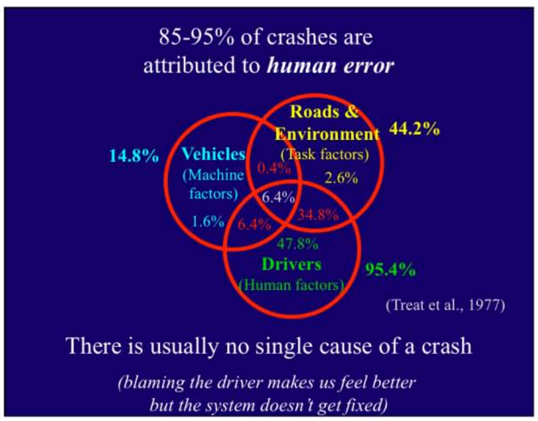
1 = Strongly disagree 2 = Somewhat Disagree 3 = Neutral 4 = Somewhat Agree 5 = Strongly agree	
The risk of being caught speeding is small	1 2 3 4 5
Most people who get caught speeding are just unlucky	1 2 3 4 5
Enforcing speed limits helps lower the road toll	1 2 3 4 5

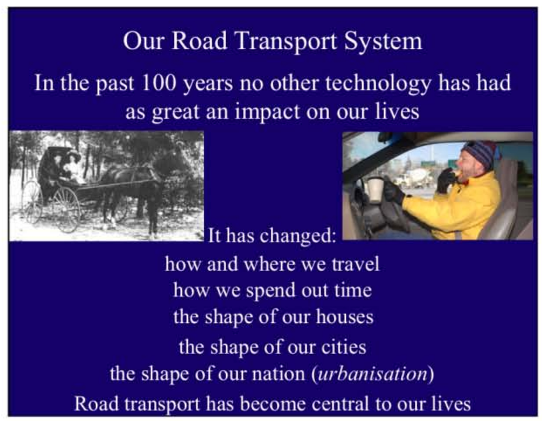
1 = Very unlikely 2 = Somewhat unlikely 3 = Uncertain 4 = Somewhat likely 5 = Very likely	
The likelihood that you will drive more than 50km/h on a 50km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 60km/h on a 50km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 70km/h on a 70km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 80km/h on a 70km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 100km/h on a 100km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 110km/h on a 100km/h road in the next twelve months	1 2 3 4 5

1 = Strongly disagree 2 = Somewhat disagree 3 = Neutral 4 = Somewhat agree 5 = Strongly agree	
I would be happier if speed limits were more strictly enforced.	1 2 3 4 5
People stopped for speeding are unlucky because lots of people do it.	1 2 3 4 5
It's okay to drive faster than the speed limit as long as you drive carefully.	1 2 3 4 5
Speed limits are often set too low, with the result that many drivers ignore them.	1 2 3 4 5
Speeding is one of the main causes of road accidents.	1 2 3 4 5
I know exactly how fast I can drive and still drive safely.	1 2 3 4 5
Sometimes you have to drive in excess of the speed limit in order to keep up with the traffic flow.	1 2 3 4 5


The Road Safety Design Challenge
The University of Waikato
SALT
Traffic & Road Safety Research Group
Waikato University


85-95% of crashes are attributed to ***human error***
Roads & Environment
(Task factors)
Vehicles
(Machine factors)
Drivers
(Human factors)


85-95% of crashes are attributed to ***human error***
Roads & Environment
(Task factors)
44.2%
14.8%
Vehicles
(Machine factors)
0.4%
2.6%
6.4%
1.6%
6.4%
34.8%
47.8%
Drivers
(Human factors)
95.4%
(Treat et al., 1977)
There is usually no single cause of a crash
(blaming the driver makes us feel better but the system doesn't get fixed)

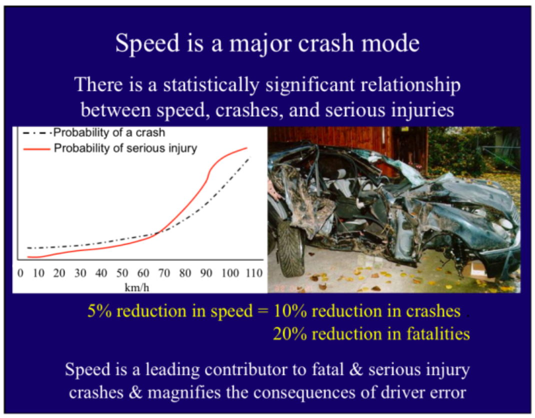

Our Road Transport System
In the past 100 years no other technology has had as great an impact on our lives
It has changed:
how and where we travel
how we spend out time
the shape of our houses
the shape of our cities
the shape of our nation (*urbanisation*)
Road transport has become central to our lives

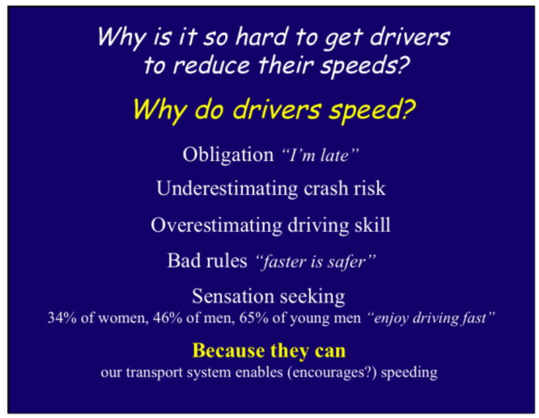

Our Road Transport System
We must love it!
(look at what it costs us)
TOM'S SHELL
#3 in the household budget
(approx. $10K per year)
30% of the urban land area
Direct Costs
40% of all C02 emissions in NZ
#1 cause of death in NZers under 35 yrs old
#3 cause of death world-wide by 2010
$10m per day in the national budget
Indirect Costs
(cost of death & injury)


The Good News…
We have made progress in road safety over the past 10-15 years
Index of fatalities (1970–2001)
Year
NZ
France
Norway
UK
Australia
Sweden
Germany
Netherlands


The Bad News…
But world-wide, the pace
of improvement has slowed
60
40
20
0
2002
2004
2006
NZ road fatalities – monthly totals
Many countries will not meet their
2010 goals

