Title: EVALUATING ISRAELI LOCAL AUTHORITIES’ PERFORMANCE IN TRAFFIC SAFETY USING DATA ENVELOPMENT ANALYSIS

Presenting Author: Doron Alper

Authors: D. Alper 1; D. Shinar 1; Z. Sinuany-Stern 1;

Affiliation
1. Department of Industrial Engineering & Management, Ben-Gurion University of the Negev, Beer-Sheva, Israel

Abstract:
This study estimates the relative 'productivity' of Israeli municipalities in terms of traffic safety, using Data Envelopment Analysis (DEA) model. DEA, developed by Charnes et al. (1978) and Banker et al. (1984), is a mathematical programming approach to measure the relative operational efficiency of Decision Making Units (DMUs) based on their multiple inputs and multiple outputs. This is a non-parametric approach that evaluates efficiency relative to the frontier. Importantly, no a priori specification of the production function is required and multiple outputs are allowed. DEA model defines the efficiency of DMU as the ratio between sum of weighted outputs and the sum of weighted inputs. The solution of this mathematical problem is obtained by finding the ideal weights for each unit, where the ratio is bounded by the value of 1 (or 100%). A DMU is efficient, if and only if there isn't a possibility to increase one of the outputs or to decrease one of the inputs without increasing other input or demolishing one of outputs. A unit that reaches the optimal efficiency (1) will be defined efficient. As by product, the model is also able to find the variables that need to be improved in the non-efficient units. Moreover, DEA performs benchmark analysis by pointing at the peer DMUs that caused a unit to be inefficient.

The main goal of this study is to compare the Israeli municipalities in term of their performance in the field of traffic safety. In this study the DMUs represent local authorities and the inputs and outputs were chosen accordingly. We examine three different sub-models: the main model includes major objective inputs (such as the amount of money and human resources invested by the local authority in traffic safety) and major outputs (such as number of road accidents or injuries). In the second model the same inputs are evaluated against intermediate safety measures as outputs (such as the percent of streets with sidewalks, percent of drivers maintaining the speed limit, percent using belts, etc). In the third model intermediate measures (inputs) are compared with the main outputs. The output of this stage is a classification of the DMU’s to efficient and non-efficient local jurisdictions; i.e. safe and unsafe municipalities. In addition we rank the authorities from the most efficient to the least inefficient in each sub-model. Finally we search for measures that need to be improved in the inefficient units. An integral part of this study analyzes the results obtained by the DEA using correlations between the inputs and outputs, and multiple regressions utilizing some exposure variables that might impact the Local Authorities' efficiency scores, such as population size in the different jurisdictions.

The DEA model can be used to improve the traffic safety at the local community level by pointing to areas for improvements in each jurisdiction's inputs or outputs. Although the DEA model has been applied in a variety of fields, our review of the literature did not find any studies that applied it to the field of road safety. Moreover, as far as we could determine, the efficiency of local authorities in terms of traffic safety has not been empirically measured before.
Title: A STATISTICAL ANALYSIS ON CHARACTERISTICS OF PEDESTRIANS’ TRAFFIC ACCIDENTS IN TOYOTA CITY

Presenting Author: Ryosuke Ando

Authors: R. Ando 1; Y. Mimura 1

Affiliation
1. Department of Research, Toyota Transportation Research Institute, Wakamiya-cho 1-1, Toyota, Aichi 471-0026, Japan,

Abstract:
Toyota City is one of the most typical motorized cities in Japan. The fatalities because of the traffic accidents in 2008 and 2009 were respectively 18 and 15 persons and the number of the fatalities every 100,000 population was 3.5 in 2009. This figure had been decreased from 4.3 in 2008. And it had become smaller than 3.8, that of the whole country. Among fifteen fatalities in 2009, four were pedestrians. In this paper, we report the result of the statistic analysis by using the traffic accidents data in Toyota City. At the same time, the measures having been implemented are introduced. Then we make some discussion for further studies to approach the zero-mization (a new term means to minimize the number and let it to be zero finally) of the fatalities.

Keywords
Pedestrians, Toyota City, Traffic accident, Statistical analysis, Fatality, Zero-mization

Introduction
In 2009, there was very excited news for the people who are working in the field relating with the traffic safety in Japan. The number of fatalities was 4,914 that is the first time to be less than 5,000 since 1970 when the biggest number of the fatalities, 16,765 was investigated.

Normally, the number of traffic accident fatalities in Japan is relatively smaller in the World (see Figure 1 (IRTAD and National Policy Agency of Japan)). However, if we pay attention to vulnerable road users (pedestrians and bicyclists), the percentages are relatively higher (see Table 1 (IRTAD and National Policy Agency of Japan)). In this paper, we focus on the pedestrians and tend to make the situation be much more clearly. Because Toyota City is one of the most typical motorized cities in Japan, we make the detail analysis by using the traffic accidents data of Toyota City.
Figure 1 Fatalities per 100,000 Population in 2008 (Data Source: IRTAD, some are in 2007)

Table 1 Fatalities by Road Users in 2008 (Data Source: IRTAD, some are in 2007 or 2006)
Outline of Traffic Accidents in Toyota

Numbers of the traffic accidents and fatalities in Toyota City in the past 20 years have been shown in Figure 2 (Toyota City & Toyota Citizens Association for Traffic Safety, 2009). The number of the traffic accidents clearly decreased in the past three years although it had increased during 1990 to 2006. If we see the recent two years, it was 2,382 in 2009 and reduced from 2,597 in 2008. The decreased rate is 8.28% and that is higher than that of all Japan 3.85%. This means that the traffic accidents have been reduced much faster comparing to all Japan. Regarding the fatalities, the number in Toyota City was reduced to be 15 persons (3.5 per 100,000 residents) in 2009 from 18 persons (4.3 per 100,000 residents) in 2008. Similar to the traffic accidents number, the decrease rate is 16.67% and higher than that of all Japan 4.68% (from 5,155 persons in 2008 (4.0 per 100,000 population) to 4,914 persons in 2009 (3.8 per 100,000 population)). However, as shown in Figure 2, the number of fatalities tended to be stable between 15 to 20 persons. In Figure 3, the similar tendency can be seen by the death rate (number of fatalities / number of injured persons). Although the injuries have been reduced effectively in the past four years, the death rate is stable around 0.50%. To realize the zero-mization, the much more effective countermeasures need to be studied and implemented.

![Figure 2 No. of Traffic Accidents and Fatalities in Toyota City in the Past 20 Years](image)

![Figure 3 No. of Injuries and Death Rate in Toyota City in the Past 20 Years](image)
Current Situation of Pedestrians and Other Vulnerable Road Users

Figure 4 can be used to explain why we call the pedestrian et al. the vulnerable road users. When the traffic accidents happen, all kinds of users may become injuring party or injured party. However, as shown in Figure 4, the big difference between automobiles and pedestrians is the rate of injured/injuring. That of the pedestrians is 10.4 and is about 15 times of that of the automobiles, which is only 0.7. That means the probability that the pedestrians are injured is quite higher than the automobiles users.

Figure 4 No. of Accidents by Injured/Injuring and Injured/Injuring Rate in Toyota City in 2008

As the trend in terms of the historical data in the past 10 years, Figure 5 (Toyota City, 2010) tells us that both the pedestrian fatalities and the injured pedestrians have almost been stable in average except 2008. However, the number of pedestrian fatalities in 2008 doubled that in 2007. This is really serious problem in Toyota City and in all Japan although various countermeasures have been implemented.

Figure 5 No. of Injured Pedestrians and Fatalities in Toyota City in 1999-2008
From another viewpoint, the shares of the four travel modes among the fatalities and injuries are shown in Figure 6. Although the pedestrian is only 5.8% of all injuries, it shares 36.4% of all fatalities. On the other hand, the automobile user is 33.3% of all fatalities although is shares 66.5% of all injuries. If we see the current situation by the death rate given in Figure 7, the death rate of the pedestrians is 3.48% whereas that of the automobile users is only 0.28%. Both Figure 6 and Figure 7 show us that the pedestrians are especially vulnerable in Toyota City (and in all Japan, too) even comparing with the bicycle and motorbike users.

Figure 6 Percentages of Four Travel Modes of Fatalities and Injuries in Toyota City in 2008-09

Figure 7 Death Rates by Travel Mode in Toyota City in 2008-09

Characteristics of the Pedestrian Traffic Accidents

As given in Figure 8, about half of the pedestrian accidents occurred inside intersection. If we make the aggregating by the width of roads as shown in Figure 9, the number occurred in the road with the width being less than 3.5 m increased in 2008 comparing with that in the passed five years. Furthermore, the share of the pedestrian traffic accidents occurred in the road with the width being 3.5–5.5 m has increased year by year in the past six years although the numbers in the recent two years have been reduced.

When we depict the pedestrian injuries and death rates by the age group, we can understand the 30-39 years old group shows the biggest number of the injuries as shown in Figure 10. However, regarding the death rates, that of the 65 and older group shows the biggest value which is about 2.5 times of that of the second biggest group (the group being 50-59).
Figure 8 Occurred Places of Pedestrian Traffic Accidents in Toyota City in 2008

Figure 9 No. of Pedestrian Traffic Accidents by Road Width in Toyota City in 1999-2008
Countermeasures to Reduce the Pedestrian Traffic Accidents and Fatalities

Focusing to the characteristics of the pedestrian traffic accidents, some countermeasures have been put into the deployment. The first countermeasure example by closing up that many pedestrian traffic accidents occurred inside of the intersection is the pedestrian attention information system for driving at the intersections, which was first deployed in 2004 in Toyota City and shown in Figure 11. The pedestrian walking across the road is detected by the sensor equipped at the intersection and then the information about the pedestrian is transferred to the cars driving at intersections by the car Navigation system.

The second example is related on the accidents in the road with the narrow widths. As depicted in Figure 12 (Lee et al., 2009), the non-signalized (and the signalized) intersections are colored by the pavement, which was introduced in Toyota City in 2008. As a result, the automobile vehicles are improved to be stopping and make the confirmation before entering the going through.

The third example regarding the accidents of the older people is the Toyota City Traffic Safety Learning Center just opened on April 1st 2010. Normally, the traffic safety education facilities in Japan are mainly served for the school kids. By considering the
increase of the traffic accidents related with the older people, the newly opened Toyota City Traffic Safety Learning Center is also taking the learning and training of the older people into the consideration seriously. There are many facilities such as the theater of learning knowledge, the simulation machines to understand themselves and the park like a real town for experiencing the risks as shown in Figure 13 (Toyota City Traffic Safety Learning Center).

![Facilities Examples at Toyota City Traffic Safety Learning Center](image)

Figure 13 Facilities Examples at Toyota City Traffic Safety Learning Center (theater, simulation machines and park from left to right)

**Summary and Conclusion**

Toyota City is one of the most typical motorized cities in Japan. One reason may be because Toyota Motor Corporation was found here and the headquarters have been located here since then. When we analyzed the characteristics by the accident type, the percentage of the accident between the human and the vehicles to the whole accidents in Toyota City is 6.3%. This figure is a few lower than 8.6%, that of the whole country, but is not so different from the nationwide average. Among the accidents, about 50% are during pedestrians’ crossing over the road. The measures should be discussed from both the viewpoints of cautions of pedestrians to make the crossing and calling the attentions for the pedestrians of the car drivers. Next, to classify the accidents by the violation of laws and ordinances, the violation of the safety un-checking and the carelessness etc. which are not intentionally performed but unconsciously is 73% in Toyota City (Ando & Kawai, 2009). This is higher than 54%, the average level in Japan. That implies that the necessity of performing the information service to vehicles is high. And it also shows us that the accident reduction effect by such kind of measures in Toyota may become higher than a nationwide average level. Although we cannot say all were because of the countermeasures stated in the previous chapter, it is the fact that the pedestrian traffic fatalities have been reduced from 8 persons in 2008 to 4 persons in 2009 in Toyota City. However, we surely need to make the further effort to approach the zero-mization. Figure 14 shows another trial we undertook in 2007, we should make them to be deployed in a near future.

Furthermore, by considering that Japan has become one typical aged country in the world, we should study much more about the traffic safety measure responding for the older people being increasing.
References


Figure 14 Safe Walking Support Systems (above: pedestrian information provision, below: automobile vehicle information provision).
Title: ELDERLY PEDESTRIANS’ BEHAVIOUR AT CROSSWALKS: A STUDY OF RISK PERCEPTIONS

Presenting Author: Erel Avineri

Authors: E. Avineri 1; D. Shinar 2

Affiliation
1. Centre for Transport & Society, University of the West of England, Bristol, UK, 2. Chief Scientist, National Road Safety Authority, Jerusalem, Israel, 2. Ben-Gurion University of the Negev, Beer-Sheva, Israel. Corresponding author. Erel.Avineri@uwe.ac.uk

Abstract:
Pedestrians over the age of 60 account for a disproportionate share of deaths in most nations of the OECD. With a rapidly aging population, and with the increase in the level of mobility and physical activity of older people, the safety of older pedestrians it is expected to become a more substantial issue in the years ahead. In addition to their physical vulnerability, some argue that older pedestrians exhibit risky behaviour in crossing roads, which increase their involvement in traffic accidents. In addition to their vulnerability to traffic, older people are exposed and vulnerable, more than other age groups, to falls. Increasing age was found to be correlated with fear of falling (FOF). It might be argued that rather than exhibiting an intended risky behaviour in crossing roads, older people, who are more likely to be afraid of falling, might pay less attention to cross traffic, and pay more attention to the pavement and their footsteps. It has been therefore hypothesized that FOF might be correlated with the walking speed of older pedestrians crossing a road, and that age and FOF might have an effect on the proportion of time pedestrians have their heads down in crossing a road. In this research an observatory technique is combined with face-to-face short interviews. 203 pedestrians in two crosswalks (signalized and unsignalized) were video recorded. The FOF of pedestrians of different age groups have been revealed by means of questionnaire. It was found that FOF among pedestrians increases with age. Walking speed at the unsignalised crosswalk was found to be in negative correlation with FOF among older pedestrians. The proportion of time pedestrians have their head down during cross walking increases with age. Therefore it can be argued that risky behaviour of older pedestrians might be explained not by an intended risk taking, but by FOF.

Keywords: older people, crosswalk, FOF (fear of falling)
Title: AN IN-DEPTH EXPLORATION INTO PUBLIC ATTITUDES TOWARDS MOTORCYCLIST RISK-TAKING BEHAVIOUR

Presenting Author: Erel Avineri

Authors: C. Musselwhite 1; E. Avineri 1; Y. O. Susilo 1

Affiliation
1. Centre for Transport & Society, University of the West of England, Bristol, UK

Abstract:
This paper reports on the attitudes of and towards motorcyclists with the aim to examine the perceptions of road user safety amongst different road users and the link between attitudes, empathy and skill in motorcycle safety behaviour. This paper focuses on motorcyclists as vulnerable road users. Motorcyclists were perceived by the study participants, members of the public at four different locations at the UK (including motorcyclists and non-motorcyclists), as a group more likely to be at risk of accidents on the road. This was due to perceived behavioural characteristics of motorcyclists – who were viewed as ‘thrill seekers’ - as well as observed behaviours on the road. This, coupled with the physical vulnerability and excessive speeds, meant that motorbike driving was considered one of the least safe forms of road use. There was broad agreement that motorcycling was dangerous as a whole, but not all motorcyclists were necessarily risky riders.

The issue of ‘competitive space’ emerged between car driver and motorcyclists in particular and it was suggested that there was a lack of mutual awareness and considerations between the two groups. Generally, greatest empathy comes from drivers who are motorcyclists themselves.

The predominant interventions suggested by participants for improving motorcycle safety focused on engineering solutions – mainly because it was seen to offer greater support for a dangerous and vulnerable mode of transport. There were three main types engineering solutions that were seen to be important for this group: road conditions, performance and space. In addition to engineering, education and enforcement interventions were also deemed important by the study participants. These were aimed at two main areas: normalizing safer driving behaviours for motorcyclists and increasing awareness of bikes for motorists – particularly in relation to reducing speed limits at urban junctions. Finally, the idea of risk mapping and reduced speed limits on rural roads was seen as potentially effective – particular as certain motorcyclists highlighted that they changed their riding behaviours by increasing speed and taking greater risks on these roads.
Title: SAFETY EVALUATION OF URBAN STREETS WITH MIXED LAND USE FOR IMPROVING DETAILED TOWN PLANS

Presenting Author: Doron Balasha

Authors: D. Balasha 1; V. Gitelman 1; J. Roth 1;

Affiliation
1. The Ran Naor Road Safety Research Center, Technion, Haifa, Israel,

Abstract:
An urban street with mixed land-use is a street which, in addition to residential use also serves other land-use purposes, such as: commerce, business and public buildings, which compose more than 50% of the properties along the street on at least one of its sides. Pedestrians present a significant share of road users on such streets, creating pedestrian-vehicle interaction problems, accordingly. This study investigated the relationships between detailed town plans (DTP), infrastructure and traffic characteristics and the level of road safety on such streets seeking for ways for preventing unsafe solutions at early stages of planning.

For analysis purposes, detailed data was collected from 88 street sections in 25 towns. The database included the components of: (1) general characteristics of the streets, (2) engineering characteristics of cross-sections and intersections, traffic and pedestrian volumes, travel speeds; (3) accident characteristics for the period 2002-2006; (d) DTP details, including the calculation of a mixed land-use index out of the total street length.

The data analysis revealed that the streets examined were of four types: dual carriageway two ways, single carriageway two ways, single carriageway one way and single carriageway one way with a bus lane. Examinations showed that the majority of streets were with two ways traffic, straight and level, with between 70%-100% commercial frontage, multi-level buildings of up to 8 floors, and with DTP classified as “planned for mixed land-use”. Most of the streets had marked pedestrian crossings and bus stops and had considerable volumes of pedestrians and traffic. At the same time, traffic arrangements did not convey a clear message as to the priorities in the streets and traffic calming elements for vulnerable road users were missing. In over 30% of the accidents in these streets a pedestrian was injured and over 50% of the accidents occurred at the intersections.

A comparison of the accident characteristics on the study streets with those on all streets in 20 towns in Israel showed that the level of road safety on the study streets is lower than that of the other streets: the number of accidents per 100 meter street length and the number of serious accidents and the number of pedestrian accidents per 100 meters were all significantly higher in the study streets than in the general street population of the towns.

An explanatory model was developed linking street characteristics with the number of accidents, according to which an increase in the number of accidents is associated with: percentage of commercial frontage; increased variance in the speed distribution; an increase in the number of pedestrian crossings per road section; increases in traffic volumes and also whether the street was designed as residential with commerce or with open public space. On the other hand, characteristics associated with a decrease in the number of accidents were grades and curves along the street, an increase in cross-section width and when the street received a grade as originally designed for mixed land-use, at least on one side of the street. From this, the initial design of the
street as mixed land-use affected the accident frequency.

Another model was developed linking street characteristics with pedestrian accidents. Explanatory variables included the cross-section, type of intersections traffic volume, percentage of public transport, type of street, existence of pedestrian railings, travel speeds and initial design characteristics for land-use other than for residence.

According to the model, designing the street initially for mixed land-use increases the accident risk for pedestrians. Streets with high actual levels of traffic and pedestrians are associated with an increase in accidents, while the existence of arrangements meant to increase pedestrian safety, such as wide sidewalks, pedestrian railings were not found to decrease pedestrian risk consistently.

The study concluded that to minimize the potential conflicts between traffic and pedestrians streets with mixed land-use should be prevented from turning into high volume traffic arterials. Efforts should be put in providing appropriate engineering arrangements, which are recommended accordingly. Among those: Streets with mixed land-use should have one traffic lane per direction; On two way streets, a physical separation should be provided between the directions, partly with a low raised median; All streets should have traffic calming elements.
Title: DETERMINATION OF THE CAR - PEDESTRIAN COLLISION AVOIDANCE PROBABILITY

Presenting Author: Michael Ben Chaim

Authors: Michael Ben Chaim 1, Shlomo Yanetz 2, Moshe Brand 1

Affiliation
1. Mechanical Engineering - Mechatronics Department of Ariel University Center of Samaria, Ariel, 40700, Israel E-mail: michailbc@ariel.ac.il/ E-mail: mosheb@ariel.ac.il
2. Mathematics Department of Bar-Ilan University, Ramat-Gan 52900 Israel E-mail: yanetz@macs.biu.ac.il

Abstract:
Determining which of the road-conditions parameters are directly associated to road accidents recurrence is of importance in the field of road-accident prevention. Given an accident scenario, it is a common practice to evaluate road-accidents related parameters via deterministic dependencies such as the driver's accuracy of the subjective assessment, his ability to implement a given task and car dynamics. Still, it is better to take into account also the statistical nature of such processes. The main advantage of a probabilistic evaluation is the synthesis between deterministic and stochastic characterizations. These may provide an answer for the vehicle motion, enabling, in turn, a scheme for accident prevention. In this paper, we made an attempt to define probabilistic characterizations of the Car-Pedestrian collision. To these end previous incidents parameters were also taken into account (parameters associated to the vehicle, the pedestrian, the road and the dynamic characteristics of the vehicle etc.). Our main result is a Monte-Carlo based calculation of a car-pedestrian collision probability. Furthermore, we were able to extract some analytical dependencies, relating the incidents avoidance probability with several influence arguments. Finally, these provided us with a platform for solving some practical problems in the field of pedestrian's safety. When studying certain practical tasks such as preliminary consideration and investigation of road accidents, when instructing new drivers in practical skills of driving as well as estimating the efficiency of various systems of increasing traffic safety, etc., it is important to have a clear notion of scenarios of various road situations. Using numerical characteristics of road accidents prevention probability in such cases may be of great help. This paper considers the questions of analytical dependence of the probability of prevention of road accidents using the example of the Passenger Car- Pedestrian collision. More specifically, it considers two variants of equipping a car with the systems increasing the traffic safety, namely: a) the ABS system and b) the ABS and ESC (ESP) systems. Completing a vehicle with these systems predetermines the difference in the dynamics of prevention of the Car-Pedestrian collision. In the former case, the Car-Pedestrian collision may be prevented by braking and maneuvering whereas in the latter case it can be prevented by a) braking b) maneuvering without ESC and c) maneuvering with ESC. Calculations of the probability of prevention of collision with a pedestrian must be based on determining the minimum distance of the preventi
method of Least squares we received regression equations for determining probability of collision prevention by: braking, maneuvering without ESC and maneuvering with ESC. Calculations of the probability of prevention of collision were based on the collision prevention minimum distance, using the three above possibilities. For braking was used well-known formula of the so-called stopping distance, for maneuvering without ESC and maneuvering with ESC we received functional dependences between longitudinal and lateral moving of the car during maneuver under consideration of the car's dynamics. Studying of the received regression models of collision prevention probability testify that their use is not limited only to parameters: the distance between the car and the pedestrian at the moment of its occurrence, the pedestrian speed, the initial speed of the car and as regression dependences expand their possibilities of the analysis of influence of various parameters on road accident prevention.