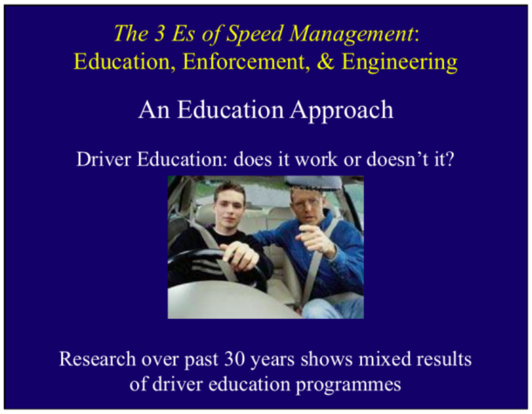

A variety of reasons have been
suggested for the plateau
"The easy things have all been done"
"Misguided emphasis on speed enforcement"
"Recidivist drivers are the reason for the plateau"
"Licensing age is too low"
"Advent of mobile phone use by drivers"
"Backlash against the 'Nanny State' mentality"
"Need to focus on changing entrenched
attitudes and vested interests"

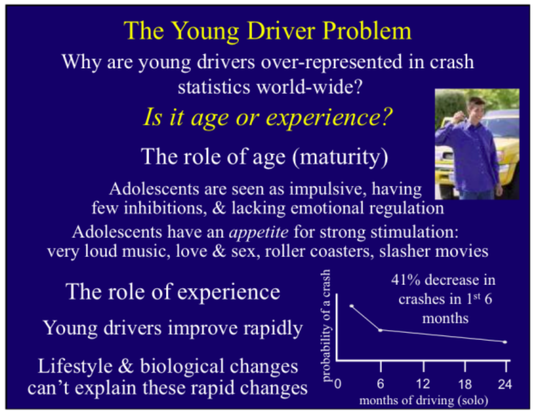

Speed is a major crash mode
There is a statistically significant relationship
between speed, crashes, and serious injuries
Probability of a crash
Probability of serious injury
0 10 20 30 40 50 60 70 80 90 100 110
km/h
5% reduction in speed = 10% reduction in crashes
20% reduction in fatalities
Speed is a leading contributor to fatal & serious injury
crashes & magnifies the consequences of driver error

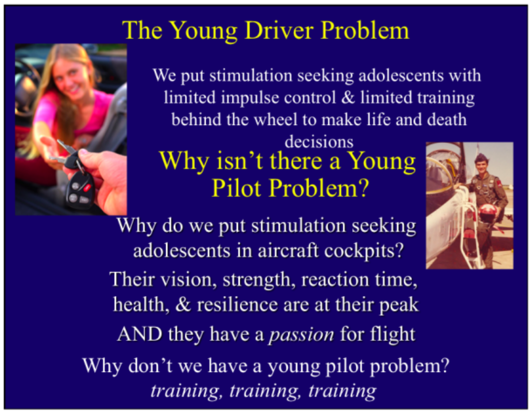

Why is it so hard to get drivers
to reduce their speeds?
Why do drivers speed?
Obligation "I'm late"
Underestimating crash risk
Overestimating driving skill
Bad rules "faster is safer"
Sensation seeking
34% of women, 46% of men, 65% of young men "enjoy driving fast"
Because they can
our transport system enables (encourages?) speeding

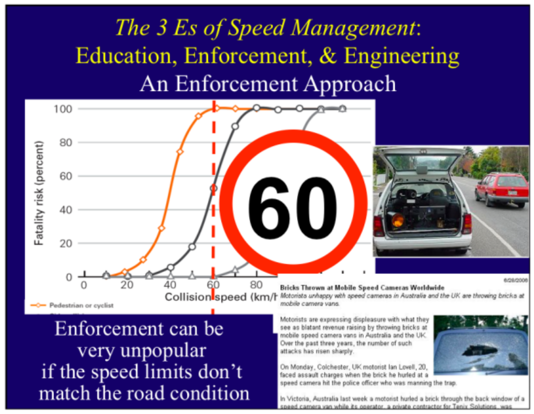

Why do drivers speed?
Inadvertent speeding
Much of our driving behaviour is governed implicitly
esp. lane keeping & speed maintenance
Most drivers are driving without
awareness, most of the time

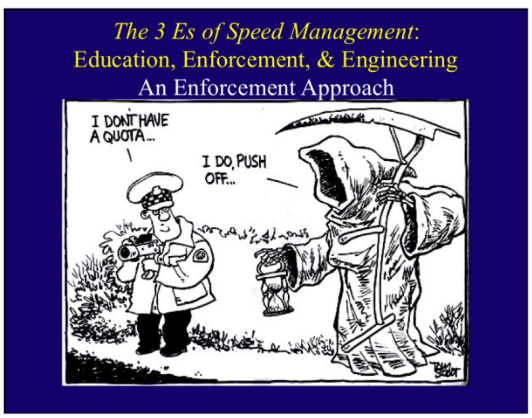

Latent Failures – Failures of Design
The Swiss Cheese Model
James Reason, 1990
Latent Failures
Latent Failures
Latent Failures
Unsafe Acts
Latent failures set the stage for
unsafe acts (active failures);
appropriate safeguards are
missing
Designs that fail to prevent,
or contribute to, user errors
We design roads that say: Go Fast Fast Fast
and then put up signs that say: SLOW DOWN

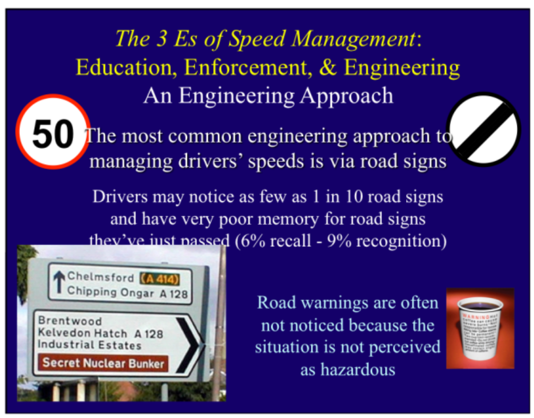

The 3 Es of Speed Management:
Education, Enforcement, & Engineering
An Education Approach
Driver Education: does it work or doesn't it?
Research over past 30 years shows mixed results
of driver education programmes