Key words: Pedestrian's safety, car's dynamics, car-pedestrian collision, Monte Carlo method, statistical models, probability of collision.

1. Introduction

Avoid of collision, related to the sudden appearance of the pedestrians on the Road problem many fields: technically, psychologically and udders. Collision with the pedestrians involved the problem safety of pedestrians is very crucial in Israel. Pedestrians are one third of the total number of victims that died in the road accidents. Pedestrian safety is also a serious problem in other countries.

Traffic safety reports that include pedestrian fatality risk curves most often cite the work of (Anderson et al. 1995, 1997), (Ashton1982), (Pasanen 1992), (Teichgräber 1983), (Walz et al. 1983). For example, the reports mentioned in the introduction were all based on one or several of these articles. Rather surprisingly, we found that neither Ashton, nor Teichgräber, or Walz et al. derived any risk curves in their articles. It is true that (Ashton1982) included fatality rates at different speed ranges from pedestrian accident investigations in Great Britain during the 1960s and 70s. However, Ashton et al. have specifically pointed out that, due to sample bias, these fatality rates did not give a fair description of the total population of accidents (Ashton et al., 1977; Ashton, 1982). This statement has been largely overlooked in subsequent studies using these data. Teichgräber merely included a risk curve, which could be traced back to a report by (Yaksich 1964). Furthermore, we found that when (Walz et al. 1983) were cited, people actually included the risk curve derived by (Anderson et al. 1995, 1997), who applied an unconventional approach to deriving fatality risks. Furthermore, the analysis of Anderson et al. was based on only 56 accidents with a substantial bias towards severe injuries, thus yielding crude and exaggerated risk estimates. Finally, (Pasanen1992) applied regression analysis to the biased data presented by (Ashton 1982), which inevitably rendered his risk estimates too high (Davis, 2001). It was pointed out by (Davis2001) that the probable cause for the bias in the data presented by (Ashton 1982) was the use of an outcome-based sampling scheme, meaning that the probability of an accident to be included in the sample depended on the injury severity of the accident. When outcome-based sampling is present, the data cannot be directly used to estimate fatality risks. This is easily realized by considering the following hypothetical example: Assume that 100 accidents have occurred at a certain impact speed and that 10 of these were fatal and 90 were non-fatal. The fatality rate, or empirical fatality risk, would then be 10%. However, if only a subset of these accidents were investigated, e.g., all fatal and every third non-fatal accident (outcome-based sampling), the sample would comprise 10 fatal and 30 non-fatal accidents. Hence, direct use of this sample would give an estimated fatality risk of 25%, which is 2.5 times
higher than the actual fatality rate. Notice, that if one knew the sampling rates for both fatal and non-fatal accidents, the risk estimate could be adjusted by giving each non-fatal accident a weight factor equal to three (the inverse of the sampling rate). Some other analyses on this topic have also been reported (Cuerden et al., 2007; Davis, 2001; Hannawald & Kauer, 2004; Oh et al., 2008a, 2008b), but these have not had the same impact on the traffic safety community as the articles mentioned above. (Cuerden et al., 2007) reported fatality rates from the British crash study On-The-Spot. However, the data only included seven fatalities (and 101 survivors), thus making the results very approximate. (Davis 2001) made use of the data presented by (Ashton, 1982) but tried to adjust for the bias by a weighting scheme, which was derived by comparing the distribution of pedestrian injury severities to national statistics. The results showed substantially lower fatality risks than those presented by (Ashton, 1982) and (Pasanen, 1992). However, these data are by now more than 30 years old and both car design and medical care have changed during these years.

The objective of these papers is the creating an analytical function of the probability to avoid the collision with the pedestrian and estimation of the technical possibility to avoid the collision in dangerous situations with different parameters: speeds of the vehicle and the pedestrian, the distance between the vehicle and the pedestrian, the moment the dangerous situation occurred, the width of the road, etc. Improvement of such methods, especially in real road conditions will help the driver to correctly evaluate the situation and make the correct decision to avoid the accident. Such methods should create the necessary stereotype to the extent that in dangerous situations the driver would perform the necessary operations automatically. The practical significance of this research includes the recommendations about driver's professional skills, increase of pedestrian safety, and the improvement of collision investigations methods. Looking for explanation of this phenomenon we paid attention to the fact that the meaning of the expression “the technical possibility to avoid the collision” in dangerous situations with different parameters (speed of the vehicle and the pedestrian, the distance between the vehicle and the pedestrian, the moment the dangerous situation occurred, the width of the road, etc.) may be different and may include: 1. Braking 2. Maneuvering 3. Simultaneously braking and maneuvering, whereas the majority of drivers use only emergency braking.

The main research methods are the statistical analysis, imitational modeling (Monte Carlo method), and method of Least squares and investigation of the road accidents. The result of the theoretical research - the description (statistical models) of various dangerous situations with their relevant statistical characteristics, parameters and the technical possibility of avoiding collision with the pedestrians by using different types of vehicle control in compliance with the parameters of the dangerous situation. The main stages of research are as follows: Collection of information regarding collisions with pedestrians, their processing, using necessary data from other sources for statistical (imitation) modeling of “Vehicle – Road – Driver – Pedestrian” system at the time the dangerous situation occurs, modeling of “Vehicle” element (braking and maneuvering process with the definition of stability and controllability, modeling of the “Road” element (road width, the cohesion coefficient), modeling of the “Driver” element (time of reaction for braking and maneuvering), modeling of the “Pedestrian” element (speed and direction of movement),This paper considers the questions of analytical dependence of the probability of prevention of road accidents using the example of collision of a vehicle with a pedestrian. More specifically, it considers two variants of equipping a vehicle with the systems increasing the traffic safety, namely: a) the ABS system and b) the ABS and ESC systems. Completing a vehicle with these different systems predetermines the difference in the ways of prevention of collision with a pedestrian. In the former case, collision with a pedestrian may be prevented by braking and maneuvering whereas in the latter case it can be prevented by a) braking, b) maneuvering and c) simultaneously braking and maneuvering. The model belongs to
the microscopic category where pedestrians/vehicles behave in their environment by making a sequence of decisions. The interactions among vehicles and pedestrians are also incorporated which signifies various effects, ranging from accident risk of pedestrians to the generation of traffic jams. Calculations of the probability of prevention of collision with a pedestrian based on determining the minimum distance of the prevention of collision using the above methods. We have developed a probabilistic model of object motion that takes this kind of factor into account and generates a probability of collision as a function of distance between vehicle and pedestrian. Rather than picking a fixed trajectory, we sample from the trajectories that the vehicle could follow: faster or slower, turning more or less, and (for pedestrians) more or less likely to step off a curb and into the roadway. Each of these sampled trajectories is then examined to see if it causes a collision with the vehicle, and at what time. The fraction of trajectories that causes collisions is used as the probability of collision.

2. The collision avoiding distance

Calculation of the minimum distance required to prevent the collision is based on the assumption that an accident can be prevented provided distancing (timely) carrying out all the operations aimed at such prevention:

\[ S_v \geq S_{Mt} = X_m + X_r \]  \hspace{1cm} (1)

Where

- \( S_v \) – Distance between the car and a pedestrian at the moment of its occurrence;
- \( S_{Mt} \) – The minimum distance necessary for prevention of collision with a Pedestrian;
- \( X_m \) – The minimum distance necessary for performance of maneuver (Braking, maneuvering or simultaneous maneuvering and braking);
- \( X_r \) – Total distance which the car takes place during reaction of the driver and the systems of the car which are taking part in maneuver;
- \( i \) – Kind of preventing maneuver;

In turn

\[ X_i = V_i(t_d + t_m) \]
\[ X_m = f(V_i, V_p, S_p, ...) \]  \hspace{1cm} (2)

Where:

- \( V_i \) – Initial speed of the car;
- \( V_p \) – Speed of the pedestrian;
- \( S_p \) – Distance of the pedestrian;
- \( t_d \) – Time of reaction of the driver;
- \( t_m \) – Reaction time of the car systems which is taking part in the maneuver (Braking or steering).

The probability of prevention of collision with a pedestrian will be expressed as follows

\[ P_{s} = P(S_v \geq S_{Mt}) \]  \hspace{1cm} (3)
It is clear that to obtain numerical values of the probability of prevention of collision \( P_a \), it is necessary to have an opportunity to determine, in any situation on the road, values \( S_{M, i} \) for every method of prevention of collision with a pedestrian.

For example, if the collision is prevented using braking, there is a well-known formula of the so-called stopping distance for this maneuver (Ilarionov, 1989), (Jams et al., 1985), (Ben Chaim et al., 2010a)

\[
S_{M(i)} = (t_d + t_m)V_a + V_a^2 / 2g \phi_x
\]

(4)

Where

- \( \phi_x \) – Longitudinal road adhesion coefficients;
- \( g \) – Free falling acceleration.

Our task requires that we should have similar analytical expressions for other ways of prevention of collision, too – for maneuvering and simultaneously maneuvering and braking. This task can be solved by consideration of a vehicle dynamics during its curvilinear movement.

To derive this equation, the necessary transverse movement should be functionally connected with the longitudinal movement, provided the movement is stable. The longitudinal movement will be the minimal distance of the detour around the obstacle:

\[
\begin{align*}
S_M &= (t_i + t_m)V_a + X_M \\
X_M &= f(Y_M, V_p, V_s, S_p, \ldots)
\end{align*}
\]

(5)

where

- \( X_M \) – Longitudinal moving of the car,
- \( Y_M \) – Lateral moving of the car.
For the establishment of functional relation between longitudinal and lateral moving of the car during maneuver (lane change maneuvering) following equations is used (Litvinov, 1971), (Wong, 2001):

\[
X_M = \int_0^T \left( V_0 \cos \gamma - \frac{b}{L} \left( \tan (\theta - \alpha_f) - \frac{\alpha_f}{L} \right) \sin \gamma \right) dt
\]

\[
Y_M = \int_0^T \left( V_0 \sin \gamma + \frac{b}{L} \left( \tan (\theta - \alpha_f) - \frac{\alpha_r}{L} \right) \cos \gamma \right) dt
\]

\[
\gamma = \int_0^T \left( \tan \theta + \alpha_f - \alpha_r \right) dt
\]

(8)

In these equations designations are assumed:

\[ \text{\textSigma} \tau \] - Steering wheels rotation time during of the maneuvering;

\( \gamma \) - Yaw angle;

\( \alpha_f, \alpha_r \) - Slip angles of the front and rear axles;

\( a, b \) - Distances between vehicle centre of gravity and front and rear axles;

\( L = a + b \) Vehicle wheelbase;

\( \theta \) - Front wheels steering angle.

It is very important to exclude time from equations (6), (7), (8) (the time of rotating the steering wheel in one direction), for it is not contained in the information about the conditions occurred; it just contains the distance to the obstacle and its width. On the other hand, the time of rotating the steering wheel in one direction is an important element for solving these equations. There are various approaches to its definition, cf. see (Shiller, Sundar 1998), (Shiller, et al., 1998), (Ryu, et al., 2002), (Hattori, et al., 2006), (Tijerina, 1999), (Kiefer, et al., 2007). However, when considering our problem we decided to determine the transverse movement using methods of gradual approximation. It is important to note that the lateral deviation of a vehicle towards axis OY during the maneuver goes on till the angle between its front wheels and the road axis reaches zero, and the lateral deviation reaches its maximum when angle between the road axis and wheels of a vehicle equals zero (\( \psi = 0 \)). Actually, the lateral
movement of a vehicle along the obstacle's width continues during the time period $3\tau$ (fig. 3).

![Figure 3. Laws of maneuvering parameters changes](image)

As to the longitudinal movement and the course angle, they are measured till time period $4\tau$. Then the obstacle proceeds in a current of time $3\tau$, i.e., in a rotation, the current front wheels are alternately to the left-to the right-to the left (if there is an obstacle detour it is necessary to rotate to the left and on the contrary, to the right-to the left-to the right; if there is an obstacle detour it is necessary to rotate to the right). Hence we have:

$$Y_M = Y_1 + Y_2 + Y_3$$

For longitudinal moving and a course yaw angle, we have

$$X_M = X_1 + X_2 + X_3 + X_4$$

$$\gamma_M = \gamma_1 + \gamma_2 - \gamma_3 - \gamma_4$$

$$X_M = \sum_{i=1}^{4} \left[ V_i \left( \cos\gamma - \tan(b/L)\tan(\theta - \alpha_f) - \frac{a}{L}\alpha_r \right) \sin\gamma \right]$$  \hspace{1cm} (9)

$$Y_M = \sum_{i=1}^{4} \left[ V_i \left( \sin\gamma + \tan(b/L)\tan(\theta - \alpha_f) - \frac{a}{L}\alpha_r \right) \cos\gamma \right]$$  \hspace{1cm} (10)

$$\gamma_M = \sum_{i=1}^{4} \left[ \frac{V_i}{L_o} \tan(\theta + \alpha_f - \alpha_r) \right]$$  \hspace{1cm} (11)

If we add the required width of an obstacle to the left side of the equation (10) and if we gradually change entrance values in the right side till both parts of the equation are equal, it will make it possible to determine time $\tau$. Then entering the time value $\tau$ in equation (9) will determine the corresponding longitudinal movement $X_M$. For the assumed pairs $X_M$ and $Y_M$ of lateral and longitudinal movements, equations (5) are derived using the method of Least squares.

Calculations of $\alpha_f, \alpha_r$ dawn under formulas (Litvinov 1971), (Wong 2001), (Gaevsky, et al., 2007):

$$\delta_1 = \frac{\sum Y_1}{2K_1}, \delta_2 = \frac{\sum Y_2}{2K_2}$$
Where: \( \sum Y_1, \sum Y_2 \) – Lateral reactions to a front and rear axis accordingly also was calculated under formulas:

a) At an entry in turn
\[
\sum Y_1 = \frac{1}{L \cos \omega_1 t} (bV_a^2 m_a \omega_1 t + M_z) \\
\sum Y_2 = \frac{1}{L} (aV_a^2 m_a \omega_1 t - M_z)
\]

b) For a case of an exit from turn
\[
\sum Y_1 = \frac{1}{L \cos \omega_1 t} (bV_a^2 m_a \omega_1 t - M_z) \\
\sum Y_2 = \frac{1}{L} (aV_a^2 m_a \omega_1 t + M_z)
\]

The moment of mass inertia, operating round axis Oz:
\[
M_z = m_a \rho \frac{V}{L} \omega_c
\]

where:
- \( \rho \) – Radius of mass inertia round axis Oz;
- \( m_a \) – Mass of the vehicle;
- \( K_1, K_2 \) – Current lateral stiffness of the front and rear tires (axels),
- \( K_i = K_w \cdot q_h \)
- \( K_w, K_w2 \) – Lateral stiffness of the front and rear tires (axels);
- \( q_h \) – Correcting coefficient of lateral stiffness to depending on nominal static and dynamic (from loading redistribution in longitudinal plane of car) loadings on a wheel (axle) (Gaevsky, Ivanov 2007):
\[
q_h = 2.4a_Z - 1.8a_Z^2 + 0.4a_Z^3
\]
\[
a_Z = \frac{p_z}{P_{zp}}
\]
where:
- \( p_z \) – Loading on one wheel;
- \( P_{zp} = 0.25m_a \) – A share of full weight having on one wheel.

The angular speed of the front wheels turn:
\[
\omega_a = \frac{g \cdot \phi \cdot L}{V_a (V_a t + b + \rho^2/b)}
\]

The change of the angular speed of the front wheels turn is assumed to be sinusoidal:
\[
\omega_c = \omega_a \sin(\pi \cdot t/2t)
\]

The maximum value of the speed is limited by conditions of preventing the lateral slide and stability as well as by physical abilities of an average driver suggested in the paper. (Borovskiy, 1984)

\[
\omega_a \leq \omega_f
\]

For dry road
\[
\omega_f = 0.32 - 0.0025 \cdot V_a
\]
For wet road
\[ \omega_f = 0.27 - 0.0027 \cdot V_a \]

For definition of longitudinal and lateral moving of the car during joint maneuver and braking (lane change maneuvering and braking) following equations are used:

\[
X_M = \sum_{i=1}^{i=j} \left( \frac{V_j - j_i}{\sin \gamma} \frac{b}{L} \text{tg}(\theta - \alpha_j) - \frac{a}{L} \alpha_i \sin \gamma dt \right) \tag{12}
\]

\[
Y_M = \sum_{i=1}^{i=j} \left( \frac{V_j - j_i}{\sin \gamma} \frac{b}{L} \text{tg}(\theta - \alpha_j) - \frac{a}{L} \alpha_i \cos \gamma dt \right) \tag{13}
\]

\[
\gamma_M = \sum_{i=1}^{i=j} \left( \frac{V_j - j_i}{L} \text{tg}(\theta + \alpha_j - \alpha_i) dt \right) \tag{14}
\]

Where \( j_b \) - braking deceleration at joint maneuvering with braking and for its definition following conditions are accepted. This deceleration is determined from the condition of stability during the simultaneous action of lateral \((\sum \gamma_1, \sum \gamma_2)\) and braking forces \((p_{bf}, p_{br})\):

\[
\left( \sum \gamma_1^2 + \gamma_2^2 \right)^{0.5} \leq m_g \varphi_\gamma
\]

\[
\left( \sum \gamma_2^2 + \gamma_2^2 \right)^{0.5} \leq m_g \varphi_\gamma
\]

(15)

And its change is assumed to be cosinusoidal during the time period \( t \). Conditions (15) can be provided at the change of braking deceleration by rules (Fig. 3):

\[ j_b = j_{max} \cdot \cos(\pi \cdot t/2 \cdot \tau) = g \cdot \varphi \cos(\pi \cdot t/2 \cdot \tau) \]

During the simultaneous maneuver and braking, the slip angles of the front and rear axles \( \alpha_f, \alpha_r \) are also influenced by braking forces and weight redistribution in the transverse plane which cause additional deformation of the tires. This is taken into account by introducing additional correcting coefficient of lateral stiffness \( q_{l_1}, q_{l_2}, q_{l_3} \) (Gaevsky, et al., 2007), i.e.:

\[ K_l = K_{l_1} \cdot q_{l_1} \cdot q_{l_2} \cdot q_{l_3} \]

Where correcting coefficient of tires lateral stiffness considering changes of deformation of tires by brake forces and redistributions weight of vehicle by force of inertia under the formulas (Gaevsky, et al., 2007):

\[ q_{l_1} = \frac{1}{2 \varphi_h} \frac{L}{g} \left( 1 - \frac{b + q \varphi}{h} \right) \]

\[ q_{l_2} = \frac{1}{2 \varphi_h} \frac{L}{g} \left( 1 - \frac{\alpha - q \varphi}{h} \right) \]

\[ q_{l_3} = 1 + \frac{j_b (a - h)}{g L}, \quad q_{l_4} = 1 + \frac{j_b (a + h)}{g L} \]

Where:

\( h \) - Gravity centre height of the vehicle.

3. Construction regression dependences by method of the Least squares

To increase the accuracy within the intervals of parameters that is of practical importance, the elements of equations (9) - (11) and (12) – (14): \( V_x, Y_{yo}, a, b, K_{w_1}, K_{w_2}, \varphi, h \)
were determined as random numbers using the Monte-Carlo method on the basis of the statistical data of the actual road accidents (Table 1.).

**Table 1.** Statistical characteristics of road accidents

<table>
<thead>
<tr>
<th>Parameter And Ranging</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_a$ , (30-110) km/h,</td>
<td>72.5</td>
<td>21.7</td>
<td>Log-Normal</td>
</tr>
<tr>
<td>$V_p$ , (0.7-2.6) m/s,</td>
<td>1.3</td>
<td>0.51</td>
<td>Log-Normal</td>
</tr>
<tr>
<td>$\varphi_x$ , 0.3-0.8</td>
<td>0.65</td>
<td>0.42</td>
<td>Log-Normal</td>
</tr>
<tr>
<td>$S_x$ , 0.52-6.2 m.</td>
<td>1.24</td>
<td>-</td>
<td>Poisson</td>
</tr>
<tr>
<td>$S_y / S_z$ , 0.72-1.15</td>
<td>0.87</td>
<td>0.27</td>
<td>Normal</td>
</tr>
<tr>
<td>$K_{w1}$ , N / rad , (4-6)10^4</td>
<td>4.5 · 10^4</td>
<td>0.16</td>
<td>Normal</td>
</tr>
<tr>
<td>$K_{w2}$ , N / rad , (4-6)10^4</td>
<td>5.1 · 10^4</td>
<td>0.23</td>
<td>Normal</td>
</tr>
<tr>
<td>$a$ , 1.2-1.7 m.,</td>
<td>1.4</td>
<td>0.33</td>
<td>Normal</td>
</tr>
<tr>
<td>$b$ , 1.2-1.8 m.,</td>
<td>1.6</td>
<td>0.29</td>
<td>Normal</td>
</tr>
<tr>
<td>$h$ , 0.55-0.90 m,</td>
<td>0.77</td>
<td>0.23</td>
<td>Normal</td>
</tr>
</tbody>
</table>

Longitudinal and lateral moving of the car $X_M, Y_M$ were defined by the equations (9) - (11) and (12) – (14). Calculation of integrals was carried out by a numerical method in the program of Matlab.

Were derived regression equations by method of the Least squares for definition of maneuvering parameters $X_M$ and $Y_M$ on the basis of the matrix:

$$ A_i = X_i B_i $$

Where:

$$ A_i = \begin{bmatrix} 1 & Y_{M1} V_{a1} \frac{(a/b)}{1} \frac{(K_{w2} / K_{w1})_1 \varphi_{x1} h_{1}}{1} \\ 1 & Y_{M2} V_{a2} \frac{(a/b)}{2} \frac{(K_{w2} / K_{w1})_2 \varphi_{x2} h_{2}}{2} \\ ... & ... & ... & ... & ... & ... \\ 1 & Y_{MN} V_{aN} \frac{(a/b)}{N} \frac{(K_{w2} / K_{w1})_N \varphi_{xN} h_{N}}{N} \end{bmatrix}, 
X_i = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \\ c_5 \\ c_6 \\ c_7 \end{bmatrix}, 
B_i = \begin{bmatrix} X_{M1} \\ X_{M2} \\ ... \\ X_{MN} \end{bmatrix} $$

a) For Maneuvering without braking

$$ X_M = 1.208 Y_M 0.4796 V_a 0.9611 \frac{(a/b)}{1} 0.1716 \varphi_y 0.3893 \frac{(K_{w2} / K_{w1})}{1} 0.173 $$

b) For Maneuvering with braking

$$ X_{M,S} = 0.4026 \cdot Y_{M,S} 0.5282 \cdot V_a 1.203 \cdot \frac{(a/b)}{1} 0.0981 \varphi_y 0.6839 \frac{(K_{w2} / K_{w1})}{1} 0.1421 \cdot h^{0.062} $$

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4. Modeling algorithm of the process of prevention of collision with Pedestrian

It is clear that probability of prevention of a road accident cannot be determined using active experiments. In this case statistical modeling using the information about real road accidents may be of certain value.

To determine statistical characteristics of the real road accidents, data about 163 road accidents involving collisions with pedestrians were used. The modeling was performed for the purpose of determining technical means of preventing collision, with the driver resorting to three probable actions: braking, maneuvering or both.

In the calculations adopted the following main assumptions: 1. That there is no interference to perform a maneuvering, that is, the road is free from other vehicles, 2. Pedestrian is not stopped and continued to cross the road until the collision or the successful outcome of an emergency situation.

To obtain dependence (3), the following sequence of modeling was used:

a) Formalization of cycles according to parameters \(V_a, V_p, S_p, S_v, S_s\);

b) Obtaining random values of parameters using a generator of random numbers in accordance with distribution laws;

b) Checking technical means of preventing collisions with pedestrian:

Should the condition be met for a given method of preventing a road accident, number 1 is generated in a corresponding block. If the condition (1) is not met then the number 0 is generated in the block of prevention of a road accident.

By dividing the obtained sums by the number of events \(N\), we obtain values of probability of a road accident or its prevention. Using matrix for the three methods of preventing a road accident:

\[
A_2 = X_2 B_2
\]

Where:

\[
A_2 = \begin{bmatrix}
1 & V_{p1} & V_{a1} & \frac{S_v}{S_s} & S_{p1} \\
1 & V_{p2} & V_{a2} & \frac{S_v}{S_s} & S_{p2} \\
... & ... & ... & ... & ... \\
1 & V_{pn} & V_{an} & \frac{S_v}{S_s} & S_{pn}
\end{bmatrix},
X_2 = \begin{bmatrix}
d_1 \\
d_2 \\
d_3 \\
d_4 \\
... \\
d_N
\end{bmatrix},
B_2 = \begin{bmatrix}
P_1 \\
P_2 \\
P_3 \\
P_4 \\
... \\
P_N
\end{bmatrix}
\]

Conditions for simulation were following:

1. The possibility of accidents prevention during maneuvering to the right side (fig. 4. a), the condition of the accident’s prevention will:

\[
S_p - Y_M = S_p - (B + \Delta_s) \geq 0
\]

Where:

\(\Delta_s\) – Interval of safety and calculated by the empirical formula:

\[
\Delta_s = (5L + 18) \times 0.001 V_a
\]

\(B\) – Width of the car.

2. The possibility of the accidents prevention during maneuvering to the left side (fig. 4. b), the condition of the accident's prevention will:

\[
Y_M \geq B + \Delta_s + S_n
\]

Where:
$S_n$ — Additional distance of road, which a pedestrian passes during car’s overcoming of the pedestrian line, and calculated by the formula:

$$S_n = L \frac{V_p}{V_a}$$

3. The possibility of accidents prevention during maneuvering and braking to the right side, (Fig. 5. a), the condition of the accident's prevention will:

![Figure 4. Schemes of Car-Pedestrian collision prevention by maneuvering a) to the right side, b) to the left side](image)

$Y_M = B + \Delta_s - \Delta S_p$

$\Delta S_p$ — Additional distance of road, which passes a pedestrian during deceleration (Braking) of the car (Ben Chaim, et al., 2010 b):

$$\Delta S_p = S_p - S_p = \frac{V_c}{V_p} \left( S_v + \frac{(V_a - V_c)^2}{2g \varphi} \right) - S_p$$

$V_c$ — Speed of the car while it reaches of the pedestrian line;

$S_p$ — Distance of pedestrian's movement during the car maneuver and braking at the same time. In this case, the condition of the accident's prevention will:

$$S_p - Y_M = S_p - (B + \Delta_s - \Delta S_p) = S_p - (B + \Delta_s - S_p + S_p) =$$

$$= S_p - (B + \Delta_s) \geq 0$$
4. The possibility of accidents prevention during maneuvering and braking to the left side, (Fig. 5. b), the condition of the accident's prevention will:

\[ Y_M \geq B + \Delta S + S_n + \Delta S_p \]

Using the Least squares method we obtain regression equations for determining probability of prevention of a collision with a pedestrian:

- By braking

\[ P_{br} = (S_v / S_s \geq 1) = F_0\left( \frac{[S_v / S_s]_{max} - M}{\sigma} \right) - F_0\left( \frac{1.00 - M}{\sigma} \right) = \]

\[ = F_0\left( \frac{1.15 - 0.87}{0.272} \right) - F_0\left( \frac{1.00 - 0.87}{0.272} \right) = F_0(1.0294) - F_0(0.4778) = 0.1605 \]

Assuming that if the driver fails to perform maneuver the car damage a pedestrian by right corner of the car (prevention of the collision by maneuvering from left side, fig. 4. a):

\[ P_{K1} = 117.8 \cdot V_a^{-1.23} \cdot V_p^{-0.22} (S_v / S_s)^{1.46} \cdot Y_L^{-0.27} \cdot B^{-0.43} \]

Assuming that if the driver fails to perform maneuver the car damage a pedestrian by left corner of the car (prevention of the collision by maneuvering from right side, fig. 4. b):

\[ P_{K2} = 122.103 \cdot V_a^{-1.68} \cdot V_p^{0.35} (S_v / S_s)^{1.78} \cdot Y_L^{0.51} \cdot B^{-0.38} \]

Assuming that if the driver fails to perform maneuver the car damage a pedestrian by right corner of the car (prevention of the collision by simultaneous maneuvering and braking from left side, fig. 5. a):
\[ P_{K3} = 111.6 \cdot V_u^{-1.35} \cdot V_p^{-0.21} \cdot (S_V / S_S)^{1.32} \cdot Y_L^{-0.38} \cdot B^{-0.26} \]

Assuming that if the driver fails to perform maneuver the car damage a pedestrian by left corner of the car (prevention of the collision by simultaneous maneuvering and braking from right side, fig. 5. b):

\[ P_{K3} = 96.6 \cdot V_u^{-1.32} \cdot V_p^{0.18} \cdot (S_V / S_S)^{2.01} \cdot Y_L^{0.23} \cdot B^{-0.42} \]

Studying of the received equations testifies that their uses are not limited only to parameters \( S_V, B, S_S, Y_L, S_p, V_u, V_p \) as regression dependences (17), (18) expand their possibilities of the analysis of influence of various parameters on road accident prevention.

**Figure 6.** Maneuvering without braking

**Figure 7.** Maneuvering without braking
Conclusion

This paper presents regression models of collision prevention probability, for the example of collision of a vehicle with a pedestrian. To determine statistical characteristics of the real road accidents, data about 163 road accidents involving collisions with pedestrian were used. Using the Monte Carlo method and a method of Least squares we received regression equations for determining probability of Car-pedestrian collision prevention by: braking, maneuvering and simultaneous maneuvering and braking. Calculations of the probability of prevention of collision with a pedestrian were based on the collision prevention minimum distance, using the three above methods. For braking was used well-known formula of the so-called stopping distance, for maneuvering and simultaneous maneuvering and braking we received...
functional dependences between longitudinal and lateral moving of the car during maneuver under consideration of the car's dynamics. Studying of the received regression models of collision prevention probability testify that their use is not limited only to parameters: the Distance between the car and an obstacle at the moment of its occurrence, the Obstacle width, the Initial speed of the car and as regression dependences expand their possibilities of the analysis of influence of various parameters on road accident prevention.

Reference


Erik Rosen, Ulrich Sander (2009) Pedestrian fatality risk as a function of car impact speed Published article available at http://dx.doi.org/10.1016/j.aap.02.002/


Title: UNIVERSAL HELMET LAW: THE INTERACTION BETWEEN LAW, ENFORCEMENT AND CULTURE ON LEVEL OF USE

Presenting Author: Gitit Bar-On

Abstract:
Although the universal bicycle helmet law went into effect in Israel in October 2007, there have been a few attempts to amend it so adults will only have to wear helmets while cycling in inter-urban roads, during competitions and while engaging in sport-related activities on bike trails.
The main arguments that have been raised against the universal helmets law are:
1. Legislation regarding the mandatory usage of helmets discourages a large portion of the population from cycling.
2. Despite the increasing use of bicycles in the past few years there has been a dramatic decrease in the rate of cyclists' injuries.
3. Most of the cyclists' injuries occur while they ride in inter-urban roads in rural areas.
While the discussion about the necessity of the helmet wearing law in the political sphere is still at its peak, it was deemed necessary to ascertain the actual public opinion on this issue. To this end, a national survey was conducted in September 2009 by the National Road Safety Authority (NRSA) to fully understand the attitudes and perceived safety standards by the Israeli cyclists. The survey was based on telephone interviews with a nationally representative sample of 702 (493 Jewish and 209 Arabs) bicycle riders and parents to children riders under 17. The survey focused on the current helmet usage patterns of bicycle riders in Israel: how many riders own helmets, the frequency of use and reasons riders do or do not use helmets. The survey also collected information about characteristics of riders and their riding patterns. The main findings are that bike helmet ownership among adult bike riders is 60%. Of those who owned a helmet, 80% of the Jewish respondents and 88% of the Arabs respondents said that safety was the reason for buying the helmet. On the other hand 34% of the Jewish respondents and 42% of the Arabs respondents said a helmet is not important and doesn't contribute to safety. The three main factors that were associated with helmet usage were age (riders older than 25 years wear helmets more frequently compared to 18-24 years old riders); level of education (educated riders tend to wear helmets more than less educated riders); and having children (older and more educated riders with children are more likely to wear helmets compared to riders with no children).
Attitudes towards the universal helmet law were quite positive: 81% of the adult bicycle riders were in favor of the helmet wearing law and were familiar with its requirements. Even among those who do not use a helmet regularly, 51% favored such a law. On the other hand, only 66% of the Jewish respondents and 61% of the Arabs respondents think it is important to wear a helmet on every ride regardless of the type of road and activity. Also 75% think that there is no enforcement of the law and 77% perceive the probability of receiving a ticket as very low. There was an interaction between age and culture: more Jewish children (68%) own a helmet than Jewish adults (60%), but fewer Arab children (49%) own a helmet than Arab adults (58%). The likelihood of children to wear a helmet was related to their parents' riding habits: more children (81%) whose parents ride use helmets than children whose parents do not ride (66%). Based on the above pattern of results, recommended strategies to be used to improve helmet wearing rates are being developed. These include giving or subsidizing helmets, using
public information campaigns to emphasize the contribution of helmet wearing to the safety of the rider, and targeted campaigns to the Arab population, and to parents of bicycling children.
Title: EXPOSING AND HANDLING THE CONFLICT BETWEEN PUBLIC TRANSPORTATION DEVELOPMENT AND GROWTH (RAIL AND BUS) AND THE PEDESTRIAN SAFETY PROBLEM IN ISRAEL

Presenting Author: Moshe Becker

Authors: M. Becker 1

Affiliation
1. Consultant to Israel Railways Ltd., Israel

Abstract:
Despite the fact that Israel maintains a moderate level of motorization (330 motor-vehicles per 1000 population in 2008) relative to the European Union (with about 600) and a the USA (with about 850 respectively), the lack of sufficient road and rail infrastructure places Israel among the most dense countries in the world with regard to the number of motor-vehicles per kilometer of road or lane. Furthermore it is estimated that by the year 2020 the motorization rate will reach about 400 motor-vehicles per 1000 population and the density will increase by 30%. This situation represents, in present and in the future, a high occurrence rate of traffic conflicts causing frequent traffic congestion problems and road accident hazards. As a result, the promotion of public transportation systems development and increased usage becomes a major issue for the future development in Israel. This understanding is manifested by devising many plans to develop rail (Interurban, Metropolitan and City) and bus transportation, however, this development is associated with a fear of further increase in the pedestrian (and bicycle) safety problem.

Israel, being a dense urbanized country, is well known to have a high proportion and rate of pedestrian accidents, injuries and fatalities (about 35% percent of total fatalities) as compared to many countries. Therefore, the promotion effort to increase the use of public transportation by providing more and better railways and bus transportation, although being a positive direction in itself, might be accompanied by a further increasing safety problem to pedestrians. Israel Railways, due to the occurrence of some severe railway accidents during the years 2005-6 went into a major railway safety endeavor and programs to improve railway safety. Hence, the number and risk for severe accidents between trains and motor-vehicles at level crossings was reduced significantly in recent years (figures will be disclosed in the full paper). As the rate and proportion of rail-vehicle accident dropped the pedestrian safety problem becomes, relatively more severe, especially with pedestrian trespassers at mid railway sections. Similarly, the development of special bus lanes and light-rail transit in urban areas is causing more safety conflicts to pedestrians. On the one hand, more rail and bus transit means more pedestrian activity to and from these safer modes of transport, and yet on the other hand, increased exposure of pedestrians to conflicts with motor vehicles as well as with the public transport vehicles. The light rail in the Israeli city is a new experience from many points of view but especially with regard to the safety problem, an experience that the Israeli public was not prepared for thru education or public media campaigns. Therefore, beside the development and promotion of rail and bus transit plans and projects the safety issue related to these modes and especially the pedestrian safety problem should be taken care for by suitable and essential programs to be developed and executed.

Prof. Sadan Committee submitted 2 years ago a report to the Israeli Ministry of Transport dealing with the coordination and optimization of public transportation on a national and metropolitan scale in Israel. This coordination and optimization should
incorporate also the pedestrian safety issue as an integral part of any public transport planning and projects. Many infrastructure engineering structures and devices for pedestrian safety related to public transport lanes and tracks can be implemented learned from the international experience, some examples of these solutions will be presented in the full paper, however, in addition to these physical solutions, education and public media campaign programs must be developed and implemented in full scale ahead of time. Preparing the infrastructure to the public transport to be developed demands funds, planning and projects implementation and is a challenge in itself, however improving and adjusting the “human factor” to this increased public transport usage era is even a greater challenge.
Title: SAFETY OF THE ELDERLY SUFFERING FROM ALZHEIMER’S DISEASE ON ROADS ON THE WAY TO AND FROM ADULT DAYCARE

Presenting Author: Rakel Berenbaum

Authors: R. Berenbaum 1; S. Lichtman 1; L. Abramowitz 1; V. Sharabi 1;

Affiliation
1. Melabev-Community Clubs for Eldercare, POB 3235, Jerusalem, Israel 91031,

Abstract:
There are an estimated 35.6 million people with dementia worldwide and there are new cases of Alzheimer’s disease being diagnosed every day. For the moment there is no cure for the disease that leaves people disoriented and with a loss of memory. Day care programs that include various therapeutic activities geared especially for this population have proven helpful in dealing with the behaviour problems associated with the disease. Many adult day care programs are available worldwide that provide full activity programs to community abiding elders and help them remain in their own homes rather then have to move into nursing homes. These programs provide transportation to and from the centers since the people may suffer from mobility difficulties and/or are unable to find their way to the center on their own due to problems of orientation caused by the disease. This poster presentation will deal with issues in transporting this population safely to and from their home to these adult daycare programs. Melabev-Community Clubs for Eldercare in Jerusalem is one such adult day care program and have been transporting elders with Alzheimer’s disease to our 9 day care centers for 30 years. This is done both with volunteer drivers in their private cars and with minivans driven by bus companies. This poster demonstrates best practices in transporting this special population of vulnerable road users. The poster will deal with issues related to human behaviour of all those involved in the process-the elders, their family caregivers, the bus drivers, and adult daycare staff. It will also address educational goals with all those involved in getting the elders to and from the center safely. With the estimated increase in cases of Alzheimer’s disease, more research must be done into ways of keeping these people safe on the roads.
Title: IMPLICATIONS FOR SAFETY AND PLANNING OF A SHARP INCREASE IN MOPED AND SCOOTER USE.

Presenting Author: Ross Blackman

Authors: R. A. Blackman 1; N. L. Haworth 1;

Affiliation
1. Centre for Accident Research and Road Safety - Queensland (CARRS-Q), Queensland University of Technology, Brisbane, Queensland, Australia,

Abstract:
Background
Powered two-wheelers (PTWs) have traditionally comprised only a small percentage of vehicles on Australian roads, and most of these have been conventional motorcycles, with relatively few mopeds (up to 50cc) and scooters (over 50cc with step-through design). In the last decade, growth in mopeds and scooters has underpinned overall PTW sales growth, particularly in the State of Queensland where mopeds can be legally ridden by car licence holders and the climate is conducive to year-round riding. The fourfold increase in reported moped crashes in Queensland from 2001-2005 has triggered research into moped and scooter safety, and associated implications for transport management and planning. Motorcycle safety research is not always relevant due to different design and performance characteristics, and some international research on mopeds and scooters is of limited relevance due to differences in legislation, environment and culture. A clearer understanding of moped and scooter use in Australia is required if attendant safety issues are to be identified and appropriately addressed.

Objective
This research aims to address current gaps in knowledge regarding moped and scooter use in jurisdictions where their use is increasing from a low level. As part of a larger program of research into moped and scooter safety, the primary objective is to outline aspects of PTW usage in Brisbane, Australia, which has a population of approximately 1.9 million. Inner Brisbane was chosen due to its high concentration of moped and scooter activity.

An observational study quantifies PTW types and distribution across Brisbane’s central business district (CBD), measuring changes over 24 months. This will help to address the current lack of exposure and usage data, as well as providing a baseline for measuring future trends which may result from proposed changes to licensing requirements. A focus group study is used to describe rider motivations, beliefs and attitudes regarding safety, providing qualitative context for the observation data.

Method
A five phase observational study is used to identify distribution of PTW types in the Brisbane CBD. Data were first collected in August 2008, and thereafter at six-monthly intervals. Stationary PTWs were directly observed in designated parking areas. Location, vehicle make, model, year of manufacture, engine capacity and PTW type were recorded.

Four focus groups with Brisbane moped and scooter riders were held in March 2009. The focus groups were intended to draw out riders’ perspectives on issues relevant to safety and transport planning in a semi-structured format. Information gathered in the focus groups is used here to supplement findings of the observation study.
Results
Approximately 500 PTWs were counted in each of three phases of the observation study to date. The sample is estimated to represent around 75% of all PTWs parked in the CBD on a weekday during business hours. Aggregate data for all three phases indicate that over one third (36%) of all PTWs observed were either mopeds (22%) or larger scooters (14%), while the majority were motorcycles (64%). No significant change in overall distribution occurred between phases one and three. Motorcycles were older on average than scooters and mopeds alike, with mean ages of 9.5 and 3.5 years respectively.

The four focus groups included 17 male and 6 female participants, ranging in age from early twenties to early sixties. Participating riders all commuted regularly on their moped or scooter, while some also took occasional recreational rides. Parking availability, traffic congestion, cost, time-efficiency and enjoyment were frequently mentioned motivating factors. Moped riders were younger and less experienced than scooter riders, less likely to have undertaken or to value rider training, and less likely to wear protective clothing.

Conclusion
Mopeds and scooters form a significant proportion of all PTWs in the Brisbane CBD and there are relatively larger scooters than expected given the need for a motorcycle license for these vehicles. Moped riders have different characteristics and poorer safety attitudes and behaviours than riders of larger scooters. Attempts to improve usage of protective clothing should particularly focus on moped riders.
Title: LABORATORY SUBJECT STUDY OF COGNITIVE EFFECTS WHEN WEARING A FULL-FACE MOTORCYCLE HELMET IN WARM CONDITIONS

Presenting Author: Cornelis P. Bogerd

Authors: C. P. Bogerd 1,2; K. Strässle 1; P. A. Bruehwiler 1;

Affiliation
1. Laboratory for Protection and Physiology, Empa, St. Gallen, Switzerland, 2. Institute of Human Movement Sciences and Sport, ETH Zurich, Zurich, Switzerland

Abstract:
Wearing a full-face motorcycle helmet offers the best available impact protection to the head and face in accidents, but may cause discomfort and/or distraction. Microclimate temperatures around the head are higher than the ambient temperature in moderate climates, due to insufficient ventilation. Since it is known that cognitive performance can be impaired by heat stress and other helmet-driven effects (e.g., increased carbon dioxide levels), we investigated the impact of wearing a full-face motorcycle helmet on cognitive performance.