The Young Driver Problem
Why are young drivers over-represented in crash statistics world-wide?
Is it age or experience?
The role of age (maturity)
Adolescents are seen as impulsive, having few inhibitions, & lacking emotional regulation
Adolescents have an appetite for strong stimulation: very loud music, love & sex, roller coasters, slasher movies
The role of experience
Young drivers improve rapidly
Lifestyle & biological changes can't explain these rapid changes
41% decrease in crashes in 1st 6 months
probability of a crash
0
6
12
18
24
months of driving (solo)


The Young Driver Problem
We put stimulation seeking adolescents with limited impulse control & limited training behind the wheel to make life and death decisions
Why isn't there a Young Pilot Problem?
Why do we put stimulation seeking adolescents in aircraft cockpits?
Their vision, strength, reaction time, health, & resilience are at their peak
AND they have a passion for flight
Why don't we have a young pilot problem?
training, training, training

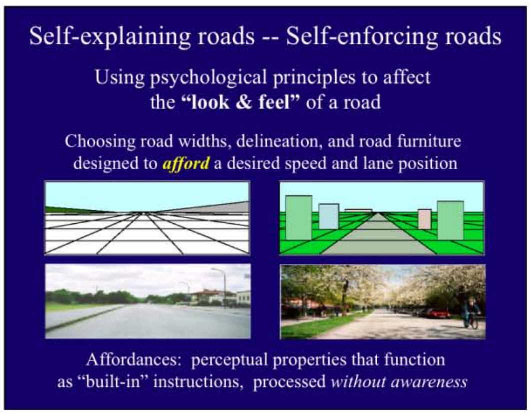

The 3 Es of Speed Management:
Education, Enforcement, & Engineering
An Enforcement Approach
100
80
60
40
20
0
Fatality risk (percent)
0
20
40
60
80
Collision speed (km/h)
Pedestrian or cyclist
60
Bricks Thrown at Mobile Speed Cameras Worldwide
Enforcement can be very unpopular if the speed limits don't match the road condition

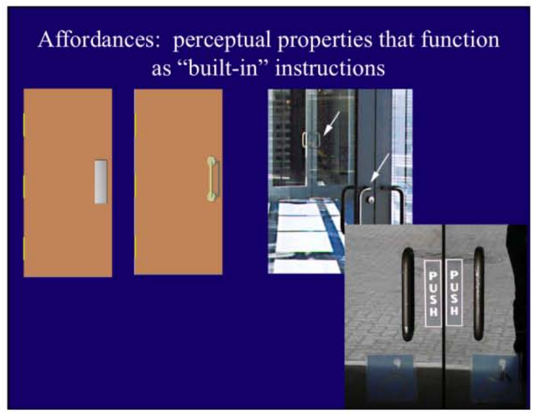

The 3 Es of Speed Management:
Education, Enforcement, & Engineering
An Enforcement Approach
I DON'T HAVE A QUOTA...
I DO, PUSH OFF...

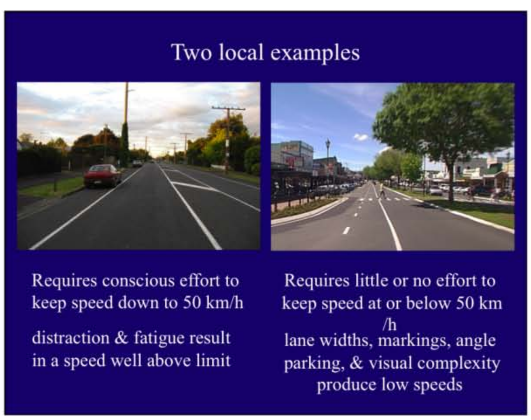

The 3 Es of Speed Management:
Education, Enforcement, & Engineering
An Engineering Approach
50
The most common engineering approach to managing drivers' speeds is via road signs
Drivers may notice as few as 1 in 10 road signs and have very poor memory for road signs they've just passed (6% recall - 9% recognition)
Chelmsford (A 414)
Chipping Ongar A 128
Brentwood
Kelvedon Hatch A 128
Industrial Estates
Secret Nuclear Bunker
Road warnings are often not noticed because the situation is not perceived as hazardous


The 3 Es: Education, Enforcement, & Engineering
Other engineering approaches rely on
forcing functions to eliminate incorrect behaviour
Speed management techniques (AKA Traffic Calming)


The 3 Es: Education, Enforcement, & Engineering
Other engineering approaches rely on
forcing functions to eliminate incorrect behaviour
People don't like forcing functions
When confronted with a forcing function
many people will find another way around


Self-explaining roads -- Self-enforcing roads
Using psychological principles to affect
the "look & feel" of a road
Choosing road widths, delineation, and road furniture
designed to afford a desired speed and lane position
Affordances: perceptual properties that function
as "built-in" instructions, processed without awareness


Affordances: perceptual properties that function
as "built-in" instructions
PUSH
PUSH


Two local examples
Requires conscious effort to
keep speed down to 50 km/h
distraction & fatigue result
in a speed well above limit
Requires little or no effort to
keep speed at or below 50 km/h
lane widths, markings, angle
parking, & visual complexity
produce low speeds


Sustainable Safety – The Netherlands
Three speed management principles
Predictability – preventing uncertainty among road users
Homogeneity – preventing major variations in speed, direction
and mass of vehicles (at moderate & high driving speeds)
Functionality – preventing unintended use of the infrastructure
Road environment hierarchy – 3 levels
Roads with an access function – access to homes and shops
while ensuring safety of the street as a meeting place
Roads with a distributor function – distribution of collection
of traffic to and from different districts and residential areas
Roads with a through function – rapid movement of
through traffic

Sustainable Safety – The Netherlands

Access roads



Distributor roads


Through roads

Access Roads

- Provide access to individual homes
- Higher pedestrian activity
- Speed management strategies
- More of a "shared" space


Distributor Roads

- Link the urban centre to main industrial and suburban areas
- Provide links between access roads and district distributors
- Provision for pedestrian access, cyclist access
- Frontage access to homes and other buildings (shops etc)

Through Roads

- Used by through traffic
- No frontage access to properties
- No or few pedestrians

Self-Explaining Roads in New Zealand

National Speed Management Initiative

*"The emphasis is not just on speed limit enforcement, it includes perceptual measures that influence the speed that a driver feels is appropriate for the section of road upon which they are driving – in effect the '**self-explaining road**'"*