Following three familiarization trials, nineteen subjects completed two experimental trials, alternately wearing a full-face motorcycle helmet or no headgear at all, in random order. The cognitive performance was assessed with a letter cancellation test (LCT) and a task of simultaneous visual tracking/vigilance test (VTT) and auditory vigilance test (AVT). During each trial, acclimated subjects completed 30 min VTT+AVT preceded and followed by a LCT. In addition, the heart rate (HR) and heart rate variability (SDNN and pNN50) were obtained during the VTT+AVT. At the end of each trial, whole-body temperature perception and thermal comfort were assessed. All trials took place in a climate chamber at an ambient temperature of 27.2 ± 0.6 ºC, a relative humidity of 41 ± 1%, and with a minimal wind velocity of 1.8 ± 0.2 km/h. The results were analyzed using non-parametric statistics.

Wearing a helmet resulted in a larger displacement on the tracking task, with a median increase of 7.2% (25th percentile -9.9%; 75th percentile 23.7%) (p = 0.021). However, the other eight performance parameters did not show an intervention effect. Interaction effects were found between the intervention and time for five out of 46 cases. The heart rate variability parameter pNN50 showed an intervention effect, with 17.5% (26.9; 62.1) larger values for wearing a helmet. Furthermore, the helmet condition resulted in a less favorable temperature perception and thermal comfort (p < 0.01). Finally, most cognitive parameters showed a time effect during the 30 min VTT+AVT, indicating poorer performance towards the end.

Compared to not wearing headgear, a full-face motorcycle helmet negatively affected tracking performance, and subjects reported less favorable whole body temperature perception and thermal comfort. Finally, a helmet-induced reduction was found in the heart rate variability parameter pNN50. Since only one out of nine cognitive parameters was affected by wearing of a helmet, resulting in an impaired performance of 7.9%, indicates that under the given laboratory setting the effect of wearing a full-face motorcycle helmet is subtle. Conditions in the field can be more extreme in terms of temperature and humidity than studied here, but should often offer better air circulation due to wind. These counteracting influences make it difficult to speculate how the present results relate to traffic safety. Notably, the reduced tracking performance observed here is related to hand-eye coordination, which is generally relevant to traffic safety.
According to the Israeli Road Safety Authority in 2008 the total number of fatal and serious injuries from traffic crashes in urban areas was 20,807 compared to 11,004 in intercity areas where the total number of injured pedestrians was 3131 and 186 respectively. Although, pedestrian injuries are more likely to occur in urban areas, fatal accidents are more likely in intercity areas. Thus, conflicting situations involving pedestrians are more typical of residential and urban areas than intercity areas. Yet, atypical situations in which pedestrians interact with drivers at unexpected locations are detrimental. Obviously, drivers in intercity areas adopt higher speeds, therefore, given a crash occurs its outcome is more likely to be detrimental. Nevertheless, beside travel speed hazard perception should also be considered. The ability to anticipate an upcoming hazardous situation is dependent on drivers’ expectations and past experiences (e.g., Borowsky et al., 2007, Pollatsek et al., 2006; Horswill and McKenna, 2004). Experienced drivers who tend to categorize traffic scenarios according to the similarity in their traffic environment characteristics (Borowsky et al., 2009), might, for example, expect seeing pedestrians crossing the road more in residential areas than in inter-city areas. Thus, the appearance of a pedestrian in such atypical environment, may take more time for a driver to perceive (Borowsky et al., 2008), and may also require application of maneuvers that are not well practiced relative to the typical pedestrian-related situations. To assess hazard perception abilities of drivers we ask participants to observe traffic-scene videos and press a button when they perceive a hazard. We have found that, in general, experienced drivers tend not to indicate pedestrians as hazard instigators when the environment is inter-urban, whereas they do tend to do so when the environment is residential, even if no pedestrian was actually present. Parked cars, buildings, zebra crossings, etc., probably indicate drivers of the possibility that pedestrian may suddenly appear. One additional concern that has been raised is with the ability of elderly drivers to maintain their hazard perception skills. In Borowsky et al. (2009, submitted) we examined hazard perception abilities among elderly (65+) and experienced drivers (25-32), also with regard to the presence of pedestrians in the road environment. Previous studies suggested that Hazard perception abilities are not affected (although older drivers tend to compensate for their deteriorating driving abilities) (Ball et al., 1998; DeRaedt & Ponjaert-Kristofferson, 2000; Hakamies-Blomqvist, 1994). Consistent with others (e.g. Underwood et al., 2005), our findings indicated that older drivers are as likely as younger drivers to perceive hazards. Older drivers, however, tend to rely more on other users intentions (e.g., they were highly concerned when a driver in front of them did not signal) and to indicate an intersection as hazardous much closer to the intersection than younger drivers. Such findings might indicate that they are aware of the extra time they need in order to execute an action and try to avoid surprises. Recently, Cavallo et al. (2009) have showed that elderly pedestrians (70+) based their decisions and actions of whether or not to cross the road when a vehicle approaches on distance-based heuristics whereas younger pedestrians (20-30 years-old) based it on constant-time mode (angular
velocity) independent of the vehicle speed. The distance-based heuristics resulted in more risky decisions and actions when the approaching vehicle speed increased. This is highly interesting because both older drivers and older pedestrians seem to perceive the hazard well but base their actions on different criteria than those probably used by younger drivers.

To conclude, our studies on hazard perception elicited two pedestrian-related factors. Based on our findings, we first suggest that drivers’ expectations play a key role in their ability to project and detect hazards in advance (proactive behavior). Therefore, unexpected locations in which pedestrians may appear should include road signs to enhance drivers’ awareness of the possibility that a pedestrian may cross the road (similar to work zones signage indicating the possible appearance of unexpected heavy vehicles). Secondly, with respect to older drivers, although they tend to compensate for their deteriorating driving abilities, it would be intriguing to examine how they perform when circumstances, such as driving in unexpected pedestrian-related situations, are dictated. The additive contribution of age-related deficiencies and wrong expectations may be detrimental.
Title: THE PERCEPTION OF PEDESTRIANS FROM THE PERSPECTIVE OF ELDERLY AND EXPERIENCED DRIVERS

Presenting Author: Shani Bromberg

Authors: S. Bromberg 1; T. Oron-Gilad 1; A. Ronen 1;

Affiliation
1. Ben-Gurion University of the Negev, Department of Industrial Engineering and Management, Beer-Sheva, Israel,

Abstract:
The elderly population (typically defined as 65+ years old) is the relatively fastest growing age group in the population of the Western world. In addition, life expectancy increases and quality of life is constantly improving (Hakamies-Blomqvist et al., 2004). As a result, more drivers on the road are elderly. The variance in performance in most functions, of individuals over the age of 65, is very large (Midwinter, 2005). Situations that were found more demanding for elderly drivers were: heavy traffic load, loaded parking, bad road conditions and darkness. Researchers are trying to establish a way to distinguish between the "competent" and the "incompetent" drivers among the elderly drivers population. Hakamies-Blomqvist (2006) claimed that it is possible to classify a driver to 'safe' and 'unsafe' according to his/her probability to be involved in accidents, if permitted to drive. Our study examined hazard perception abilities among elderly and experienced drivers, particularly with regard to the presence of pedestrians in the urban road environment. Two evaluation methods were used; a) a commonly used hazard-perception evaluation method utilizing videos, where participants view videos of traffic scenes and press a button when they perceive a hazardous situation (see Borowsky, Oron-Gilad & Shinar, submitted), and b) simulated driving scenarios with or without dynamic elements (e.g., pedestrians) present, where the evaluation of hazard perception is embedded in the participants' driving behavior. By using two different means of assessment we were hoping to characterize "hazard perception performances" more accurately. We hypothesized that driving behavior in a driving simulator allows the drivers, particularly the elderly drivers, to respond more naturally to the environment. In the simulator drivers can also control their driving speed which is something elderly drivers often complain about in video observation tests. However, in the common method of video observation, the picture shown is of a real street, in a rather familiar environment, rich with details and cues. Possibly, combining both methods will create a more holistic dataset of parameters that measure hazard perception abilities. Our second objective was to characterize differences in hazard perception performances of elderly drivers in comparison to experienced drivers. Thus examining whether the elderly drivers differ from the experienced drivers in their hazard perception, and if they do, what are the characteristics of this difference and how it affects their driving. Previous studies suggested that Hazard perception abilities are not affected and that older drivers are as likely as younger experienced drivers to perceive hazards (e.g., Borowsky, Oron-Gilad & Shinar, submitted) however, they tend to rely more on other road-users intentions as well as to compensate for their deteriorating driving abilities (Ball et al., 1998; DeRaedt & Ponjaert-Kristofferson, 2000; Hakamies-Blomqvist, 1994).

Twenty four 'Experienced drivers' aged 28-55 (M=33) and twenty 'Elderly drivers' aged 65+ (M= 68) participated in the experiment as volunteers. The results of the video observation component had shown that elderly drives identified fewer hazards, and that their response time for hazard detection was longer. An analysis of the reasons for the presses, that were also recorded, had shown that experienced and elderly drivers relate
to different traffic elements as hazards. The elderly drivers frequently did not relate to pedestrians as a hazard, as opposed to their adversary, the experienced drivers. There was also evidence that they referred less to approaching a junction as a hazard. However, they referred more to the fact that the velocity driven in the video movies was ‘too fast’. The results of the simulated drive had shown a different picture, the elderly and the experienced driver’s performances were similar. There was only one pedestrians-related traffic event in which the differences in performances were significant. Based on our findings, we concluded that the elderly driver relate differently to pedestrians-related events. In addition, in the simulated drives, we found that elderly drivers press the brake pedal about 30% more than the experienced drivers and that they drive about 20% slower. This may lead us to the conclusion that in actual driving, elderly drivers compensate for their impairments in hazard perception by reducing the velocity and using the brake pedal more often.
Title: RISK TAKING AND ENJOYMENT: A COMPARISON OF CAR DRIVERS AND MOTORCYCLE RIDERS

Presenting Author: Paul Broughton

Authors: P. Broughton 1; L. Walker 2;

Affiliation
1. Owl Research Ltd., Scotland, UK, 2. University of Strathclyde, Glasgow, Scotland, UK

Abstract:
It is widely recognized that motorcyclists and young car drivers are vulnerable road users and these groups require interventions that specifically targets them. However, a greater understanding of their underlying motivation for driving or riding is necessary in order to design of suitable interventions. Using Fuller’s Risk Allostasis Theory (RAT) car drivers and motorcyclists are compared, with particular consideration on the motivation for driving and how this affects the target task demand and acceptable risk level. More precisely, this research examines some of the differences and similarities in risk taking and enjoyment found in road use between car drivers and motorcyclists. One of the main findings is that riders generally dislike driving while riders enjoyed riding. However, this does not hold true in one group – young drivers. Young drivers tend to have much higher levels of enjoyment than other drivers and even riders. Considering that young drivers and motorcyclists are generally over represented in road traffic crash statistics then this similarity in enjoyment may be an important lever that can be used in interventions. These, and other differences, are discussed in the light of road safety intervention design.

Keywords: speeding behaviour; Powered Two-Wheeler riders; driver behaviour; Task-difficulty Homeostasis.

Introduction
Within the UK there has been a reduction in crashes for most vehicle groups, however similar gains have not been seen for PTWs (Department for Transport, 2006, 2009). The causes of crashes for PTWs are often different to that of other motorised vehicles (Clarke, Ward, Bartle and Truman, 2004). In part the differences in the manoeuvres that PTWs can perform, such as overtaking without crossing the centre line and filtering through traffic, explain this. Motorcycles also have different acceleration and cornering characteristics compared to other motor vehicles. These factors are some of the reasons why the number of PTW crashes is disproportionate compared to other vehicle types (Preusser, Williams and Ulmer 1995).

The personality of PTW riders may also affect their crash rate; Mannering and Grodsky (1995) suggested that riding a PTW might attract ‘thrill seeking’ individuals as riding is considered riskier than other forms of transport (Broughton, 2005; Department for Transport, 2006). As well as PTW characteristics and rider personality traits, trip purpose also has an effect on crash differences between riders and drivers (Stradling 2003, Broughton 2005). Road safety interventions are often based on the premise that the vehicle user’s goal is to safely arrive at a destination, such as getting to work or the shops, however as well as functional trip purposes, some
trips may also have an expressive element (Steg, Vlek and Slotegraaf 2001; Stradling, Meadows and Beatty, 2001). Expressive use of vehicles is often found in PTW use (Broughton and Stradling 2005) with riders often just going out for a run without a specific destination in mind, just the goal of arriving back home safely having enjoyed their ride (Broughton 2007, Hannigan, Fuller, Bates, Gormley, Stradling, Broughton, Kinnear and O’Dolan 2008). As the profile of crashes suffered by leisure road users is different from functional road users (Walker 2007; Walker and Page 2004) then this is another factor that differentiates PTW riders from other road users. These expressive and functional purposes will now be discussed within the framework of risk allostasis theory.

Risk Allostasis Theory

Task-Difficulty Homeostasis (TDH) model, the fore-runner to Risk Allostasis Theory (RAT) provides a useful theoretical framework for the understanding of some of the differences between rider and driver behaviour (Fuller, 2005). It is suggested by the TDH model that drivers attempt to maintain driving task difficulty within a target range where task difficulty arises from the dynamic interplay between the demands of the driving task and the capability of the driver. When task demand is lower than capability then the driver is in control but when task demand exceeds capability loss of control results (Fuller 2005). The RAT model expands TDH to suggest that the level of task difficulty may cause feelings of risk and it is these feelings that act as a control. A driver’s target level of risk and task difficulty can be fluid changing to match the dynamic situation that they may find themselves in. It has been demonstrate that this theory is equally valid for PTW riders as it is for car drivers (Broughton, Fuller, Stradling, Gormley, Kinnear, O’Dolan, & Hannigan 2009, Broughton 2007 and Broughton & Walker 2009).

Figure 1 shows the TDH model; the ‘Comparator’ measures perceived task difficulty against the target range. The driver can make adjustments, such as changing speed or direction, to bring perceived task difficulty into an acceptable range. [Figure 1 about here, please]

One of the factors that affect the range of acceptable risk/task difficulty is the goals of the journey with this being a key difference between riders and drivers. Also a rider’s goal is to seek enjoyment from the ride rather than just getting to a destination then a rider may be more willing to put more effort into the riding task than a driver would be. These factors may be associated with an increase in vehicle speed and a higher acceptance of risk.

The motivation to use a PTW, and the goals of PTW use, may be different from those of car drivers. One area where these differences can be seen is in how vehicle use enjoyment varies with the amount of perceived risk involved in the driving or riding activity.

Enjoyment and risk

Research by Broughton (2007) and Broughton & Walker (2009) demonstrated that there are considerable differences between a riders’ view of risk and enjoyment compared to those of a car driver. For drivers as risk increases enjoyment decreases, however for motorcyclists enjoyment increases with risk until a peak in enjoyment is reached; after this point as risk increases enjoyment declines rapidly. Thus riders set a higher risk threshold than drivers to enable them to experience the goal of enjoyment (Broughton and Stradling 2005). This is further emphasized by considering the relationship
between speed a driver/rider is willing to go at and their estimate of how risky the situation they are driving in is. Drivers tend to go slower as the estimate of risk increases while there is no detectable pattern for riders. Another difference in enjoyment for drivers is within gender; male drivers tend to enjoy driving more than females while for riders there is no detectable difference. Broughton and Walker (2009) explain that:

“This dissimilarity between riders and drivers may be due to females who do not enjoy driving, but feeling that they have to drive; it is a functional activity based on other life choices or commitments. Riding is more of a choice activity and females who ride do so because they want to.”

Riders find road-use more enjoyable that drivers do, however the exception to this is younger drivers who find high levels of enjoyment in their driving activity. Young riders and drivers do not want drive or ride slowly, but young riders tend to be more conservative in their speed choice than young drivers (Broughton et al 2009). As enjoyment is often related to speed then an appreciation of speed selection would add to the understanding of enjoyment/risk profile differences.

**Speed selection**

Within Fuller’s (2005) Theory of TDH and the subsequent Risk Allostasis Theory (RAT) drivers select a target task difficulty/risk range and speed is one of the main methods used for controlling task difficulty. Riders tend to set a higher target task difficulty and risk threshold when taking part in an expressive riding activity and therefore are willing to accept a higher level of risk and will ride with a smaller safety margin (Broughton, P.S., Fuller, R., Stradling, S., Gormley, M., Kinnear, N. O’Dolan, C. & Hannigan, B. 2009 and Broughton & Walker 2009). However when riders are riding in the urban environment they are more likely to increase their safety margin by reducing their speed; this partly is because of an increase in perceived risk caused by having to interact with other vehicles which accentuates the rider’s feeling of vulnerability (Broughton and Stradling 2005). Riders and drivers feel that they are more at risk when they are in an environment that has numerous road features such as emerging junctions, however riders are more vulnerable a where a low speed collision might result in minor damage for a car, for a rider it could be fatal. Riders generally select lower speeds within urban areas compared to drivers and therefore are more likely to be conforming to the speed limit.

Conversely out with this urban situation riders are more likely to select higher speeds compared to drivers as this fits with the goals of a recreational ride. Current research investigating the effectiveness of fixed point interventions within the Strathclyde area of Scotland being carried out by the PEACH Unit at the University of Glasgow supports the idea that riders are going slower than drivers within the urban environment by showing that fixed speed cameras are less effective in reducing crashes for PTWs than for cars. Cameras are less effective in reducing PTW crashes because riders are going slower prior to the installation of cameras compared to drivers and therefore there is less of a safety gain for PTWs.
The odds ratio of post/pre camera crashes between cars and PTWs is 0.813 (95% CI 0.758 to 0.872). This value shows that there are relatively more bike crashes post intervention than car crashes. Or to put another way, if both had reduced by the same amount the value would have been 1.00; car crashes have reduced more than bike crashes. The ratio for all crashes within the Strathclyde area is 1.009 (95% CI of 0.996 to 1.020) and for the UK is 0.943 (95% CI 0.942 to 0.944). Preliminary calculations using an empirical Bayes methodology suggests that the cameras within Strathclyde reduced car crashes near their sites by 23% compared to a reduction of around 5% for PTW users. Research on the DfT funded HUSSAR project supports this finding and interpretation (Broughton, Fuller, Stradling, Gormley, Kinnear, O’Dolan & Hannigan 2009):

“These data suggest that while fewer riders than drivers say they would be speeding on approaching a camera in an urban 30mph / 50 kmh speed limit zone, for those who are speeding, urban speed safety cameras are less effective in changing the behaviour of a speeding motorcyclist than a speeding driver.”

The rider goal of finding enjoyment in the ride often means riding fast in non-urban areas where the risk of conflict with other vehicles is low and to accomplish this a level of risk is accepted. However in urban areas where conflict with other vehicles is seen as being more likely riders tend have larger safety margins with this seen by going slower than car drivers would go. With the exception of younger drivers, drivers tend not to enjoy driving where risk is involved with this being related to a functional trip purpose. What is required is a translation of this understanding of differences between riders, young drivers and other drivers into intervention guidelines.

**Intervention design**

The differences between riders and drivers are often trip purpose related; therefore to expect that a general ‘one size fits all’ road safety intervention to be effective for all road user groups would not be logical. Not only must the road safety message to be transmitted to the road user be considered, but also how trip purpose will affect the way that the message will be received. For example an intervention aimed at trying get road users to slow down must also considered the reasons for the use of speed in the first place; for drivers this is likely to be for logistical reasons but expressive for riders and younger drivers.

Interventions must respect the trip purpose of the road user because if an intervention attempts to remove or interfere with expressive enjoyment goals then it is likely that the intervention message will be deflected by its intended audience (Broughton 2006, 2008). If the goal is to arrive safely so that some task can be carried out at the destination then interventions that interfere with the actual driving or riding activity might be accepted, however if the trip purpose is expressive then this interference is not likely to be tolerated. When a rider is riding expressively then they often accept a small safety margin, therefore interventions may be designed that attempt to get riders to expand their safety margin while at the same time not reducing their enjoyment, could provide safety benefits (Broughton, Allan and Walker, in press); this approach of encouraging wider safety margins without detracting from enjoyment may also be suitable for young drivers who have similar profiles.
Conclusion

Road safety interventions must respect the road user goals otherwise the intervention is likely to be rejected as not being relevant or as being ‘thought up’ by someone who does not understand their particular mode of travel. There are differences between how riders and drivers use the road, in particular what the trip purpose goals are. However this is not the case for young drivers who demonstrate quite similar profiles to riders. Riders and young drivers use the road for pleasure with this pleasure often being found by riding or driving quickly in non-urban environment. However when a rider is in the urban environment then the perceived risk acts as a speed inhibitor; risk does not act as a speed inhibitor for young drivers in the urban environment. Drivers on the other hand drive for functional reasons where enjoyment is not one of the major keys. This difference in goals often means that riders and young drivers will accept a smaller safety margin compared to other drivers. Getting riders and young drivers to realize that they may be riding with a small safety margin and that expanding the margin may not reduce their enjoyment is one of the keys to effective interventions aim at PTW users and young drivers.

References


Figure legends, tables

Figure 1. Representation of the process of task-difficulty homeostasis.
Title: MOTORCYCLING AND RISK: THE EFFECT OF RIDING WITHIN A GROUP

Presenting Author: Paul Broughton

Authors: P. Broughton 1; L. Walker 2

Affiliation
1. Owl Research Ltd., Scotland, UK, 2. University of Strathclyde, Glasgow, Scotland, UK

Abstract:
Those who ride motorcycles are over represented in Killed and Seriously Injured (KSI) crashes and are often targeted in road safety interventions. An understanding of the motivations and purpose of leisure riding and how this impact on the nature and type of incidents can be used to design effective safety interventions. Therefore it is prudent to research rider motivation.

It is well understood that riding a motorcycle is often done for pleasure (Broughton and Walker 2009) and to enhance that pleasure some motorcyclists choose to ride in groups. One of the issues of this group riding is that the rider ceases to become just a solo entity; rather they are now part of a unit interacting with their riding cohort. This raises the question of how this interaction affects the riding and the risk-taking behaviour of an individual.

Within sports it is recognized that when a person is being watched it often raises that person’s arousal level (Gill 1986). If this arousal is not raised above an optimum level, then performance quality may increase. However, if the level of arousal is raised beyond this optimum point then performance quality suffers. Moreover, when a person feels that an expert is watching them then they may feel some sense of being judged and this can raise their arousal level even further, increasing the chance that their arousal will be pushed past their optimum level. Within the group motorcycle riding activity a rider is in the situation of riding with a group of other riders, some of whom they may consider to be experts. Thus arousal levels may have a detrimental effect on riding performance and safety.

This paper is based on research into riding behaviour with respect to risk taking and preferred riding position within a group. Overall the research suggests that for some riders, riding within a group has a negative impact on riding safety. The results also show that the changes in risk-taking behaviour also depend on the makeup of the group.

When riding in an informal group the pressure of being watched by peers can cause a feeling of being judged, which in turn can cause a rider to ride in a way that they feel the person judging them would approve of. This may result in the rider wishing to show off their skills to their cohort and thus increase the amount of risk taking that they may be willing to accept. Even more concerning is that some may deliberately ride beyond their skill levels so as not to be seen as having skills that are ‘below par’ for the group. Formal group riding is less prone to such effects due to more defined rules and norms of behaviour.

The research shows that riding as a part of a group can cause a rider to ride in a riskier manner than if riding alone and therefore this is an area that should be addressed in road safety interventions. These interventions may include addressing beliefs into what makes a skillful rider and teaching methods that riders can use to withstand real, or imagined, peer pressure.

References:
Title: COST 357--ACCIDENT PREVENTION OPTIONS WITH MOTORCYCLE HELMETS

Presenting Author: Paul Bruehwiler

Authors: P. A. Bruehwiler 1; D. Otte 2; M. J. Carley 3; D. Crundall 4; C. P. Bogerd 1

Affiliation
1. Laboratory for Protection and Physiology, Empa, St. Gallen, Switzerland, 2. Accident Research Unit, Medical University of Hannover, Hannover, Germany, 3. Department of Mechanical Engineering, University of Bath, Bath, England, 4. Accident Research Unit, University of Nottingham, Nottingham, England,

Abstract:
COST 357 is an Action formed in 2005 with the goal of gaining knowledge on ‘Accident Prevention Options with Motorcycle Helmets’, with corresponding acronym PROHELM. The Action and many of its activities will conclude at the end of 2009. The research carried out in this framework has examined the problem of powered two-wheeler (PTW) accident prevention from several perspectives, with a common aspect being cognitive effects and full-face motorcycle helmets.

Riding PTWs, such as motorcycles and mopeds, entails a higher risk for a fatal traffic accident than any other common mode of transport. It has been estimated that 440 PTW rider fatalities occur per 100 million person traveling hours, whereas 75 and 25 fatalities were found over the same period for a bicyclist or a car driver, respectively [1]. Half of these accidents are caused by other collision participants, approximately 40% by the PTW rider, and the remaining are attributable to factors such as vehicle and road failures [2, 3]. Cognitive failures on the part of the PTW rider are known to lie at the root of 34% of PTW accidents [2]. Cognitive failures by automobile drivers are also important, since looked-but-failed-to-see accidents contribute substantially to the accident statistics. However, it is difficult to identify the sources of this impaired cognitive performance, for the PTW rider or the automobile driver.

Automobile drivers and passengers are well-protected compared to PTW riders, whose survival of an accident is strongly supported by wearing a helmet, especially a full-face motorcycle helmet. Most PTW riders wear a motorcycle helmet [2, 4, 5], yet fewer do so in warmer weather, if given the option [6]. This suggests that discomfort influences the willingness to wear a helmet, and may therefore distract the rider who wears one.

Motorcycle helmets typically act as insulators, especially in the scalp region, generally increasing the temperature at the head for ambient temperatures below that of the body core. Hence helmet ventilation and temperature perception are factors to be considered. Vision and hearing are fundamental senses for traffic participants, and are obviously modified by a full-face motorcycle helmet. Although vision restrictions are addressed in helmet standards, visors are often modified after the helmet purchase, either intentionally with tinting, or inadvertently through wear. Hearing is known to be an issue with many helmets due to air turbulence; nevertheless, there is little knowledge about its effects on reducing rider awareness in traffic. These aspects were addressed in research in Working Groups 1, 2, and 3. A laboratory study of the cognitive effects of wearing a full-face helmet was undertaken in Working Group 4.

The failure to notice an oncoming PTW is often given as the reason that an automobile driver did not yield the right-of-way properly, thereby causing an accident. The conspicuity of the PTW rider combination is therefore a central aspect of PTW accident
prevention. The potentially beneficial effects of conspicuity cannot be considered in isolation. A wide range of other bottom-up factors are equally important, and are likely to interact with helmet colour or pattern (e.g., spatial frequencies). Similarly there are many top-down influences that also need to be considered. One of the considerable steps forward that has been produced from Working Group 4 is the creation of a framework to interpret the interplay of all these factors on the car drivers’ ability to look at, perceive and correctly appraise a conflicting motorcycle. It is our hope that current research will demonstrate that car drivers’ abilities to avoid colliding with motorcycles can be improved through a mixture of top-down training (where to look, appraisal techniques) and bottom-up interventions (increasing conspicuity, and decreasing drivers’ processing thresholds for motorcycles).

The activities will be presented in 30 minute talks (including questions) corresponding to three groups of activities, corresponding to Working Group 1, Working Groups 2 & 3, and Working Group 4, respectively. The Action Chair will introduce the Symposium with a brief summary of the activities and act as Symposium Chair. The last 20 minutes of the Symposium will be available as a question-and-answer session.
Title: MSF RETS: A SYSTEM DESIGNED TO SUCCEED

Presenting Author: Tim Buche

Authors: T. Buche 1; R. Ochs 1;

Affiliation
1. Motorcycle Safety Foundation, Irvine, CA, USA

Abstract:
Research has shown the more experienced operators scan the road better and recognize important clues much earlier than novices. There is also earlier identification by experienced operators that a hazardous situation is developing. This is likely to lead to action before the conflict occurs. The MAIDS study confirmed that one of the main contributing factors to motorcycle crashes is related to perceptual errors. Both the United Kingdom and Australia have added a hazard perception component to their licensing process.

The Motorcycle Safety Foundation (MSF) has been working on several new programs that are designed to provide training in hazard perception. The programs will be available to training providers and government agencies. Dr. Raymond J. Ochs, Director of Training Systems at MSF, will provide an overview of Street Smart – Rider Perception program (a 90-minute classroom-only learning experience that includes modern visual technology and classroom activities), its accompanying online hazard awareness activity (a self-paced hazard awareness module called Rider Perception Challenge), and the SMARTrainer Class – Traffic Awareness program (SMART stands for Safe Motorcyclist Awareness and Recognition Trainer). The value of hazard perception training has been demonstrated in laboratory settings. The intent of these MSF-developed programs is to not only assist riders in developing their hazard perception skills, but to transcend the straightforward practice of hazard identification by expanding learning activities to address the human visual characteristics as well as executive functions. The idea of giving riders an awareness of the importance of executive functions like attention, prioritizing and strategizing would mean more meaningful hazard perception training.

INTRODUCTION
Since March 1973, the Motorcycle Safety Foundation (MSF) has set internationally recognized standards of excellence in motorcycle rider education and training. The MSF is a leader in championing the safety of the motorcyclist in many ways. The Foundation develops and maintains a high-quality, research-based rider education and training curricula, establishes national certification standards, provides technical assistance for training and licensing programs, actively participates in government relations, research and public awareness, and works in powerful partnerships with other motorcycling and public organizations toward improving and enhancing the safety and enjoyment of motorcycling.

Late in the 1990s, MSF embarked on a significant renewal endeavor to improve the education and training processes related to motorcyclists and its certified instructors. It reinvented its entire motorcycle safety rider education and training system by significantly updating and improving its curricula and instructor certification programs and processes. Developed over the period of several years and continually analyzed, improved and expanded, the MSF Rider Education and Training SystemSM (MSF RETS) uses proven and cost-effective approaches to promote motorcyclist safety, ensure a positive image of motorcyclists, and enable a superior riding experience.

Preparing Riders to S.E.E. Better: MSF Tools for Improving Hazard Perception is about how the MSF addresses hazard perception in its Rider Education and Training System programs. S.E.E.
specifically means to Search-Evaluate-Execute. Hazard perception is considered to be a significant element in crash prevention. As noted in Groeger (2000): It has been suggested that hazard-perception abilities can be trained and it does seem that people who receive rather general road safety training perform better on tests of hazard-perception ability (e.g. McKenna & Crick, 1991, 1994). Precisely what is learned from such training, and how it may generalize to hazard perception or actual driving, remains unclear. It is possible that what can be gained from such training is a general idea of what unexpected events may occur, and what the consequences of these might be, or that people are motivated to become more responsible or cautious.

Haworth and Mulvihill (2006) in their first stage of a program of research to develop hazard perception for motorcyclists, point out that Crick and McKenna (1992) define hazard perception as the ability to identify potentially dangerous traffic situations. Evans and McDonald (2002) define hazard perception as “the process whereby a road user notices the presence of a hazard.” For the purposes of this paper and as used in MSF programs, perception is defined as seeing and understanding accurately.

The purpose of this paper is to (1) provide a rationale for hazard perception training, (2) connect the importance of addressing the executive functions of the brain in order to provide the most effective training, and (3) show how MSF has incorporated hazard perception training into its Rider Education and Training System. Several MSF courses, including one specifically designed program titled Street Smart – Rider Perception (SSRP), include hazard perception awareness and training. The SSRP program, which is the primary focus of this paper, has a companion online interactive program called Rider Perception Challenge! It is found on the MSF website (msf-usa.org) and is available to anyone with Internet access. (Warning: The training situations use United States signs and all riding is assumed to be on the right side of the roadway.)

This paper addresses how hazard perception training can expand to include the executive functions that are critically important for identifying and prioritizing factors while riding. A safety mindset is an antecedent for effective hazard perception, and hazard perception training that focuses only on select situations may be minimizing potential positive effects for helping riders manage their risks.

IDENTIFICATION OF THE PROBLEM
Traffic safety experts have long known that motorcycling is a complex psychomotor task that includes mental, physical and social competencies and abilities. Motorcycling is a mental task because a rider must process information and make decisions; motorcycling is a physical task because it requires simple and complex motor skills; and motorcycling is a social task because it requires interaction with other highway users.

The MSF characterizes the riding task as more a skill of the eyes and mind than of the hands and feet. This means that once basic skills are acquired, safety on the road is more about using the eyes well and using the brain to sort, organize and prioritize factors in the traffic environment. Quality rider education and training must transcend the notion that safe riding is to solely focus on skill development.

Dorn (2005) suggested that a focus on skills training may explain why research results have been disappointing for driver training. He noted:

In contrast to engineering and enforcement interventions, education has received comparatively little attention as a method to alter driver behaviour. Hitherto, much of the research on driver
behavior is disappointing in not providing sound practical solutions to bring about a desired change in driver behaviour. It seems common sense then that training drivers would reduce the risk of collisions; yet studies to evaluate whether driver training delivers a safety benefit have been largely unsuccessful. However, driver training takes a skills-based approach and little attention is paid to the behavioural aspects of driving known to be a major factor in collision risk. This could explain why existing methods have frequently failed to reduce accidents.

When reviewing crash causation studies, conclusions contain little emphasis on a lack of skills as the primary cause of crashes. The Motorcycle Accident In-Depth Study (MAIDS) (2004) reported: “In about 1/3 of accidents PTW riders and other vehicle (OV) drivers failed to account for visual obstructions and engaged in faulty traffic strategies.” Another MAIDS finding states that among the secondary contributing factors, PTW riders “failed to see the OV and they also made a large number of faulty decisions; i.e., they chose a poor or incorrect collision avoidance strategy. In 13% of all cases, there was a decision failure on the part of the PTW rider.” In the same vein, the Hurt Report released in the United States, officially known as Motorcycle Accident Cause Factors and Identification of Countermeasures (1981), recommended that a priority for rider education and training programs would be to emphasize the rider’s capabilities to see and be seen.

That distributions of attention within the visual field play an important role for safe driving behaviour is confirmed by several studies Dorn (2005); the link between attention and traffic accidents was the subject of a study of Hendricks, Fell and Friedman (1999) who found by analyzing 723 crashes that 37.8 percent were due to driver inattention or perceptual errors. In an earlier investigation by Treat, Tumbas, McDonald, Shinar and others (1979), 2258 traffic accidents were evaluated and the authors concluded that improper outlook and inattention were the two leading causes of traffic accidents. More recently, the 100 Naturalistic Car Study found driver inattention as a primary contributing factor in most crashes.

Today, it is important for motorcyclists to be more vigilant and perceptive than ever. Devices that distract other drivers are on the increase, from cell phones that can be used for talking or texting to video devices and navigation systems that create inattention to the driving task. And what has been learned about driver distraction has implications for riders who may not give due attention to their capacities while riding.

Yet, would training that focuses on identification of possible hazards alone improve hazard perception on the road? Can training initiatives shape executive functions? Can hazard perception training cause greater overall attention when riding?

There is little doubt that developing one’s executive functions better will lead to better functioning in driving and other areas of life. Meltzer (2007) stated:

…life success depends increasingly on the mastery of executive function processes such as goal setting, planning, organizing, prioritizing, memorizing, initiating, shifting, and self-monitoring. Executive function is a cognitive process involved in controlling behavior and readying the person for situations. More important in real-life decision making and everyday reasoning than in responding to questions on standardized tests, executive function comprises the ability to be mentally and behaviorally flexible to changing conditions and to provide coherence and smoothness in one’s responses.

Caine and others (2009) state that the primary key to learning is developing the ability to make good decisions in the real world, based on the knowledge that people have and the sense they have made of experience. In short, at the heart of great teaching is the development of the executive functions of learners. They additionally note that the “notion of thinking about one’s own thinking is called metacognition, and it has been studied extensively (see, for example, Perfect &
Schwartz, 2002). In fact, working with metacognition is essential for enhancing the executive functions, all of which are strengthened as people become aware of their own behaviors, capacities, and predispositions.”

Connecting the two areas, executive function and hazard perception, The National Safety Council’s white paper report (2010) alludes to the fact that hazard perception needs to be preceded by executive functions. The brain handles tasks sequentially, switching between one task and another. A person’s brain can juggle tasks very rapidly, which leads to erroneously belief that we are doing two tasks at the same time. In reality, the brain is switching attention between tasks – performing only one task at a time. From the report:
In addition to “attention switching,” the brain engages in a constant process to deal with the information it receives:

1. Select the information the brain will attend to
2. Process the information
3. Encode, a stage that creates memory
4. Store the information.

Depending on the type of information, different neural pathways and different areas of the brain are engaged. Therefore, the brain must communicate across its pathways. Furthermore, the brain must go through two more cognitive functions before it can act on saved information. It must:

5. Retrieve stored information
6. Execute or act on the information.

When the brain is overloaded, all of these steps are affected. But people may not realize this challenge within their brains.

It is important for hazard perception training to address the antecedents of good hazard identification: the executive functions. Most people recognize when they are visually or mechanically distracted and seek to disengage from these activities as quickly as possible. However, people typically do not realize when they are cognitively distracted, such as taking part in a phone conversation; therefore, the risk lasts much, much longer (National Safety Council, 2010).

Riding safely requires more than good physical skills and attention to the riding task. It requires respect and a healthy attitude that puts safety as a top-of-mind matter when riding. As noted in Forbes (1972), the question remains “Will an outright attempt to change driver skills help solve the problem or is the continued accident problem symptomatic of a deeper private and public issue? What assurance do we have that more skilled drivers will use their skills to avoid accidents, rather that slice the margin of safety more closely?”

At a more practical level, improved skills would seem to be of value only to those drivers who are already predisposed to drive safely. Add to this what Vanderbilt (2008) related about a real-time functional magnetic resonance imaging study: “That small peek into the brain of the driver revealed a simple, if underappreciated truth about driving: When we are in traffic, we all become on-the-fly risk analysts. We endlessly have to make snap decisions in fragments of moments, about whether it is safe to turn in front of an oncoming car, about the right speed to travel on a curve, about how soon we should apply the brakes when we see a cluster of brake lights in the distance.”

Education and training programs that address the human functions of the riding task, including hazard perception, must provide awareness and development of the executive functions, or at least instill an appreciation for the value of making attention to safety a priority when riding. It is from this perspective that rider education and training can become more effective. As noted in Vanderbilt (2008): “Human attention, in the best circumstances, is a fluid but fragile entity, prone to glaring gaps, subtle distortions, and unwelcome interruptions. Beyond a certain threshold, the more that is asked of it, the less well it performs. When this happens in a psychological experiment, it is interesting. When it happens in traffic, it can be fatal.”
DEVELOPMENT OF THE S.E.E. STRATEGY
In the MSF Rider Education and Training System, Search-Evaluate-Execute (SEE) is the terminology used to address the human functions of the riding task. Over the years, many similar methods have been used. Most ubiquitous is Identify-Predict-Decide-Execute, which was adopted by many traffic safety agencies and promulgated in several driver and traffic safety education textbooks.

IPDE and SIPDE (S adds Search or Scan) are decision-making processes for motor vehicle operators that have been around the driver and traffic safety education community for many years. Although no one person or entity has been credited with their development, the source most often cited was reported in Traffic Safety Research Review (1967), where Lawrence E. Schlesinger stated:

…the skilled driver is one who accurately processes and organizes the information of the driving scene in terms of the field of safe travel and minimum stopping zone, and who maintains a safe field-zone ratio over time. The skills required to accomplish this task are observation of the changes in the driving scene, identification of the change and estimation of its consequences, decision-making and executing the decision. These are assumed to be learnable and measurable.

One of the early uses of IPDE is provided in an Automotive Safety Foundation (1970) publication. In explaining a curriculum rationale, the authors named as one of the aspects pervading the curriculum the “human functions.” In a section titled Human Functions—Basic Points of Contact and Connection for the Curriculum, it states:

Performance depends upon the efficiency and effectiveness of human functions applied to the task, so educational efforts should be directed toward the quality of these functions. Although researchers have classified these functions somewhat differently, these analyses appear to agree in substance. The terms of the study follow closely those proposed by Schlesinger. They are: 1) identify the relevant cues; 2) predict their significance; 3) decide what to do; and 4) execute your decision.

This resource curriculum provided a chart titled “Man-Machine-Environment Analysis: Human Functions.” The chart named six categories: input, identifying, predicting, deciding, executing, and vehicle responses (see Chart 1 below).
Chart 1. MAN-MACHINE-ENVIRONMENT ANALYSIS

Human Functions

<table>
<thead>
<tr>
<th>Input Stimuli from:</th>
<th>Identifying</th>
<th>Predicting</th>
<th>Deciding</th>
<th>Executing</th>
<th>Vehicle Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>roadway</td>
<td>Sensing:</td>
<td>Time-space</td>
<td>Kinds of</td>
<td>Responding</td>
<td>Location</td>
</tr>
<tr>
<td>other highway</td>
<td>Vision</td>
<td>judgments</td>
<td>decisions:</td>
<td>with vehicle</td>
<td>Location</td>
</tr>
<tr>
<td>users</td>
<td>auditory</td>
<td></td>
<td>simple</td>
<td>controls:</td>
<td>Direction</td>
</tr>
<tr>
<td>own vehicle</td>
<td>tactile</td>
<td>Behavior of</td>
<td>habitual</td>
<td>Steering</td>
<td>Speed</td>
</tr>
<tr>
<td>position</td>
<td>olfactory</td>
<td>other highway</td>
<td>complex</td>
<td>controls:</td>
<td>Changes</td>
</tr>
<tr>
<td>control signs</td>
<td>Perceiving:</td>
<td>Vehicle</td>
<td>sudden</td>
<td>accelerator</td>
<td></td>
</tr>
<tr>
<td>and signals</td>
<td></td>
<td>capabilities</td>
<td>(high risk)</td>
<td>brake</td>
<td></td>
</tr>
<tr>
<td>distracting</td>
<td></td>
<td>(including</td>
<td></td>
<td>signaling</td>
<td></td>
</tr>
<tr>
<td>stimuli</td>
<td></td>
<td>own)</td>
<td></td>
<td>devices</td>
<td></td>
</tr>
</tbody>
</table>

The Maryland State Department of Education (1972) under a grant for the Division of Transportation Safety, Maryland Department of Transportation, and the Highway Traffic Safety Administration, U.S. Department of Transportation developed an Instructor’s Guide for the IPDE System. In its preface, the authors state: “In creating The IPDE System, the driver education staff of the Maryland State Department of Education sought counsel from several sources. Throughout this search, one over-riding fact became apparent: There is a great ‘gap’ between what on-road driving task requirements appear to be and those instructional materials that are generally available or used. For example: if one were to ask each individual involved in developing The IPDE System for an unconditional endorsement of the entire program of instruction, one would have a difficult time getting a consensus. This was a major concern to the authors. In an attempt to accommodate this fact, a certain degree of flexibility has been provided in The IPDE System. In essence, each teacher will find his own way to handle The IPDE System.”