National Road Safety Cttee/Ministry of Transport 2004

We have already developed candidate designs for the NZ road hierarchy

Field trials of NZ design options

Laboratory development of innovative treatments

Self-Explaining Roads for NZ

	Through		Distributor		Access
	Urban	Rural	Urban	Rural	(Residential)
Design speed	60 - 70	100 - 110	50	80	30 - 40
Number of lanes	2+2	2+1 or 2+2	1+1 or 2+2	1+1 or 2+1	1 or 1+1
Lane width (m)	3.75	3.5	3.5	3.25	2.5
Centre median	Planted median	Barrier	Raised or planted	Barrier	None
Cycle lane	Yes (sep)	No	Yes	No	Shared
Footpath	No	No	Yes	No	Shared
Road surface	Smooth	Smooth	Smooth	Smooth or rough	Coloured and /or textured
Centre line	None (mdn)	None (mdn) or double	Dashed	Double or dashed w /RRPMs	None
Edge line	Solid	Solid	Solid	Solid	None
Clear zone (m)	1 - 10	1 - 10	0 - 6	1.58 - 8	0 - 1.5
Other	Landscaping	Side barriers & RRPMs	Raised zebra crossings	Side barriers & RRPMs	Speed humps

Speed Management Designs

Two types of speed management designs

Speed change treatments
applied to speed change thresholds

Speed maintenance treatments
applied to speed change thresholds

Speed Change Treatments

Visual design features
signs & perceptual countermeasures

	% reduction	Avg speed (km/h)	C85 speed (km/h)
Static signs Speed roundels Oversized signs	0 0 – 3%	Depends on speed limit 67.2	Depends on speed limit 89.6
Dynamic signs	11%	Depends on speed limit	Depends on speed limit
Visual narrowing	11-20%	Depends on speed limit	Depends on speed limit
Transverse lines	8-14%	57.5 - 65	77.5-82.8
Coloured pavement	0%	_	_

Perceptual Counter-measures

Dragon's teeth, herring bones, transverse lines, etc.

Subject to habituation (within 250m) and visual motion after effects (VMAE)

Speed Change Treatments

Some types of signs function as perceptual countermeasures

Curve warnings that highlight the perceptual features of the curve work best, particularly in cognitively demanding situations (i.e., when drivers aren't paying attention)

Speed Change Treatments

Physical design features
obstructions, deflections, & discomfort

	% reduction	Avg speed (km/h)	C85 speed (km/h)
Transverse rumble strips & mats	0.1-6%	43-62	48-72
Traffic medians	9%	49.3	57.3
Chicanes 10° path angle 15-20° path angle	26% _ _	36.8 40 < 32	44.8 > 48 32-40
Speed cushions 75mm high	9.3%	27.2	35.2
Speed humps 75mm high	21%	23.5	30.4

Speed Change Treatments

Gateways & urban thresholds
combination of physical & visual features

	% reduction	Avg speed (km/h)	C85 speed (km/h)
Signing & marking	0 – 3%	67.2	89.6
High visibility signs & PCMs	7.5%	64	76.8
High visibility & physical features	15-27%	52.8-66	70.4

Location, location, location!
gateway placed at 1st house is much more effective than gateway at city or village boundary

Speed Maintenance Treatments

Speed maintenance treatments must accommodate a broader range of operating speeds, and thus comprise a greater range of treatment types

- Lane width & road width
- Number of lanes & central medians
- Roadside features
- Road surface & delineation
- Physical obstacles

Speed Maintenance Treatments

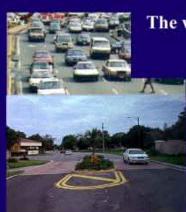
Lane width & road width
have some of the largest speed maintenance effects

	Avg speed (km/h)	C85 speed (km/h)
Lane width (urban arterials)		
3.0m	40	65
3.25m	42	68
3.5m	45	72
3.75m	48	76
4.0m	–	80
4.25m	–	82
Carriageway width (through roads)		
6.0m	80	
8.0m	90-100	

Speed Maintenance Treatments

Number of lanes & central medians
nearly as important as lane width

	Avg speed (km/h)	C85 speed (km/h)



The wider the median, the higher the speed
unless it narrows the lanes

Median width	C85 speed (km/h)
0 (local)	53.1
0 (arterial)	69.2
3m (local)	69.2
3m (arterial)	86.9
6m (local)	72.4
6m (arterial)	96.5

Speed Maintenance Treatments

Roundabouts
an effective form of deflecting median
(don't need to be placed at intersections)

Speed Maintenance Treatments

Roadside features

	C85 speed
Access density	
> 29 pts per km	74 km/h
< 29 pts per km	83 km/h
Parking	51 km/h
No parking	77 km/h
Road environment 3m from road edge	
clear	50mph
yielding objects	45mph
yielding & rigid	38mph
isolated rigid (arterial)	42mph
isolated rigid (local)	33mph
continuous rigid (arterial)	47mph
continuous rigid (local)	27mph

Our Roads

We can design *self-explaining roads* that encourage correct driver behaviour

Involve road users to develop a road hierarchy with predictable and clear functions

Ensure our road environments are error-tolerant & forgiving


Making roads user-friendly
Applying usability principles to road design
Roads shouldn't need an instruction manual
Participatory Design / Generative Design
in the development of consumer products
Focus is on user interactions with the product
Involves users in the design process
A father and son collaborating on creating an ideal remote control using a velcro toolkit

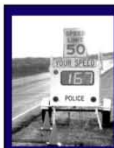

In participatory design, users help define the problem, focus ideas for solutions, and help evaluate proposed solutions


Participatory design for self-explaining roads


Participatory design for self-explaining roads


How Will You be Involved Tonight?
With Participatory Design..
• An approach that encourages the participation of end -users in the design process in a democratic way
• The approach focuses on empowering users by making them part of the design process rather than simply testing a finished product
• In tonight's design challenge you will use what you know to design a new approach to reducing speeds and improving safety and liveability on two of your local roads


The Challenge
• Two teams are going to work on two local roads
• Moa Road and Point Chevalier Road



The first step, categorisation..

- Many roads are initially difficult to categorise but…
- This is an important step
- The wrong road for the wrong purpose can increase the occurrence of speeding and accidents or conversely cause traffic congestion

Consider this Road

Things to consider

- When choosing which category a road belongs to remember to consider:
  - Traffic flow (cars per day)
  - Surrounding environment (houses, shops, schools)
  - Road function (through road, distributor, access)
  - Other road users (cyclists, pedestrians etc)
  - If the road doesn't fit neatly into a particular category, what compromises can be made

So what is Moa Road?

Things to remember…

- Moa road has a low traffic flow (1,000 cars per day)
- The width of the road is 9~9.2 meters
- The hills are causing most of the speed and visibility issues
- Key aims are to:
  - Reduce Speeds
  - Improve safety for vulnerable road users

What are the issues?

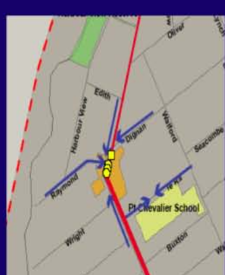
- The blue arrow represents a path travelled regularly by pedestrians, including school children, crossing Moa road at the bottom of a hill
- Over two months 27,403 cars were found to be in excess of the speed limit. Speeds ranged from 51km/h to 130km/h. The 85th percentile speed was 61.14km/h
- The hills make it difficult for pedestrians crossing the road to see oncoming vehicles and easy for vehicles to inadvertently go over the speed limit

What is Point Chevalier Road?

Things to remember…

- Point Chevalier road has a traffic flow of 3,500 cars per day
- The width of the road is12.5 meters
- The corner is the major issue on this stretch of road
- Main aims are:
  - To reduce the accident rate by
  - Addressing issues with the corner, including loss of control and visibility

What are the issues?



- This road has been the site of 16 crashes since 2002, including 4 involving pedestrians and 1 involving a cyclist
- The issue with this road is a sharp blind corner
- Vehicles lose control on this corner and drivers, pedestrians and other road users cannot see oncoming vehicles

•The two teams will have 40 minutes to complete their road designs

•Half way the audience will get a chance to provide some input into the design, so make sure to write down you ideas

•Once the two teams have completed their designs, you will be asked pick the best one using your score sheets

•Once completed, score sheets will be collected and scores will be counted

•During this time, please fill the "after" section of your questionnaires

•The winning team will then be announced


Teams Please Begin…


Time's
Up!

Appendix D: Materials For Experiment Four

Screening Questionnaire

Questionnaire

SECTION 1: Road Ratings

Please tell us what you think about these roads:

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	____________ km/h

The road safety	1 very poor – 2 – 3 – 4 – 5 very good
The road aesthetics	1 very poor – 2 – 3 – 4 – 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely – 2 – 3 – 4 – 5 very likely
Would you choose to live on this road?	1 very unlikely – 2 – 3 – 4 – 5 very likely
How fast would you drive down this road?	________________ km/h

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	______________ km/h

The road safety	1 very poor, 2, 3, 4, 5 very good
The road aesthetics	1 very poor, 2, 3, 4, 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely, 2, 3, 4, 5 very likely
Would you choose to live on this road?	1 very unlikely, 2, 3, 4, 5 very likely
How fast would you drive down this road?	____________ km/h

The road safety	1 (very poor) – 2 – 3 – 4 – 5 (very good)
The road aesthetics	1 (very poor) – 2 – 3 – 4 – 5 (very good)
Would you use this road as a regular route to work or school?	1 (very unlikely) – 2 – 3 – 4 – 5 (very likely)
Would you choose to live on this road?	1 (very unlikely) – 2 – 3 – 4 – 5 (very likely)
How fast would you drive down this road?	____________ km/h

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	______________ km/h

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How fast would you drive down this road?	____________ km/h

SECTION 2: Driving Habits and Experience

The following section asks questions regarding your driving habits and experience:

How often do you do each of the following?

For each item, you are asked to indicate how often this kind of thing has happened to you, using the following key. Base your judgements on what you remember of your driving over, say, the past year.

0 = never 1 = hardly ever 2 = occasionally 3 = quite often 4 = frequently 5 = all the time	
please circle the most appropriate number for EACH item	never ... All the time
Hit something when reversing that you had not previously seen	0 1 2 3 4 5
Intending to drive to destination A, you "wake up" to find yourself heading for destination B, maybe because the latter is a more usual destination	0 1 2 3 4 5
Drive when you suspect you might be over the legal blood alcohol limit	0 1 2 3 4 5
Get into the wrong lane approaching a roundabout or an intersection	0 1 2 3 4 5
Queuing to turn left onto a main road, you pay such close attention to the main stream of traffic that you nearly hit the car in front	0 1 2 3 4 5
Fail to notice that pedestrians are crossing when turning into a side street from a main road	0 1 2 3 4 5
Sound your horn to indicate your annoyance at another road user	0 1 2 3 4 5
Fail to check your rear-view mirror before pulling out, changing lanes, etc.	0 1 2 3 4 5
Brake too quickly on a slippery road, or steer the wrong way in a skid	0 1 2 3 4 5
Pull out of an intersection so far that the driver with right of way has to stop and let you out	0 1 2 3 4 5

0 = never 1 = hardly ever 2 = occasionally 3 = quite often 4 = frequently 5 = all the time	
please circle the most appropriate number for EACH item	never All the time
Disregard the speed limit on a residential road	0 1 2 3 4 5
Switch on one thing, such as the headlights, when you meant to switch on something else, such as the wipers	0 1 2 3 4 5
On turning left, nearly hit a cyclist who has come up on your inside	0 1 2 3 4 5
Miss "Give Way" signs, and narrowly avoid colliding with traffic having right of way	0 1 2 3 4 5
Attempt to drive away from the traffic lights in third gear	0 1 2 3 4 5
Attempt to overtake someone that you hadn't noticed to be signalling a right turn	0 1 2 3 4 5
Become angered by another driver and give chase with the intention of giving him/her a piece of your mind	0 1 2 3 4 5
Stay in a motorway lane that you know will be closed ahead until the last minute before forcing yourself into another lane	0 1 2 3 4 5
Forget where you left your car in a car park	0 1 2 3 4 5
Overtake a slow driver on the inside	0 1 2 3 4 5
Race away from traffic lights with the intention of beating the driver next to you	0 1 2 3 4 5
Misread the signs and exit from a roundabout on the wrong road	0 1 2 3 4 5
Drive so close to the car in front that it would be difficult to stop in an emergency	0 1 2 3 4 5

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please circle the most appropriate number for EACH item	never All the time
Cross an intersection knowing that the traffic lights have already turned against you	0 1 2 3 4 5
Become angered by a certain type of driver and indicate your hostility by whatever means you can	0 1 2 3 4 5
Realise that you have no clear recollection of the road along which you have just been travelling	0 1 2 3 4 5
Underestimate the speed of an oncoming vehicle when overtaking	0 1 2 3 4 5
Disregard the speed limit on the open road	0 1 2 3 4 5

SECTION 3: Driver Attitudes

This section asks some questions about your attitudes towards driving.