There are several examples of how the basic IPDE system or similar processes or systems have been utilized. … (1971) Learning to Drive: Skills, Concepts, and Strategies used the five-step process of See, Understand, Predict, Evaluate, Control. The 1972 text Let’s Drive Right used IPDA (Identify, Predict, Decide, Act). The 1975 driver education text Driving: A Task Analysis Approach used SIPDE, and where the “S” stood for Sensing. AAA for many years has used SIPDE, with the “S” meaning Search. The Washington State curriculum Guide has adopted WEA (Watch, Evaluate, Act). The 1989 Motorcycle Safety Foundation Experienced RiderCourse utilized SPA (Search, Predict, Act). The National Safety Council Defensive Driving Courses have been utilizing Recognize the hazard, Understand the defense, Act correctly in time. The American
Driver and Traffic Safety Education Association (ADTSEA), in its teacher preparation and recognition program, promotes a 3-step approach including Mottola’s ABCs of Zone Control of A: Alert switched on to check zones, B: Before acting check other zones, and C: Create time/space management.

From an education and training viewpoint, the exact terminology is not critical to the achievement of objectives. It becomes a matter of what best communicates to riders and what best transfers from the learning environment to the actual streets and highways. As stated in an Automotive Safety Foundation (1975):

The precise division and labels are not important so long as they come from a systematic and logical analysis, and are meaningful to the teacher and his students. Some may prefer to use “perception” instead of identify”; and “judge” instead of evaluate, or “assess” instead of “predict.” In any case the person senses and processes information, decides and acts. There functions tend to blend together and overlap in the rapidly changing traffic environment. None of them is independent; indeed, listing them is more a convenience than a reflection of reality.

In many ways, rider perception is a euphemism for situational awareness. In Banbury (2004), it is noted that in surveying definitions of situational awareness (SA) reveals the variety of conceptions currently conveyed in the literature. Breton and Rousseau (2001) performed a systematic classification of 26 SA definitions. These definitions turned out to be evenly divided in two classes corresponding to the now accepted duality of SA as a State or as a Process.

The Motorcycle Safety Foundation Basic RiderCourse utilizes the acronym SEE (Search-Evaluate-Execute) as a personal riding strategy (see Figure 1 below). Search, a visual function, means to actively scan and identify factors that could create increased risk; Evaluate, a cognitive function, means to consider potential problems from the interaction of those factors; and Execute, a motor skills function, refers to physical, manipulative actions required for communication as well as time and space adjustments.

![Motorcyclist Task](image)

Figure 1. Motorcyclist Task

SEE is an active, thinking strategy that places responsibility on the motorcyclist to reduce risk by creating time and space in order to control a personal margin of safety. Besides being a simplified
three-step process and easy to remember, SEE as a word acronym connects a thinking strategy with the importance of visual perception. This is supported by the Hurt Report (1981) that stated in one of its recommendations and proposed countermeasures: “…and this points out the need for the motorcycle rider to develop a traffic strategy so that he can see and be seen in traffic. This should be the most important component of any motorcycle rider training program.”

INTEGRATION OF S.E.E. INTO THE MSF RIDER EDUCATION AND TRAINING SYSTEM

With the introduction of the MSF’s latest learn-to-ride curriculum, the Basic RiderCourse in 2001, S.E.E. became the primary method used to convey the notion of the human functions of the riding task. But using S.E.E. is the tip of the iceberg in terms of improving rider safety through the development of hazard perception ability. Consider the MSF Pyramid of Safety (see Figure 2 below). It demonstrates the components of a safe rider, which certainly transcends the notion that rider safety is a function of primarily physical skills. And the development of physical riding skills too often becomes the central feature of rider education and training safety programs.

Figure 2. MSF RETS Pyramid of Safety

All MSF programs incorporate the topical areas of the pyramid. The more basic programs emphasize the baseline topics while acknowledging the higher-order functions; the more advanced programs renew the fundamentals while delving deeper into the functions of rider decisions and choices. Notice that Perception is essentially in the middle.

It is important to situate perception in the context of a larger of general human error, which transcends the notion of basic hazard perception. As noted in Breakwell (2007), some hazards are the product of human error. Several types of error create hazards:

- Failures in problem analysis – e.g. missing the way peripheral elements in the problem can interact with each other to become major obstacles to it;
- Solution failures in problem solving – e.g. believing that the solution is identified without adequately testing it;
- Failure in attention to information – e.g. ignoring information that is available (or sometimes, not recognizing what information is not available);
Failure in interpretation of information – e.g. misunderstanding the implications of the data that you have noted;

Failure in the choice of action that a situation requires – e.g. deciding that it is necessary to intervene when it is not;

Failure in the appropriate execution of the chosen action – e.g. either in when it is done or how it is done.

Note all but the final point address the brain/mind connection associated with perception.

Dominguez (1994) suggests a set of processes “on which situation awareness depends: information extraction, information integration, mental picture formation, and projection and anticipation.” Training in hazard perception not only connects with the executive functions of the human brain, but also creates the opportunity to delve deeper into a rider’s risk reduction management strategies. Endsley (1998) also describes three cognitive processes or functions: perception, comprehension and projection.

The MSF recommends a core set of courses for complete preparation in developing and maintaining safe and responsible performance and behavior. S.E.E. is the fundamental strategy the forms the central thread that ties together the mental aspects of riding. Here are the primary programs of the MSF’s recommended core of courses, and how S.E.E. is addressed in each:

- Basic RiderCourse (BRC): S.E.E. is introduced as the strategy for minimizing risk. It is to be applied when learning basic operation on the closed-course practice area, and is reinforced in audio-visual training aids.
- Street RiderCourse 1: Basic: Part IV of the Street Smart – Rider Perception program is used prior to the on-street instructional activities. During the route, riding experiences under the supervision of a RiderCoach with radio communication and during the mid-route debriefs, S.E.E. is used as the focal point the identification of potential hazards.
- Street Smart – Rider Perception: this classroom only program solely focuses on developing good perception, and details are provided later in this paper.
- Rider Perception Challenge! that is an online program related to Street Smart – Rider Perception.
- Advanced RiderCourse – SportBike Techniques: a segment of the classroom learning activities uses parts of the SSRP.
- The Safe Motorcyclist Awareness and Recognition Trainer (SMART) – Traffic Awareness: this learning tool provides simulated traffic scenarios and uses S.E.E. in the learning environment.

Just as motor skills are developed from gross to fine skills, so too is rider perception developed over time with deeper levels of understanding. It would be preferred to have perfect riders before ever letting them on the street, but this is not practical. So it becomes important throughout training, particularly in the beginning when only basic skills have been acquired, that every rider knows how to keep their skills ahead of their risks. Riders must keep a margin of safety as they consider their capabilities and limitations. Awareness and training in rider perception not only enhance hazard identification capabilities, but also provide experiences in the vulnerabilities when riding in traffic.

In summary, it is important for riders to have the mental, physical and social skills necessary for safe motorcycle operation. The mental aspect can be developed and used in a course, but more importantly, riders need the appreciation of and value for making safety a priority. One way to accomplish this is to provide learning activities that not only built hazard perception skills, but show how quickly the eyes and mind can work if attention is devoted to the riding task. If a rider makes safety a priority, has good hazard perception skills, and chooses to keep the mind in a state of readiness, then hazard perception training has accomplished more than merely the surface learning of identifying potential collision traps while riding.
STREET SMART – RIDER PERCEPTION PROGRAM
Street Smart – Rider Perception (SSRP) is an MSF Host-an-Event program that is totally devoted to rider perception. (Host-an-Event programs are available to the public and do not require specialized training or certification.) The SSRP has been implemented in two formats: one is a kit that contains a Leader’s Guide with a core lesson plan, student workbooks, oversized playing cards and floor mats for highlighting central vision and peripheral vision, and a training aid with PowerPoint program and interactive scenarios that consist of traffic signs and traffic situations; the other is an online web-based version that may be used as a perceptual awareness activity that includes self-assessment with personal perceptive abilities specific to motorcyclist operation.

The SSRP kit consists of learning activities divided into four separate parts: (1) Introduction to Rider Perception; (2) Improving Perception; (3) Analysis of Collision Traps; and (4) Road Sign and Collision-Trap Practice. The PowerPoint program is designed with highly interactive learning activities and Part IV, Road Sign and Collision-Trap Practice tests participants as a capstone activity.

As stated in the SSRP Leader’s Guide, the overall aim of the SSRP is to improve a rider’s perceptive abilities when riding in traffic. Having good perception skills means to see and understand accurately.

The stated objectives of the SSRP are:

1. Name several factors that affect perception.
2. Explain how quickly the eyes and mind can effectively work to accurately perceive a situation (in the case of this module, that would be quick identification of road signs and traffic situations).
3. Identify traffic signs and state their meaning.
4. Identify factors in traffic situations that could affect rider speed, lane position or path of travel.
5. Increase the speed of identification of key factors in traffic.
6. State the value of attention in identifying factors and managing risks.
7. Name several collision traps that could affect rider safety.

Objectives 2 and 6 above allude to the executive functions as they relate to hazard perception. As stated in the Leader’s Guide when referencing the collision traps practice test items: “A point to keep in mind is that the purpose is not to solve specific situations with an absolute, only-one-answer response, but to gain an appreciation of how quickly the eyes and mind can work…..” For the online Rider Perception Challenge it is explained about the signs and situation tests that: “Both types of tests demonstrate how quickly your eyes and mind work together if you are attentive.”

The Leader’s Guide also provides an overview of the program as well as the administrative requirements. The guide lists the facility requirements and materials, provides facilitation tips and contains appendices that include Rider Perception Facts, an explanation about select slides used in the program, a Feedback Form and Sample News Release.

A typical classroom facility is needed to conduct the SSRP. A classroom should have tables with comfortable chairs where small groups of three to five participants may sit together (as opposed to desks in rows or theater-style seating). All participants must be able to clearly see the visual display and should not have their backs to the screen. Room lighting should be adjustable for the presentation of the visuals.

The core lesson plan materials consist of a compact disk (CD) that contains the four parts of the program. A computer is necessary to play the CD, which contains PowerPoint slides and the 10 tests. Specialized floor mats are used, and together with oversize playing cards make up a vision
challenge related to peripheral vision and central vision. A Participant Workbook is used and it contains several learner-centered activities to ensure participant interaction.

For a hazard perception experience, visit the MSF website (msf-usa.org) and click on Hazard Perception Challenge! It will give you a first-hand example of a type of hazard perception training and the connection to the executive functions of the brain.

SAFE MOTORCYCLIST AWARENESS AND RECOGNITION TRAINER
The Safe Motorcyclist Awareness and Recognition Trainer (SMART) is a training tool that provides simulated traffic experiences for a virtual riding environment. It combines a personal computer, computer generated traffic images and video monitor, plus a handlebar, seat, footrests and all the standard controls found on a real motorcycle. The combination of this specialized software with actual motorcycle controls makes it possible to navigate an on-screen motorcycle (or scooter) through various scenarios presenting the rider with real-world situations and hazards. The program will record the ride and provide feedback to the rider. The SMART is not a passive teaching device. It has a powerful playback feature that provides feedback regarding crashes or near crashes.

The purpose of the SMART is not to teach riders how to operate a motorcycle or acquire the feel of an actual motorcycle; rather the goal is to enhance a rider’s hazard perception capabilities. It works for all experience levels by providing opportunities to experience typical hazards that riders face in city streets, suburbs and open highways. The way a rider perceives and responds to situations is measured and evaluated electronically. The SMART software gives feedback on the results and allows self-assessment of decisions regarding perception to various situations, provides an evaluative rating for each, summarize the results and offers advice for safety improvement.

SMART provides a rich learning environment to help a rider develop hazard awareness and traffic-related perceptual skills. S.E.E. is developed two primary ways. One is with immediate feedback as a first-person crash is experienced on the screen; the other is with safety related dialogue between the rider and a qualified coach.

Each riding scenario lasts from five to ten minutes. At the conclusion of each scenario, a color print out provides information about specific situations and shows the results of rider actions. The rider’s results appear as a map, showing the route with indications of speed, turn signal use, lane position, braking and other data that may be used during the interactive debrief and coaching segment. Another important feature of each scenario is the replay function. A replay allows the rider’s performance to be reviewed either forward or backward, and from various points of view: hovering mode, bird mode, other-vehicle mode, sky mode, and rider viewpoint mode. The SMART can pause the replay at any point for further individualized feedback.

Besides learning specific hazard perception techniques, the SMART raises a rider’s awareness of the need for heightened attention and the importance of early identification of roadway and traffic factors that contribute to risk. A rider who experiences SMART learns the value of constant vigilance and how the mind must be constantly alert for possible risky situations.

SUMMARY
Preparing Riders to S.E.E. Better: MSF Tools for Improving Hazard Perception is about how the Motorcycle Safety Foundation (MSF) deals with hazard perception in its Rider Education and Training System programs. The purpose of this paper is to show how MSF has incorporated hazard perception training into its Rider Education and Training System, and to show details of the Street Smart – Rider Perception program.
The MSF develops and maintains high quality, research-based rider education and training curricula. Its mission focuses on quality rider education and training as well as maintaining a safe riding environment.

With the development of a comprehensive rider education and training system, the MSF has transcended simple skill-based training programs and has expanded into behavioral programs the target rider perception as a primary executive function that can lead to safe and enjoyable riding. Because MSF characterizes the riding task as more a skill of the eyes and mind than of the hands and feet, using the eyes well and using the brain to sort, organize and prioritize factors in the traffic environment is of integral importance for training programs.

The MSF will continue to develop programs to enhance rider safety. As new and more effective programs become available and as research demonstrates viable and effective programs, the MSF will embrace its programs and methods to improve and enhance its existing programs.

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Title: INFRASTRUCTURE SOLUTIONS TO IMPROVE PEDESTRIAN SAFETY

Presenting Author: Robert Carmel

Authors: V. Gitelman 1; D. Balasha 1; R. Carmel 1; L. Handel 1; F. Pesahov 1;

Affiliation
1. The Ran Naor Centre for Road Safety Research, Technion - Israel Institute of Technology, Haifa, Israel,

Abstract:
Pedestrians present more than a third of the fatalities and nine percent of total road accident injuries in Israel. The share of pedestrian fatalities out of the total road fatalities in Israel is higher than in most industrialized countries (according to OECD data). This finding and its over-time stability arouse concerns, especially when dealing with basic road safety indicators, e.g. fatality rate per population, which are relatively low in Israel in comparison with other countries, and decreasing general fatality and injury trends recently observed. The pedestrian safety problem is well known in many countries, where in the research and professional literature extensive data and knowledge have accumulated regarding the efficiency of various infrastructure and other treatments to deal with the problem. Thus, a comprehensive study was initiated aiming at:
(a) Characteristic and conducting a detailed analysis of pedestrian accidents in Israel, including international comparisons, detailed analyses on national statistics and development of accident typology;
(b) A diagnosis of infrastructure problems in a wide range of locations where high concentrations of pedestrian accidents were observed;
(c) Assembling a collection of proven and innovative infrastructure solutions from the international experience, and conducting an examination of their applicability and potential efficiency for local conditions.

A detailed analysis of pedestrian fatalities over the years 2003-2006 revealed that high proportions of these fatalities are associated with several accident patterns such as: an accident occurring not at a pedestrian crossing, on an urban street section (35% of fatalities); an accident on a dual-carriageway rural road section (16%); an accident at a pedestrian crossing on an urban junction (12%); an accident not at a pedestrian crossing on an urban junction (10%); an accident in an Arab town (9%).

To diagnose the infrastructure characteristics and deficiencies associated with pedestrian accidents, detailed field studies, observations and measurements were carried out at 95 locations with high accident frequencies. Among the accident locations, six categories of sites were recognized which are: pedestrian crossings at signalized intersections; pedestrian crossings at roundabouts; pedestrian crossings at non- signalized intersections; pedestrian crossings at “half-intersections” (without left turns); mid-block crossings; and street sections without crossings. The majority of sites are situated on arterial multi-lane streets belonging to city centres. Among typical safety problems observed on the sites were: high vehicle speeds on road sections; split crossings and long waiting times at signalized junctions; pedestrians crossing on red; visibility problems and missing pedestrian signs over the crossings. Besides, among the locations with high accident numbers some features were overrepresented such as roundabouts on multi-lane roads; non-signalized crossings situated near signalized junctions; a common phase for turning vehicles and pedestrians at signalized junctions.

Based on the literature study, a comprehensive classification of pedestrian safety related solutions was constructed. This includes about 80 measures, subdivided into six categories which are: physical arrangements for pedestrians on street sections; physical arrangements for pedestrians near mid-block crossings; along-street traffic arrangements; junctions’ design; traffic calming; and traffic control. For each measure, a summary of its safety efficiency was prepared, in terms of the associated pedestrian accident reduction, reduction in vehicle-pedestrian conflicts and/or vehicle
speeds. A potential applicability of each measure for local conditions was estimated based on an expert opinion survey.

Finally, a cross-checking between safety problems identified at pedestrian accident sites and appropriate infrastructure solutions was performed. The research findings showed that, on the one hand, pedestrian safety can be improved by increasing the use of known infrastructure solutions, and conversely, a need in examination of advanced infrastructure solutions which are accepted in other countries is indicated. However, in order to generate a significant change in the state of pedestrian injury in urban areas, a different approach is required, i.e. a transfer from a spot treatment to a systemic treatment of the problem. A systemic inquiry and transformation of the urban road network is required in order to diminish the areas of vehicle-pedestrian contacts and/or to significantly reduce the vehicle speeds in pedestrian presence and activity areas. The study recommended a list of infrastructure solutions for examination by controlled field experiments in Israeli conditions.
Title: THE PROFILE OF BYCICLE USER IN THE CITY OF JUIZ DE FORA - BRAZIL

Presenting Author: Jose Castanon

Authors: U. Castanon 1; M. P. S. Santos 1; R. Balassiano 1; J. A. B. Castanon 1;

Affiliation
1. Federal University of Rio de Janeiro, Rio de Janeiro, Brazil,

Abstract:
Juiz de Fora is a city located in Minas Gerais - Brazil, which has 513,348 inhabitants (2007), a fleet of 143,154 vehicles (2008) being considered the largest city in this region by the Brazilian Institute of Geography and Statistics - IBGE and comes facing problems related to transport, transit and land use. The city is mountainous, however, its main transit corridors are located in plain areas, as well as its center of activities.

This research aims to identify the bicycle user profile, knowing their socioeconomic characteristics and use of bicycles as means of transportation in order to use these data as a tool to aid in the development of public policy at the local level, encouraging the sustainable urban mobility, quality of life in the city and ensure a good quality of service to the user of public urban transportation system.

The number of trips made by bicycle between the junctions of the city is noticeably high, however, there are no studies to prove, through an appropriate methodology, such a situation. You can also see the volume of bicycles circling the city center, as a place of passage as on internal travel in the centre perimeter. Therefore, it is also objective of the research, conducting a survey of cycling trips in the city center, quantify and characterize these trips, to fit the user of this mode of transport as part of a significant demand for urban use, and understand the dynamics of relations between bicycles and other modes, motorized and non-motorized and the urban transportation structure.

We administered a questionnaire to users of bicycles with the ultimate goal to generate the necessary data as the condition of vehicles in circulation and the existence of security features, mandatory and provided by law, among others. The questionnaires application took place in a traditional approach, in the field, and via the Internet at website: http://www.bicicletas.ufjf.br, containing the same questionnaire applied in the field.

In addition, in the same website was available a poll for bike users or not, where the respondent should answer the question "Would you use a bicycle as his principal means of transport if there were in Juiz de Fora a secure infrastructure (bike lanes, bicycle parking, integration with public transport)?". We recorded 250 questionnaires, which were able to define some characteristics of current users. 89% of users are male, 89% have a monthly income equal to or less than US$1355, 50% of the bicycles have no signaling equipment required by law and 65% of users do not use any safety equipment. It was concluded also that the means of transport used during the week by respondents is the bicycle (50% of respondents) and then the collective public transport by bus (26% of respondents).

The last step of the questionnaire was designed to a brief survey of the perceived risk of bicycle users, based on the work of Yang Ti I in his work on the risk perception of cyclists with respect to the urban traffic in Rio de Janeiro.