For each item please circle the appropriate number.

1 = Strongly dislike 2 = Dislike 3 = Neutral 4 = Like 5 = Like very much	
Do you enjoy driving fast on the open road	1 2 3 4 5

1 = Strongly disagree 2 = Somewhat Disagree 3 = Neutral 4 = Somewhat Agree 5 = Strongly agree	
The risk of being caught speeding is small	1 2 3 4 5
Most people who get caught speeding are just unlucky	1 2 3 4 5
Enforcing speed limits helps lower the road toll	1 2 3 4 5

1 = Very unlikely 2 = Somewhat unlikely 3 = Uncertain 4 = Somewhat likely 5 = Very likely	
The likelihood that you will drive more than 50km/h on a 50km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 60km/h on a 50km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 70km/h on a 70km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 80km/h on a 70km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 100km/h on a 100km/h road in the next twelve months	1 2 3 4 5
The likelihood that you will drive more than 110km/h on a 100km/h road in the next twelve months	1 2 3 4 5

1 = Strongly disagree 2 = Somewhat disagree 3 = Neutral 4 = Somewhat agree 5 = Strongly agree	
I would be happier if speed limits were more strictly enforced.	1 2 3 4 5
People stopped for speeding are unlucky because lots of people do it.	1 2 3 4 5
It's okay to drive faster than the speed limit as long as you drive carefully.	1 2 3 4 5
Speed limits are often set too low, with the result that many drivers ignore them.	1 2 3 4 5
Speeding is one of the main causes of road accidents.	1 2 3 4 5
I know exactly how fast I can drive and still drive safely.	1 2 3 4 5
Sometimes you have to drive in excess of the speed limit in order to keep up with the traffic flow.	1 2 3 4 5

Questionnaire

SECTION 1:

This section asks some questions about your attitudes towards driving.

For each item please circle the appropriate number.

1 = Strongly dislike 2 = Dislike 3 = Neutral 4 = Like 5 = Like very much	
Do you enjoy driving fast on the open road	1 2 3 4 5

1 = Strongly disagree 2 = Somewhat Disagree 3 = Neutral 4 = Somewhat Agree 5 = Strongly agree	
The risk of being caught speeding is small	1 2 3 4 5
Most people who get caught speeding are just unlucky	1 2 3 4 5
Enforcing speed limits helps lower the road toll	1 2 3 4 5

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Speed limits are often set too low, with the result that many drivers ignore them.	1 2 3 4 5
Speeding is one of the main causes of road accidents.	1 2 3 4 5
I know exactly how fast I can drive and still drive safely.	1 2 3 4 5
Sometimes you have to drive in excess of the speed limit in order to keep up with the traffic flow.	1 2 3 4 5

River Road:

The road safety	1 (very poor) 2 3 4 5 (very good)
The road aesthetics	1 (very poor) 2 3 4 5 (very good)
Would you use this road as a regular route to work or school?	1 (very unlikely) 2 3 4 5 (very likely)
Would you choose to live on this road?	1 (very unlikely) 2 3 4 5 (very likely)
How fast would you drive down this road?	______________ km/h

<u>Feedback/comments</u>: Please give feedback or comments on any other aspects of the redesigned road, such as the safety of pedestrians and cyclists, traffic flow, how viable the design is etc…

SECTION 2: The Road Safety Design Challenge

Please give us some feedback on the road safety design challenge:

Do you feel that everyone was able to contribute to the design process? YES/NO

How would you rate participatory design as a way to improve road design?

How would you rate the effectiveness of participatory design as a tool to teach people about roads and road safety?

Has this process changed your attitude towards driving? YES/NO

If yes, what do you feel has changed?

General feedback/comments:

SECTION 3: Personal Details

Please tell us a bit about yourself.

Name:	
Age:	
Gender:	
Years that you have held a full driving license:	
Number of years of driving experience:	
Annual amount of kilometres driven:	
Number of infringements (including speed camera fines) in the past year:	
Crashes (including minor) in the past year:	
How did you take part in the experiment, please circle:	Audience Member or Team Member

Follow up Questionnaire

Follow up Questionnaire

Please write your name here: ____

SECTION 1: Road Ratings

Please tell us what you think about these roads:

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	______________ km/h

The road safety	1 very poor — 2 — 3 — 4 — 5 very good
The road aesthetics	1 very poor — 2 — 3 — 4 — 5 very good
Would you use this road as a regular route to work or school?	1 very unlikely — 2 — 3 — 4 — 5 very likely
Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	____________km/h

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How fast would you drive down this road?	____________ km/h

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Would you choose to live on this road?	1 very unlikely — 2 — 3 — 4 — 5 very likely
How fast would you drive down this road?	____________ km/h

The road safety	1 2 3 4 5 very poor — very good
The road aesthetics	1 2 3 4 5 very poor — very good
Would you use this road as a regular route to work or school?	1 2 3 4 5 very unlikely — very likely
Would you choose to live on this road?	1 2 3 4 5 very unlikely — very likely
How fast would you drive down this road?	____________ km/h

SECTION 2: Driving Habits and Experience

The following section asks questions regarding your driving habits and experience:

How often do you do each of the following?

*For each item, you are asked to indicate how often this kind of thing has happened to you, using the following key. Base your judgements on what you remember of your driving, say, over the past **MONTH** since the experiment*

0 = never 1 = hardly ever 2 = occasionally 3 = quite often 4 = frequently 5 = all the time	
please circle the most appropriate number for EACH item	never All the time
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Speeding is one of the main causes of road accidents.	1 2 3 4 5
I know exactly how fast I can drive and still drive safely.	1 2 3 4 5
Sometimes you have to drive in excess of the speed limit in order to keep up with the traffic flow.	1 2 3 4 5

Has there been anything else about your driving/riding or attitudes that you think has changed since the experiment? (e.g. reduced speeds, more awareness of road design etc.)

Additional slides for the presentation

The Road Safety Design Challenge

The Challenge

- Two teams are going to work on River Road

Things to remember…

- River road has a traffic flow of 15,356 vehicles per day
- The width of the road is approximately 14 meters
- People turning on to River road have been involved in seven reported accidents since 2004.
- Key aims are to:
  - Reduce Speeds
  - Improve safety for traffic turning onto River road

•The two teams will ~40 minutes to complete their road designs

•Half way through the audience will get a chance to provide some input into the design, so make sure to write down you ideas

•Once the two teams have completed their designs, you will be asked pick the best one using your score sheets

•The winning team will then be announced

•Please fill in your questionnaires

Teams Please Begin…


Time's
Up!


Thank you for Participating

Appendix E: Booklet used to help participants choose countermeasures for their designs

Speed Reduction countermeasures

Road markings

Road markings

Can be used for: Lane width reduction

By reducing lane width, roads are viewed as less safe and more difficult to drive, so people tend to drive more slowly on narrow roads.

Advantages:

Cost effective

Speed reduction maintained over long periods

Can be used on long stretches of road

Benefits cyclists with a wider shoulder

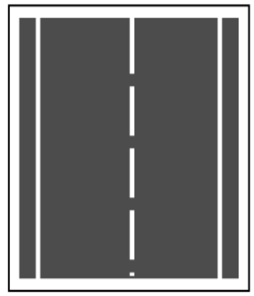
Disadvantages:

May increase the incidence of head on collisions

May disrupt traffic flow (reduce capacity)

May increase erratic driving behaviour

May increase speed variance between cars



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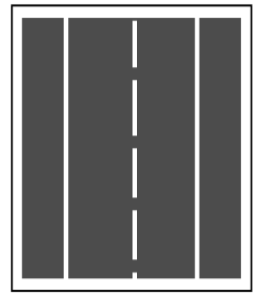


AFTER

Can be used for: Transverse lines/bars

Transverse lines are used to reduce speed by reducing the distance between them to give the illusion that one is travelling faster than one actually is.

Advantages:

Cost effective

Relatively easy to implement

Have both a warning and a perceptual effect

Can be used at dangerous intersections, roundabouts etc..

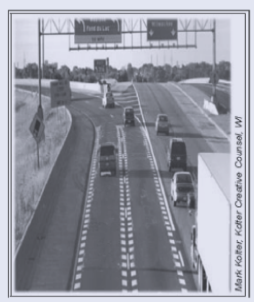
Disadvantages:

Very small speed reductions

Lack of data regarding long term effectiveness

Various ways of implementation

May not be useful over long distances



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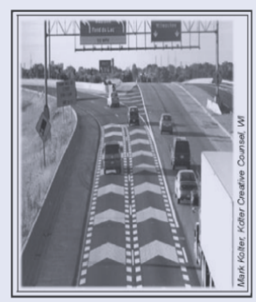


AFTER

Can be used for: Installing medians

Medians can be used to reduce lane width and increase safety.

Advantages:

Cost effective

Provide wider separation between opposing lanes

Give emergency and turning vehicles a place to wait

Provide pedestrians with a refuge

Disadvantages:

Does not physically restrain vehicular crossings

Can be difficult to see on rainy nights

Without lane width reduction, speeds increase

Confusion regarding usage

Road markings

BEFORE

AFTER

Can be used for: Written warnings

Written warnings, such as speed roundels can be used to remind motorists of the speed limit and provide warnings such as "slow down" or "children crossing"

Advantages:

Cost effective

Relatively easy to implement

Multiple uses

Roundels are effective at reducing speeds

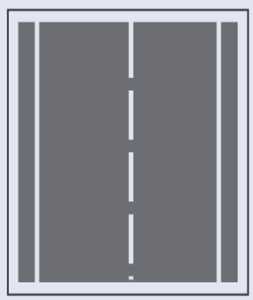
Disadvantages:

Possibility of misinterpretation

Issues with foreign drivers not understanding the sign

May be difficult to see on rainy nights

Only serves as a warning, no other effects



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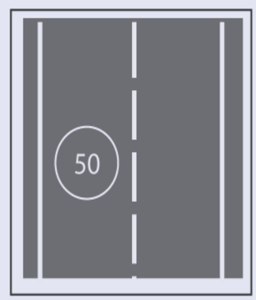


AFTER

Vertical changes

Can be used for: Speed humps

Speed humps are from 3.5 - 7 metres in length and 8 -10cm high. The size of the hump is determined by the speed reduction required

Advantages:

Cost effective

Lower and narrow the range of speeds

Residents generally support speed humps

Good option for streets that lack curbs or intersections

Disadvantages:

Issues with emergency service response times

Often described as unattractive

Difficult to construct acurately

Increases in noise and pollution from vehicle acceleration

BEFORE

AFTER

Can be used for: Speed tables

Speed tables are around 7 metres in length and 8 -10cm high. The have a flat top and, as with speed humps, the size of the hump is determined by the speed reduction required

Advantages:

Lower delays for emergency service vehicles

Not as jarring as speed bumps

Can double as pedestrian cross walks

Can be used on higher volume/speed roads

Disadvantages:

More expensive than speed humps

Increase in road noise and pollution

Maintenance

Traffic may divert to other streets

BEFORE

AFTER

Lateral changes

Can be used for: Chicanes

Chicanes are road narrowings placed on both sides of the road, they reduce traffic speeds forcing people to manoeuvre through them

Advantages:

Reduces speeds and can improve road safety

Minimal impact on emergency service vehicles

Can reduce the number of vehicles

If landscaped, can serve as a signal to reduce speeds

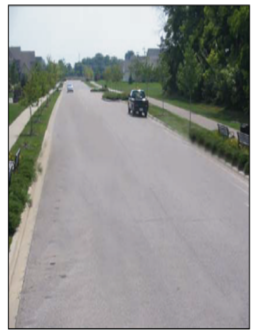
Disadvantages:

If the lanes are too wide, speeds may not be reduced

May be seen as a driving challenge.