The poll resulted in 84% of respondents saying they would use the bicycle as a principal means of transport in case of an adequate infrastructure of the city.
Thus, the research analyzes the feasibility of using the bicycle as a non-motorized vehicle capable of contributing to sustainable mobility, in large scale, from the integration of bicycle networks in the city of Juiz de Fora and its integration with other transportation modes. So we hope to contribute to replace the paradigms that govern our automobile society, with some urgency, by new paradigms of sustainable urban mobility.
Title: AGE-RELATED DIFFERENCES IN STREET-CROSSING SAFETY BEFORE AND AFTER OLDER PEDESTRIANS' TRAINING

Presenting Author: Viola Cavallo

Authors: V. Cavallo 1; A. Dommes 1; F. Vienne 2; I. Aillerie 2;

Affiliation
1. French National Institute for Transport and Safety Research (INRETS), Laboratory of Driver Psychology, Versailles, France, 2. French National Institute for Transport and Safety Research (INRETS), Laboratory for Road Operation, Perception, Simulators and Simulations INRETS-LCPC, Paris, France,

Abstract:
International accident statistics indicate that elderly pedestrians make up an extremely vulnerable road-user group. In France, more than half of all pedestrians killed on the road are over 65 years old, whereas this age group represents less than 15% of the population.
Past research has shown age-related difficulties in selecting safe gaps. More specifically, recent studies demonstrated an effect of the approaching car's speed on elderly adults' decisions: contrary to younger adults, who accepted constant time gaps, older pedestrians were found to accept shorter and shorter time gaps as the car's speed increased, putting them at a higher risk at high speeds. They also tended to miss many safe opportunities to cross in front of cars approaching at low speeds. These behaviors are thought to reflect age-related difficulties in processing information about the approaching car's speed and integrating that information into the decision-making process. With aging, distance gap seems to become the overriding parameter for deciding whether or not to cross.
Although for many seniors, walking is the major way of getting around, there are surprisingly no studies on improving the safety of elderly pedestrians through training. The present study was aimed at contributing to this issue. The objective was to develop and assess a behavior-training program aimed at enhancing the safety of elderly pedestrians via simulator-based training in street crossing.
To this end, twenty seniors (aged 65-83) were enrolled in a street-crossing training program. The training program promoted individual sensory-motor practice (via repeated practice on a simulator) and addressed elderly adults' ways of thinking about the task and the strategies they bring into play (via discussions, explicit feedback and instructions). Before the training, immediately after it, and 6 months later, the street-crossing decisions and behaviors of the older participants were assessed using a simulated street-crossing task. Twenty younger participants (aged 20-30) performed also the simulated task to serve as a baseline against which the street-crossing performance of the older trained group was compared.
The present study used an interactive street-crossing simulation device which included a portion of an experimental road (4.2 m wide, materialized on the ground), and a computer-generated visual scene with traffic approaching from one side. Participants were instructed to cross the experimental road when they judged it was safe to do so by walking at any pace but not running. Thanks to the interactive simulation, the participants could calibrate their perceptions of the approaching traffic with their actions. Traffic scenes were updated interactively by a movement-tracking system that recorded the participant’s positions via a cable attached to the participant’s waist.
The results showed that the training produced significant short- and long-term benefits and enhanced the overall safety of the older participants' street-crossing behavior. These findings suggest that combining repeated simulator-based street-crossing practice with enhanced awareness of street-crossing dangers can have a positive effect. When compared with younger participants, older pedestrians considerably improved their behavior so that no differences in safety-related indicators were observed any longer. However, the older participants’ ability to take the oncoming vehicle’s speed into account in their decisions did not improve with training.
to younger participants, older participants made more unsafe decisions when vehicles were approaching at high speeds than at low speeds. These age-related differences appeared before as well as 6 months after older street-crossing training. This finding may reflect age-related sensory or cognitive impairments that cannot be remedied by a simulator-based behavioral method. The results of this study stressed the importance of street-crossing training for seniors and provided a basis for developing future programs adapted to their difficulties. Further studies are required to identify the sensory, perceptual, and cognitive abilities involved in street-crossing decision-making. A better understanding of these skills would be useful in designing other training programs likely to improve the behavior of senior pedestrians.
Title: THE ROLE OF COGNITIVE, PERCEPTUAL AND MOTOR ABILITIES IN ELDERLY PEDESTRIANS' STREET-CROSSING DECISIONS

Presenting Author: Viola Cavallo

Authors: V. Cavallo 1; A. Dommes 1; I. Aillerie 2; F. Vienne 2;

Affiliation
1. INRETS-LPC, Versailles, France, 2. INRETS/LCPC-LEPSIS, Paris, France

Abstract:
In spite of improvements in infrastructure design, road crossing remains a highly difficult task for elderly pedestrians. Psychological research has highlighted their difficulties in selecting safe gaps and adopting sufficient safety margins, especially in complex traffic situations. More specifically, we have observed previously that the speed of the approaching vehicles strongly affected the elderly peoples' crossing decisions: whereas younger pedestrians chose constant time gaps independently of speed, elderly people were found to accept shorter and shorter time gaps as speed increased, putting them at a higher risk at high speeds. The elderly pedestrians also missed many safe opportunities to cross in front of cars approaching at low speeds. We explained these behaviours by the neglect of speed information and the preferred use of simplifying heuristics based on vehicle distance. The objective of the present study was to better understand the underlying age-related changes that lead to these behaviours, with a special focus on perceptual abilities. 20 young (20-30 years), 20 younger-old (61-70 years) and 20 older-old (71-83 years) participants took part in the experiment. All participants carried out a street-crossing task in a virtual environment displaying an urban scene with traffic coming from one side. They had to cross the experimental road when they judged that crossing between the approaching cars was safe. The time gap between the cars varied between 1 and 7 s. Five vehicle speeds between 30 and 70 km/h were simulated. The participants also completed a battery of tests. Regarding cognitive abilities we assessed flexibility (Plus-Minus), inhibition (Stroop), speed of processing and selective attention (UFOV part 3). With regard to perceptual abilities, we used a time-to-arrival estimation task as well as a speed discrimination task. Mean walking speed was also measured for as an indicator of motor ability. In line with earlier findings, the participants’ age significantly influenced the street-crossing decisions when vehicle speed was high (70 km/h): whereas young pedestrians made almost no unsafe decisions, about a fourth of the decisions of younger-old and older-old pedestrians were unsafe. No age effect was observed concerning the rate of missed opportunities at low speeds (30 km/h). As regards cognitive abilities, the younger participants obtained significantly higher scores as elderly participants in flexibility, inhibition and UFOV tests. We also noted significant age-related effects in perceptual performance measures: younger participants discriminated speeds faster and gave more correct answers. Time-to-arrival estimates were less influenced by the speed of the approaching cars in younger than in elderly participants. Finally, younger pedestrians walked faster (1 m/s) than elderly pedestrians (0.9 m/s). Step by step ascending multiple regression analyses were used to examine for each age group the influence of cognitive, perceptual and motor abilities on street crossing behaviour. The two aspects of street-crossing behaviour to be predicted were unsafe decisions at 70 km/h and missed opportunities at 30 km/h. The predictors were the cognitive, perceptual and motor abilities mentioned above. The results of the hierarchical regression analysis showed various patterns for the three age groups suggesting that the behaviour-determining abilities differed according to age. In young pedestrians, none of the considered abilities predicted unsafe decisions at high speeds. 20 % of the variance of missed opportunities at low speeds was explained by the capacity of estimating time-to-arrival. The younger-old pedestrians’ unsafe decisions at high speeds were predicted (42 % of variance) by their ability of discriminating high speed and UFOV performance. Missed opportunities at low speeds were predicted (55 %) by low speed discrimination, flexibility and inhibition. In older-old pedestrians, only walking speed predicted unsafe decisions at high speeds (25 % of variance).
Low speed discrimination predicted missed opportunities at low speeds (43 % of variance). As a whole, these findings indicate that perceptual abilities play an important role in street-crossing behaviour. With regard to unsafe decisions, the decline in perceptual abilities was determinant in early aging, whereas declining motor abilities became more decisive when age was increasing further. Concerning missed opportunities, perceptual abilities accounted for a significant part of the variance in all age groups.

By pointing out the abilities that influence street-crossing behaviour, the present study provides insight into the source of age-related risky decisions and indicates ways for implementing effective countermeasures.
Title: CHARACTERIZING ILLEGAL MID-BLOCK PEDESTRIAN CROSSINGS IN CHINA

Presenting Author: Christopher Cherry

Authors: C.R. Cherry 1; S.E. Moore 1;

Affiliation
1. Civil and Environmental Engineering, University of Tennessee, Knoxville TN, USA,

Abstract:
China has experienced major growth and expansion in the last few decades. This massive economic growth brings its share of challenges in the transportation sector; including congestion, reduced air quality, and safety, to name a few. With rising motorization, many pedestrians are coming into conflict with automobiles and pedestrians currently bear a large proportion of the fatality burden. One of the current challenges is accommodating pedestrians by providing a walkable environment along major transportation corridors. Many legal crosswalks in China are spaced hundreds of meters apart, forcing pedestrians to walk excessive lengths or make dangerous and illegal mid-block crossings to cross the major street. Besides being dangerous, this behavior negatively impacts traffic, worsening China’s congestion challenges. Illegal mid-block crossings cause longer travel times, queuing traffic, minor rear-end accidents and in the worst case, pedestrian harm. One of the primary goals of the research described in this paper is to characterize crossing behaviors, primarily the distance that a pedestrian is not willing to travel to cross legally, implying a minimum distance to a legal crossing that are required for them to cross legally. This study tracked 450 pedestrians via video cameras on two geometrically different roadways in Kunming, China to determine their crossing behaviors. The observed roads were busy urban arterials with lengths between crosswalks of 420m and 240m and widths of 31m and 23m, respectively. Several measures were observed, including the ratio of the distance actually traveled to the legal crossing distance, gap acceptance, vehicle density when crossing. The observations indicate that pedestrians tend to cross to save both time and distance as expected. Interestingly, many pedestrians cross illegally when a gap is available, with little or no walk distance savings, implying the travel time savings outweighs the perceived safety risk.

Higher flows of traffic on a roadway discourage a pedestrian to cross illegally to save time but not necessarily distance. This can also be seen with wider cross-sectional widths of roadways. The wider the roadway, the less likely a pedestrian is to cross illegally to save time. This study also investigated accepted gaps between vehicles in adjacent lanes and showed that the 85th percentile of pedestrians felt comfortable crossing a lane illegally when a gap of 11 seconds was available from the time a pedestrian enters the lane to the time an oncoming vehicle passes their path of travel.

China’s superblock urban development pattern is often suggested to be hostile to pedestrian activity and network connectivity. One of the negative outcomes is an abundance of illegal mid-block crossings, outside of designated crosswalks. In wide cross sections pedestrians often are stranded between lanes of moving vehicles creating hazardous situations. This research begins to characterize illegal pedestrian crossings and identify how different motivations for crossing imply different countermeasures. A few solutions include: increasing frequency for pedestrians to cross at legal crossings by shortening the signal cycle length, adding a mid-block crosswalk, increasing enforcement to deter pedestrians from crossing illegally, and also educating pedestrians so that they know the potential dangers and consequences for crossing a roadway illegally. Engineering countermeasures must be coupled with increased enforcement and education in order to be effective and ultimately improve the safety of the transportation system.
Title: STRATEGIES TO REDUCE INTERSECTION CONFLICTS BETWEEN AUTOMOBILES AND BIKES IN CHINA

Presenting Author: Christopher Cherry

Authors: C.R. Cherry 1; T.Q. Hill 2;

Affiliation
1. Civil and Environmental Engineering, University of Tennessee, Knoxville TN, USA, 2. Center for Transportation Research, University of Tennessee, Suite 900 James K Polk Building, 505 Deaderick St. Nashville, TN, USA,

Abstract:
With an ever-expanding population and rapid modernization, China is faced with transportation related problems that are both familiar and foreign to the rest of the industrialized world. There is also a large increase in rural-urban migration, resulting in large income disparities and thus diverse transportation needs. While a small but growing percentage of the urban population is adopting automobiles, there are still many people who rely on two-wheel transportation. Engineers and planners in many of the urban cities in China are facing challenges resulting from an increase in the number of conflicts between various transportation modes including bicycles, electric bicycles, buses, cars, and pedestrians. This paper examines reasonable operational and geometric measures that could be taken to reduce the number of conflicts between cars and VRU’s at intersections using microsimulation, with a primary focus of reducing right turning vehicle conflicts with heavy through two-wheeler (bicycles and electric bikes) flows in adjacent bicycle lanes and crossing pedestrians. To test different configurations, representative intersections in Kunming, China are analyzed. The unique traffic flows and geometric layout at three representative intersection resulted in various alternatives being applied at each intersection. Those alternatives include signal phase changes such as staggered green phases and separate bicycle phasing. Geometric changes are also modeled, such as the addition of turn lanes that allow cars to weave through bicycle traffic upstream of the intersection, which could reduce the intensity of and angle of the conflict at a single point at the intersection.

There are four main operational parameters for the evaluation of the existing conditions and the alternatives; speed, delay, queue lengths, and travel times. Each alternative is compared with the existing conditions to determine their effectiveness of reducing conflict while quantifying their impact on traffic flow parameters for all road users. The addition of right-turn lanes, which does little to decrease net conflicts relative to other alternatives, yielded the shortest queue lengths, delay, and average travel times, particularly at oversaturated intersections. Although the total conflicts are not reduced, this strategy reduces the intensity of conflicts, transferring the conflict point upstream from the intersection where bike density is significantly lower. This design does not significantly reduce conflicts with pedestrians. Separating bicycle and pedestrian and car signal phases, or giving different road users a staggered start is meant to reduce the conflicts of the densest platoons of vehicles at the beginning of the green phase. This design eliminates or greatly reduces conflict between cars, bikes, and pedestrians, but proved to increase delay for most road users, primarily because of the oversaturated nature of most intersections during peak periods.

These findings can be generalized to show that staggered phasing of green start times for different road users (and enforcing no right-on-red rules) greatly reduced conflicts, but significantly increased delay and queue length at oversaturated intersections. In areas where right-of-way exists, transitioning right turning vehicles through bicycle lanes upstream of the intersection reduced the intensity of conflicts at the intersection, while maintaining sufficient operational performance of the intersection. This strategy does not however reduce the number or nature of conflicts between right turning cars and pedestrians. As more personal cars fill China's urban
streets, the conflict between VRU’s and cars intensifies. This research aims to reduce one of the most significant conflicts, those between VRU’s and right turning vehicles at intersections and finds several strategies can be effective depending on design and operational constraints at the intersection.
Title: CROSSWALKS AT ROUNDABOUTS - EFFECTS OF PEDESTRIAN GUARD RAILS ON UTILIZATION

Presenting Author: Ariel Cohen

Authors: A. Cohen 1; A. Ronen 2; H. Bar-Gera 2; Y. Parmet 2;

Affiliation
1. The Unit of Management and Safety Engineering, Ben-Gurion University of the Negev, Israel, 2. Dept. of Industrial Engineering and Management, Ben-Gurion University of the Negev, Israel,

Abstract:
General background: Pedestrian injury is one of main concerns in road safety (Hamed, 2001; Gandhi & Trivedi, 2007; Retting, Ferguson & McCartt, 2003; Sispoku & Akin, 2003). After drivers and passengers, pedestrians are the largest group of road users killed or injured in traffic accidents (Johnston & Pearce, 2007).

One of the main areas where pedestrians are the most vulnerable is road crossing. In Israel, many crossroads do not give precedence to pedestrians, making road crossing distressing and dangerous (Cohen, 2008). One method of reducing accidents is turning crossroads into roundabouts, forcing drivers to adjust their speed. This reduces accidents involving pedestrians by about 75% (Sze & Wond, 2007). Roundabouts have become common in Israel in recent years. Beer-Sheva, Israel’s sixth largest city (over 200,000 residents), has 122 roundabouts. At roundabouts, pedestrians usually cross at crosswalks on the roads (arms) of the roundabout usually with guard rails along the sidewalks. In Israel, there are no guidelines to determine the need and the length of guard rails at roundabouts.

The rate of pedestrian accidents on road sections with guard rails is generally significantly lower than in places without guard rails (Retting et al., 2003; Zhang, Hill & McDonald, 2007). The guard rails direct the pedestrians to safe crossing areas (Retting et al., 2003).

The goal of this research is to examine the effects of guard rails at roundabouts and the conflicts that may arise. For that purpose we classified urban roundabouts using factors such as: the number of crosswalks on the arms and the existence of guard rails on the various arms. Then we examined pedestrian behavior at crosswalks at representative roundabouts and checked the influence of guard rails on their behavior.

Method: In the first stage of the study, we systematically analyzed all 122 roundabouts in Beer-Sheva. The following factors were used to classify roundabouts: presence or absence and number of crosswalks, volume of traffic entering the roundabout (according to the Beer-Sheva urban travel model, 2005), width and number of lanes entering and leaving the roundabout and within the roundabout, presence or absence of pedestrian guard rails and pedestrian central crossing refuge. The second stage of the study was an observation of ten representative roundabouts (7 of them in Beer-Sheva), with each observation studying two arms with over 60 pedestrians crossing per hour. Each arm was observed three times for one hour each, and the number of pedestrians crossing at the crosswalk or elsewhere was counted. Other factors noted: the presence or absence of guard rails (their length and position), the type of road entering the roundabout (one or two lanes, with or without central separation barrier) and conflicts resulting from the presence or absence of guard rails near the crosswalks. Overall the study included 20 arms and 60 hours of observation.

Results: An analysis of the roundabouts in the first stage showed that over 70% of the arms leading to roundabouts have two crosswalks (with separation between the entering and leaving lanes, where pedestrians can safely stop during their crossing). In 91% of roundabouts there were guard rails on all the arms. In 85% of roundabouts, drivers cannot turn right freely on all the arms
without entering the roundabout.
The observation in the second stage included typical roundabouts, with 80% having pedestrian guard rails on the sidewalk, and 80% had no direct right turn. The percentage of pedestrians not crossing on the crosswalks was between 9%–76%. This variance can be explained by the volume of traffic, the presence or absence of guard rails, the structure and the view of the road surrounding. Where there was no guard rail and no central separation between lanes, many pedestrians crossed without using the crosswalks keeping their original walking route. Analysis of the observation revealed that high traffic volumes cause more pedestrians to use the crosswalk. The guard rails seem to lead the majority of pedestrians to cross at the crosswalks relatively to sidewalks without guard rails. Few conflicts were found concerning pedestrian crossing around roundabouts: Pedestrians walking on the road alongside the guard rails and diagonal crossing outside the crosswalk.
Title: AN OVERVIEW OF THE FLORIDA TRAFFIC AND BICYCLE SAFETY EDUCATION PROGRAM

Presenting Author: Daniel Connaughton

Authors: D. P. Connaughton 1,2,3,4; J. B. Egberts 1,2,3,4;

Affiliation

Abstract:
In 2008, the state of Florida led the United States in the number of bicyclists killed in traffic crashes (National Highway Traffic Safety Administration, 2009). Funded by the Florida Department of Transportation’s (FDOT) Safety Office, the primary goal of the Florida Traffic and Bicycle Safety Education Program (FTBSEP) is to reduce injuries and fatalities by teaching children the knowledge and skills needed to be predictable and competent pedestrians and bicyclists throughout their lives. The program works with Safe Routes to School programs throughout Florida and ties in with the goals of the FDOT’s Pedestrian/Bicycle Program. The Florida Department of Education recently published the Next Generation Sunshine State Standards (2008) that require physical education teachers to teach specific skills related to traffic and bicycle safety to students in kindergarten through fifth grade levels. The FTBSEP provides statewide training workshops that “teach the teachers” about traffic and bicycle safety so that they can, in turn, teach their students. The FTBSEP also trains law enforcement personnel, recreation leaders, and bicycle safety advocates to teach bicycle safety in their local communities. Workshop participants receive not only pedestrian and bicycle safety training, but also receive educational materials that can be utilized for teaching in their schools and community. Using specifically designed, comprehensive curriculums for elementary, middle, and high schools, the FTBSEP training programs address several important pedestrian and bicycle safety topics including, but not limited to: stop and search, visual barriers, safely crossing the road, traffic signals, school bus safety, helmet importance and correct use, bicycle safety inspection, identifying and avoiding road hazards, traffic and bicycle laws, and sharing the road. Each lesson of the curriculum includes estimated time required, learning objectives, materials/equipment needed, background information, activity description, discussion topics and questions, and additional references. The curriculum also includes activities for physically/mentally challenged individuals, activity worksheets, videos, interactive software and DVDs, and a comprehensive equipment and resource contact list. Additionally, the training workshops include outside, on-bicycle skill instruction and practice. To further assist schools and communities the FTBSEP also provides a mini-grant program in which schools, communities, safety coalitions, and others can apply for funds which can be utilized to purchase new pedestrian/bicycle safety training equipment, maintain existing equipment, and/or for substitute teachers so the regular teachers can attend a training workshop. Given that the FTBSEP’s services are offered statewide, the program utilizes Regional Trainers throughout Florida to assist with, or conduct, workshops in their area. Future program plans include developing a university curriculum to educate college students about traffic and bicycle safety. This presentation will provide an overview of the FTBSEP, curricula, and training materials.
Title: AN ANALYSIS OF FLORIDA PHYSICAL EDUCATION TEACHER’S KNOWLEDGE OF FLORIDA BICYCLE LAWS

Presenting Author: Daniel Connaughton

Authors: D. P. Connaughton 1,2,3,4; J. J. Zhang 2,3,4; J. B. Egberts 1,2,3,4; L. Jin 2,3,4;

Affiliation

Abstract:
According to the National Highway Traffic Safety Administration (2009), in 2008, the state of Florida led the United States in the number of bicyclists killed in traffic crashes. The mission of the Florida Traffic and Bicycle Safety Education Program (FTBSEP) is to reduce injuries and fatalities by training children with the knowledge and skills needed to be predictable and competent bicyclists throughout their lives. The FTBSEP provides statewide training workshops that “teach the teachers” about pedestrian and bicycle safety so that they can, in turn, teach their students. Recently, the Florida Department of Education (2008) published the Next Generation Sunshine State Standards that require physical education teachers to teach specific cognitive skills related to pedestrian and bicycle safety to students in kindergarten through fifth grade levels. Several of these safety-related skills, such as helmet use and signaling when bicycling, are also requirements under Florida law. Using specifically designed curriculums for elementary, middle, and high schools, the FTBSEP has developed and provides educational training programs to address several important pedestrian and bicycle safety topics including relevant aspects of the Florida Uniform Traffic Control Law and specific state of Florida bicycle regulations. Educational programs for training physical education teachers on bicycle safety topics are frequently offered in various sites and occasions throughout the state. The purpose of this study was to assess Florida physical education teacher’s knowledge of Florida bicycle laws and the impact of knowledge level on the teacher’s instructional coverage of the related safety issues. Through a comprehensive review of the literature, test of content validity by a panel of experts, and a pilot test, a survey form was developed with 17 items that measured knowledge of Florida bicycle laws. Each item was phrased into a true or false statement, with an optional answer of unsure. Additionally, socio-demographic variables were included in the survey form for sample description purposes. After obtaining Institutional Review Board approval, research participants (N = 90) were recruited from a state physical education teacher conference who voluntarily completed the survey. Regression analyses revealed that attending formal bicycle safety education training and having taught bicycle safety in the school were positively (p < .05) related to the level of knowledge of Florida bicycle laws. This suggests that the educational programs for training physical education teachers on bicycle safety topics were overall functional and effective, and using the learned knowledge in instructional activities also reinforced the cognitive concepts of Florida bicycle laws. How often they rode a bicycle was not significantly (p > .05) related to the level of knowledge of Florida bicycle laws, indicating that bicycle riding alone was inadequate in learning Florida bicycle laws. Furthermore, descriptive statistics and ANOVA revealed that the level of knowledge of Florida bicycle laws was positively (p < .05) related to age, indicating that older teachers were more knowledgeable of Florida bicycle laws. Descriptive statistics and ANOVA also revealed that the level of knowledge of Florida bicycle laws was not significantly (p > .05) related to gender, indicating that physical education teachers of both genders had similar levels of knowledge of Florida bicycle laws and a non-differential educational program would be effective for both genders of physical education teachers. In general, these findings have further emphasized the importance of bicycle safety training in educating physical education teachers on bicycle laws.
Title: INVESTIGATING RISK COMPENSATION THEORY IN CYCLISTS: RESULTS FROM INTELLIGENT VIDEO ANALYSIS SYSTEM

Presenting Author: Aymery Constant

Authors: A. Constant 1; A. Messiah 1; M.-L. Felonneau 2; E. Lagarde 1;

Affiliation
1. Institut national de la santé et de la recherche médicale Unité 897, Equipe Prévention et Prise en Charge des Traumatismes (Injury Control and Prevention), Bordeaux, France, 2. Université Victor Segalen Bordeaux 2, Laboratoire de psychologie EA4139, Bordeaux, France,

Abstract:
Background: Head and brain injuries account for most fatalities and disabilities among cyclists. Encouraging helmet use might be of interest to improve safety, but it is challenged by some researchers stating that it might have negative consequences. Risk compensation theory postulates that the likelihood of being involved in a crash is higher among helmeted cyclists as compared with others, because they feel safer and consequently take more risk. In the absence of robust data on cyclist's behaviours, sound evidence of risk compensation is missing. The aim of the present study is to assess risk behaviours in urban cyclists by helmet-use status, using an innovative on-site observation technology.