Can reduce on street parking

Can create conflicts between vehicles



BEFORE

AFTER

Can be used for: Chokers or pinch points

Chokers are kerb extensions that narrow the road by widening the sidewalk or building out the road verge. They can reduce speeds by road narrowing

Advantages:

Easy for large vehicles to negotiate

Can be attractive

Can reduce speeds and vehicle volumes

Can be used on higher volume/speed roads

Disadvantages:

Vehicles not forced to reduce their speeds

Cyclists and smaller vehicles have to merge with cars

Eliminates on street parking

Possibility of side swipe collisions

BEFORE

AFTER

Lateral changes

Can be used for: Defecting median islands

Raised median islands are placed in the centre of the road to reduce travel lane width. They are best designed so vehicles have to manouvre to get past them and/or with narrowed lanes

Advantages:

Low cost

Gives pedestrians a refuge when crossing the road

Can improve street aesthetics

Can reduce vehicle speeds

Disadvantages:

Reduced off street parking

Potential increased vehicle and bicycle conflict

Possibility of vehicles hitting the median

Issues with driveway access

If not used in combination with deflection or lane narrowing they can increase speeds

BEFORE

AFTER

Can be used for: Roundabouts or traffic circles

Traffic circles are raised islands placed in the centre of intersections. They are used to control traffic at intersections and reduce speeds around these areas

Advantages:

Reduce speeds and accidents

Can improve street appearance when landscaped

Can simultaneously calm two streets

Does not restrict road access for residents

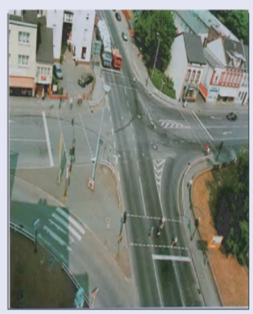
Disadvantages:

Issues with larger vehicles on smaller roundabouts

Can have issues if one entrance has high traffic flows

Difficult for cyclists to negotiate, especially multi-lane

Expensive to implement



BEFORE

AFTER

Pavement treatments

Pavement treatments

Can be used for: Changes in texture or colour of pavement

Using different materials such as cobbles or changing the colour of pavement can reduce speeds or act as a warning in dangerous areas

Advantages:

Multiple uses depending on textures and colours

Can be used to improve aesthetics

Can improve street aesthetics

Can reduce vehicle speeds

Disadvantages:

Rough textures may increase traffic noise

Colours only serve as a warning

Some pavement types require more maintenance

Can be expensive to implement

Red Pavement

Textured pavement

Can be used for: Rumble strips

Rumble strips can be used on the shoulder or centre of the road to reduce run off road accidents and vehicles crossing the centre line. They can also be laid across the road to reduce speeds at intersections

Advantages:

Reduce speeds and accidents

Installation costs are low

Low maintenance

Can be placed on various parts of the road

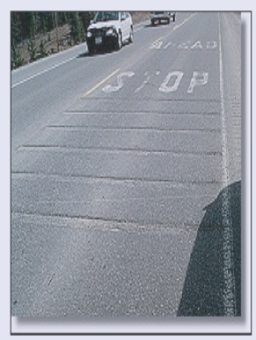
Disadvantages:

Noise is disruptive to residents

Crash migration to different sections of the road

Issues with motorcycles and bicycles driving over them

Shoulder rumble Strips



Transverse Rumble Strips

Road signs

Road signs

Can be used for: Reducing the speed limit

In some cases, the speed limit becomes too high when populations change etc. Changing the speed limit can reduce speeds

Advantages:

Cost effective

Can be used on any road

Can be used on long stretches of road

Benefits cyclists with a wider shoulder

Disadvantages:

If set too low, drivers disregard the speed limit

Has not been found to significantly reduce speeds

Needs additional measures to achieve speed reductions

High traffic volumes can cause issues if speed limits are too low

BEFORE

AFTER

Can be used for: vehicle activated signs

Vehicle activated signs are used to remind drivers of the speed limit and as such are only activated when a driver who is exceeding the speed limit passes these signs. They can also be used to warn drivers of hazards

Advantages:

Very effective at reducing speeds

Are effective over at least 3 years

Low operating costs

Also reduce accidents

Disadvantages:

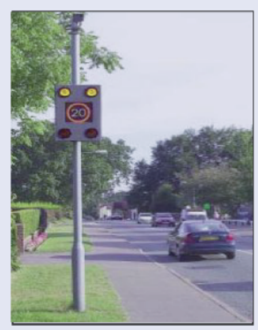
Need a mains power supply

Expensive to install

Requires maintenance

May be visually intrusive

BEFORE



AFTER

Enforcement

Can be: Stationary

Speed reduction can be achieved by placing speed cameras along sections of road where speed is a problem

Advantages:

Effective at reducing speeds

Can reduce accidents

If visible, also have a warning effect

Disadvantages:

Only useful over a short distance

Can suffer from poor publicity

Can only be used in certain locations

Care needs to be taken when placing the camera to ensure it is in an area where speed is causing danger to vulnerable road users

Enforcement

BEFORE

AFTER

Can be: Mobile

Police officers can patrol roads where speed is an issue.

Advantages:

Effective at reducing speeds

Also has a warning effect

Effective over large stretches of road

Also reduce accidents

Disadvantages:

Needs to be consistent to be effective

Not all people will be caught

Expensive

Can suffer from poor publicity

Police car

Can be used for: Integrated designs

These are roads that persuade drivers to drive at the right speed by design. The best example of a high speed design is a motorway. This approach uses a number of speed reduction countermeasures in combination

Advantages:

Reduced need for enforcement

Works with drivers' natural speed choice

Can be used on long stretches of road

Can be used to benefit all road users

Disadvantages:

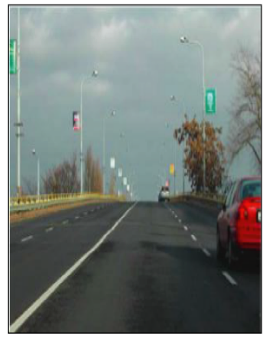
Designing roads can be time consuming

Developing a nationwide standard could be difficult

Can be expensive to implement

When using combinations of measures it is difficult to pinpoint which measure is having the biggest impact

Integrated approaches



50km/h speed limit

50km/h speed limit