Method: An Intelligent Video Analysis System (IVAS) was positioned in a one-way street of Bordeaux (France) with heavy motorized and cycling traffic, but no cycle lane. Cyclists were observed through an Internet Protocol (IP) camera placed in height and implemented with specific Image Analysis Softwares. This IP camera is programmed to detect moving objects, in particular cyclists. It computes quantitative behavioural measures such as speed, and is able to detect the use of sidewalk. A second synchronized camera takes pictures of each detected cyclist; pictures are used to collect other data such as cyclist's gender, helmet use, and red light infringement. Information collected by cameras is sent to a central server located in our settings and coded in a database by a trained video coder. Sport and child cyclists were not included in the current study. The study protocol was approved by the French national review board.

Results: During a 4-month observation period, 10 126 cyclist sequences were video-captured and analyzed (Males= 53%). Helmet use was observed in 6% of cases (8% among men and 4% among women). One sequence out of five was detected on the sidewalk. The use of sidewalks was more frequent in helmet non-users (21%) as compared to users (12%, p<0.001). Among those riding on the road (N=8109), mean average speed was estimated at 18 kilometers per hour (SD: 5). Among men, helmet users ran faster than non users (20 vs. 17 km/h, p<0.001). Among women, by contrast, there was no speed difference by helmet use (16.1 vs. 16.2 km/h, p>0.05). Men ran faster than women (19 vs. 16 km/h, p<0.001). When traffic light was red (N=3814), infringements were observed in 60% of cases. Red light infringements were more frequent among men (65%) than women (54%, p<0.001), with no difference by helmet use.

Discussion: These findings suggest that risk behaviours are frequent among urban cyclists, while helmet use is rare. They are compatible with the hypothesis of risk compensation among men, but not among women. Non-helmeted cyclists are more likely to avoid motorized traffic by using the sidewalks, but this behaviour can lead to risky situations with others vulnerable road users, especially pedestrians. Further studies are required to elicit and prevent possible negative consequences of mandatory helmet use; for example, the possibility and direction of a causal relationship between speed and helmet use among men remains to be determined. By collecting vast amounts of reliable information on cyclists during their daily trips, IVAS might prove to be a valuable tool to improve prevention toward vulnerable road users.
Title: WHY DO CAR DRIVERS PULL OUT IN FRONT OF MOTORCYCLISTS AT T-JUNCTIONS?

Presenting Author: David Crundall

Authors: D. Crundall 1; E. Crundall 1; D. Clarke 1; A. Shahar 1

Affiliation
1. Accident Research Unit, School of Psychology, University of Nottingham, Nottingham, UK

Abstract:
The most prevalent motorcycle crash on UK roads is actually the fault of the other road user: usually a car driver who pulls out of a side road onto a main carriageway into the path of an approaching motorcycle with right-of-way. Drivers often report looking but failing to see (i.e. perceive) the approaching motorcycle (a Look But Fail To See error). However it is also possible that drivers simply fail to look in the appropriate places, or that they look and indeed perceive the approaching motorcycle, but then incorrectly appraise the level of risk (i.e. time-to-contact) that it poses. To test these hypotheses we created a series of dynamic film stimuli consisting of a car approaching a t-junction. Participants were asked to press a button to indicate when they felt it was safe to turn at the junction (while at the same time monitoring the clips for any hazards). These clips contained either a conflicting car or motorcycle approaching the junction on the main carriageway from the left or right, or no conflicting vehicle was present. These clips were created by filming from a moving vehicle with 6 cameras (3 forward facing cameras taking a near 180 degree forward view, and three rear facing cameras recording the information that would normally be available in the three mirrors. The mirror information was inset into a combined forward view which was presented across three 40 inch screens, which allowed participants to look both left and right at junctions before making a decision.

Three groups of drivers participated in the task (total N = 74): novice drivers, experienced drivers and dual drivers (those who had both a driver’s license and motorcycle license). While they took part in the study their eye movements were monitored along with their response times reflecting when they decided to pull out into the junction. Eye movement analysis revealed differences between the three driver groups and according to whether there was an approaching car or motorcycle, or no approaching vehicle. Specifically dual drivers were more likely to look further down the road than novice drivers (with experienced drivers falling somewhere in between). Further analyses, including the time taken to detect the approaching vehicle, the length of gaze durations upon the approaching vehicle, and their relationship with the participants’ response times are currently ongoing. The results will identify the extent to which the different factors contribute to these typical junction accidents: whether looking (failure to scan and spot); perceiving (reflected in shorter, inconsequential gazes upon target) or inappropriate appraisal (reflected in early button presses despite looking and perceiving the motorcycle) are equally likely to result in such Look But Fail To See errors, or whether these errors truly are the sole preserve of problems in perceiving the motorcycle. Once the true cause of LBFTS accidents at T-junctions is identified, the causes can be tackled with appropriate interventions including targeted marketing campaigns and training interventions.
Title: FATALITY RISK IN MOTORCYCLE COLLISIONS WITH ROADSIDE OBJECTS IN THE UNITED STATES

Presenting Author: Allison Daniello

Authors: A. L. Daniello 1; H. C. Gabler 1

Affiliation
1. School of Biomedical Engineering and Sciences, Virginia Polytechnic Institute, Blacksburg, VA, USA

Abstract:
Motorcycle crashes often contain more than one impact event, typically involving a collision with the ground or another object. The objective of this study is to determine the fatality risk in multi-event crashes where a motorcyclist collides with both a roadside object and the ground. The roadside objects analyzed include guardrails, concrete barriers, signs, utility poles, and trees. The Fatality Analysis Reporting System (FARS) database was used in conjunction with the General Estimates System (GES) to analyze fatality risk motorcycle crashes from 2004-2008. The analysis was based upon over 4,900 fatal motorcycle crashes with roadside objects.

Five independent methods were used to determine if the collision with a roadside object is typically more harmful to a motorcyclist than a collision with the ground. The first three methods analyzed the fatality risk for roadside object crashes based on different metrics. Fatality risk was computed by dividing the number of fatal crashes (from FARS) by the total number of crashes (from GES). First, the fatality risk was computed based on the number of crash events as given in the sequence of events. This metric was examined for all crashes as well as only crashes that involved at least one collision with a roadside object. Next, fatality risk was computed for all multi-event collisions including both a roadside object and ground collision since both events did not occur in all crashes. The third method directly compared risk in collisions with roadside objects to collisions with the ground by computing the relative fatality risk of each roadside object collision to a ground collision.

The final two methods addressed the question of which event was most likely to be designated as the most harmful event under given crash conditions. The severity of roadside objects collisions was compared to that of ground collisions through an analysis of the distribution of the most harmful event for fatal, multi-event crashes involving at least one roadside object. Next, fatal crashes involving collisions with both a roadside object and the ground were analyzed to demonstrate which event is more harmful to motorcyclists.

Collisions with roadside objects were found to have a higher fatality risk than collisions with either the ground. Motorcycle collisions with guardrail were 8.0 times more likely to be fatal than overturn collisions while collisions with trees were 16.3 times more likely to be fatal than overturn collisions. In contrast, motorcycle collisions with passenger vehicles were only 2.8 times more likely to be fatal than overturn collisions. Additionally, the roadside object was reported as the most harmful event in the majority of the crashes in fatal multi-event crashes involving a roadside object. In crashes involving a roadside object and a collision with the ground, the roadside object was again most often reported as being the most harmful event during the crash in fatal crashes. The relative fatality risk for guardrail-, concrete barrier-, and signage-overturn collisions as compared to single event overturn collisions was greater than the relative fatality risk of these crashes compared to single-event roadside object crashes.
Title: VULNERABLE ROAD USER SAFETY AT ROUNDABOUTS: EMPIRICAL RESULTS

Presenting Author: Stijn Daniels

Authors: S. Daniels 1; T. Brijs 1; E. Nuyts 2; G. Wets 1

Affiliation
1. Hasselt University - Transportation Research Institute, Belgium, 2. PHL University College

Abstract:
This paper presents the results of recent research on safety for different types of road users at roundabouts. In general, roundabouts are believed to be safe and smooth intersection types. The conversion of an intersection into a roundabout has been proven to reduce the number of crashes with injuries or fatalities. Nevertheless, some doubts persist about the safety effects for vulnerable road users, in particular for bicyclists.

Regression models were developed in order to explain variations in crash counts among roundabouts. Data on injuries, traffic volumes and roundabout geometry were collected. The results show that the variation in accident counts is relatively small and mainly driven by the traffic exposure. Confirmation was found for the existence of a “safety in numbers”-effect for bicyclists, moped riders and – more uncertain – for pedestrians at roundabouts. Vulnerable road users (moped riders, motorcyclists, bicyclists and pedestrians) are more often involved in injury crashes at roundabouts than could be expected based on their presence in traffic. Moped riders and motorcyclists are overrepresented in single-vehicle crashes whereas moped riders and bicyclists are overrepresented in multiple-vehicle crashes.

A before-and-after study of injury accidents with bicyclists on 90 roundabouts in Flanders-Belgium was carried out. The study design accounted for effects of general safety trends and regression-to-the-mean. Conversions of intersections into roundabouts turned out to have caused a significant increase of 27% in the number of injury accidents with bicyclists on or nearby the roundabouts. The increase was even higher for accidents involving fatal or serious injuries (41-46%). Roundabouts with cycle lanes close to the roadway appeared to perform significantly worse compared to other design types. Also roundabouts that were replacing signal-controlled intersections had a worse evolution compared to roundabouts on other types of intersections.

1. INTRODUCTION

Although roundabouts exist almost as long as cars do, they only became common in continental Europe during the 80’s and the 90’s of the twentieth century. In North America they even emerged only recently. Knowledge and insights on traffic operations and safety on roundabouts have evolved considerably. Roundabouts have some intrinsic properties that are believed to improve traffic safety when they are constructed: they reduce speeds considerably and they decrease the number of possible conflict points between road users. Apart from their effects on traffic safety, roundabouts are considered to be adequate intersection types for accommodating high traffic flows, particularly in case of high quantities of left turning traffic.

Nevertheless some uncertainties still exist on the safety effects of roundabouts. Particularly for bicyclists and pedestrians the effects are less clear. Also the effects of some design elements are not yet fully understood. These elements justified the execution of different analyses as a part of a PHD project on safety issues at roundabouts. This paper briefly explains some of the most important findings in this PHD project, related to vulnerable road users. It starts with an overview of the collected data. The performed analyses are subsequently explained and conclusions are derived and briefly discussed. The paper finishes with some policy recommendations and some recommendations for further research.
2. DATA COLLECTION

Information was collected in two phases on a sample of 148 roundabouts departing from an initial dataset of 90 roundabouts. All those locations were on regional roads in Flanders-Belgium (i.e. roads that are owned by the Roads and Traffic Agency). The initial dataset was retrieved from the Roads and Traffic Agency and consisted of information on the location of the roundabout and the year of construction. Additionally acquired data included geometric variables, traffic volumes and crash data. Each roundabout in the sample was visited and photographed, traffic counts were executed and geometric data were collected on the spot. The collected variables are listed in 0.

Traffic volume data were collected as follows: at each examined roundabout all entering traffic was counted by one or two observers during 1 h by day (between 8:00 and 18:00). Traffic modes were classified in light vehicles, heavy vehicles, motorcycles, mopeds, bicycles and pedestrians. Light vehicles comprised mainly private cars, but also minibuses and all kinds of vans. Heavy vehicles were trucks, trailers, busses and tractors. Calibration counts were held on two roundabouts during one day (08:00–18:00). The results of the calibration counts were used to calculate adjustment factors that brought all the hourly traffic counts to a common 10 h (08:00–18:00) level. Subsequently, the counts for private cars, heavy vehicles and motorcycles were added up in order to estimate a value for the Average Daily Traffic (ADT), representing the motorized, fast traffic. The calculated ADT-values thus represent the traffic volume during a daytime period of 10 hours. It was assumed that the derived value for the 10h daytime traffic was a valid indicator for the relative 24 h traffic volume for each location, i.e. for the locations compared with each other. Differently stated, this means that it was assumed that the proportion of daytime or night time traffic in the total traffic at the observed locations was more or less constant. This assumption is justified by the fact that the share of daytime traffic between 8:00 and 18:00 in the total daily (24 hour) traffic on locations were extensive traffic volume data are available for, i.e. segments of regional N-roads, is 61.35%, with a standard deviation of only 2.33% (AWV, 2008). No particular reason seems to exist why this share and standard deviation would be different at roundabouts. Although the inference of ADT-values from counts during one hour brought an amount of uncertainty in the analyses, this approach enabled to obtain a useful classification of the sample of roundabouts according to their traffic volume (see 0).

The 148 roundabout locations were localised and geo-coded in Google Earth. Subsequently the roundabout data were linked in a geographical information system (ArcMap) with the geo-referenced crash data (available from Statistics Belgium) for the period 1996-2005. All crashes within a distance of 100 meters of the centre of the roundabout were included in the dataset. After subtraction of the crashes that occurred before the roundabouts were constructed, the dataset consisted of 1491 injury crashes.

Like in most European countries, the Belgian crash data distinct between 3 levels: crashes resulting in fatal injuries (at least someone in the crash killed immediately or – as a consequence of the crash - within 30 days after the crash), crashes resulting in serious injuries (at least someone in the crash was seriously injured, i.e. in a hospital for at least 24 hours) and crashes with slight injuries (any type of injuries, but not belonging to one of the previous categories) (European Commission, 2006; FOD Economie, 2009).

Since the dataset was developed gradually throughout the project, the used dataset for the different analyses differs somewhat. The most extended database is represented in 0.

An important distinction was made according to the present cycle facilities at the roundabouts in the dataset. 4 types were distinguished: mixed traffic, cycle lanes close to the roadway, separate cycle paths and grade-separated cycle paths. The most basic solution is to treat bicyclists the same way as motorized road users, which means that bicycle traffic is mixed with motorized traffic and bicyclists use the same entry lane, carriageway and exit lane as other road users. This is called the mixed traffic solution. In many countries this is the standard design as no specific facilities for bicyclists are provided. A second possible type consists of cycle lanes next to the...
carriageway, but still within the roundabout. Those lanes are constructed on the outer side of the roundabout, around the carriageway. They are visually recognizable for all road users. They may be separated from the roadway by a road marking and/or a small physical element or a slight elevation. They may also be constructed in a different pavement or differently coloured (red, green, blue…). However the cycle lanes are essentially part of the roundabout because they are very close to it and because the maneuvers bicyclists have to make are basically the same as the maneuvers for motorized road users. When the distance between the cycle facility and the carriageway becomes somewhat larger (more than 1 meter), the cycle facility cannot be considered anymore as belonging to the roundabout. This is called the separate cycle path-solution. Finally, in a limited number of cases grade-separated roundabouts are constructed by constructing some small tunnels that enable bicyclists to cross under the roadway. The reader is referred to Daniels et al. (2009) for some illustrations and a more detailed subdivision and description of the different concepts of cycle facilities at roundabouts.

### Table 1 Explanatory variable description

<table>
<thead>
<tr>
<th>Variable (ABBREVIATION)</th>
<th>Nr. of observations</th>
<th>Descriptive statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inside the built-up area? (INSIDE) (1 = Yes; 0 = No, thus outside)</td>
<td>148</td>
<td>Yes: 55; No: 93</td>
</tr>
<tr>
<td>Central island min. 0.5 m raised? (ELEV) (1 = Yes; 0 = No)</td>
<td>148</td>
<td>Yes: 115; No: 33</td>
</tr>
<tr>
<td>Traversable truck apron present? (APRON) (1 = Yes; 0 = No)</td>
<td>148</td>
<td>Yes: 141; No: 7</td>
</tr>
<tr>
<td>Central island diameter (in meters) (CENTRDIAM)</td>
<td>148</td>
<td>Mean: 25.22; S.D.: 12.30</td>
</tr>
<tr>
<td>Inscribed circle diameter (in meters) (OUTDIAM)</td>
<td>148</td>
<td>Mean: 40.29; S.D.: 12.85</td>
</tr>
<tr>
<td>Number of legs (3LEG, 4LEG, 56LEG) (1 = Yes; 0 = No)</td>
<td>148</td>
<td>3-leg: 32; 4-leg:100; 5-or 6-leg: 16</td>
</tr>
<tr>
<td>Gated roadway through the central island? (EXCEPT) (1 = Yes; 0 = No)</td>
<td>148</td>
<td>Yes: 4; No: 144</td>
</tr>
<tr>
<td>Bypass present in some directions? (BYPASS) (1 = Yes; 0 = No)</td>
<td>148</td>
<td>Yes: 22; No: 126</td>
</tr>
<tr>
<td>Oval roundabout? (OVAL) (1 = Yes; 0 = No)</td>
<td>148</td>
<td>Yes: 8; No: 140</td>
</tr>
<tr>
<td>Two-lane roundabout? (TWOLANE) (1 = Yes; 0 = No, thus single-lane)</td>
<td>148</td>
<td>Yes: 15; No: 133</td>
</tr>
<tr>
<td>Road width on the roundabout (all lanes together, in meters) (ROADWIDTH)</td>
<td>133 15</td>
<td>Mean: 6.38 ; S.D.: 1.26 (single-lanes) Mean: 7.78 ; S.D.: 1.41 (two-lanes)</td>
</tr>
<tr>
<td>Construction year of the roundabout (YEAR)</td>
<td>148</td>
<td>Median: 1996; range [1990:2002]</td>
</tr>
<tr>
<td>Mixed Traffic? (MIXED) (1 = Yes; 0 = No)</td>
<td>148</td>
<td>Yes: 13; No: 135</td>
</tr>
<tr>
<td>Cycle lanes close to the roadway? (CYCLLANE) (1 = Yes; 0 = No)</td>
<td>148</td>
<td>Yes: 64; No: 84</td>
</tr>
</tbody>
</table>
Variable (ABBREVIATION) | Nr. of observations | Descriptive statistics
--- | --- | ---
Cycle paths, separated from the roadway? (CYCLPATH) (1 = Yes; 0 = No) | 148 | Yes: 66; No: 82
Grade-separated cycle facilities? (GRADESEP) (1 = Yes; 0 = No) | 148 | Yes: 4; No: 144
Sidewalk present around the roundabout? (SIDEWALK) (1 = Yes; 0 = No) | 148 | Yes: 71; No: 77
Zebra markings present on exit/entry lanes? (ZEBRA) (1 = Yes; 0 = No) | 148 | Yes: 75; No: 73
Signal-controlled intersection before roundabout was constructed? (SIGNAL) (1= YES, 0= No) | 90 | Yes: 21; No: 69

**Table 2** Traffic volumes for different road user types

<table>
<thead>
<tr>
<th>Variable (ABBREVIATION)</th>
<th>Nr. of observations</th>
<th>Descriptive statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nr. of pedestrians 8:00-18:00 (PED)</td>
<td>148</td>
<td>Mean: 246; S.D.: 645</td>
</tr>
<tr>
<td>Nr. of bicyclists 8:00-18:00 (BIC)</td>
<td>148</td>
<td>Mean: 470; S.D.: 765</td>
</tr>
<tr>
<td>Nr. of mopeds 8:00-18:00 (MOP)</td>
<td>148</td>
<td>Mean: 76; S.D.: 108</td>
</tr>
<tr>
<td>Nr. of motorcycles 8:00-18:00 (MCY)</td>
<td>148</td>
<td>Mean: 98; S.D.: 260</td>
</tr>
<tr>
<td>Nr. of light vehicles 8:00-18:00 (LGT)</td>
<td>148</td>
<td>Mean: 11627; S.D.: 5818</td>
</tr>
<tr>
<td>Nr. of heavy vehicles 8:00-18:00 (HVY)</td>
<td>148</td>
<td>Mean: 1155; S.D.: 1237</td>
</tr>
</tbody>
</table>

**Table 3** Frequency statistics of crashes in the roundabout dataset according to type of involved road user

<table>
<thead>
<tr>
<th>Crash counts</th>
<th>Proportion of total crashes</th>
<th>Avg/year/roundbt.</th>
<th>Variance</th>
<th>Proportion of traffic volume</th>
<th>$\chi^2$</th>
<th>p$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injury crashes at the roundabouts</td>
<td>148</td>
<td>1491</td>
<td>100</td>
<td>1.22</td>
<td>1.33</td>
<td></td>
</tr>
<tr>
<td>Injury crashes with at least one light vehicle</td>
<td>1261</td>
<td>0.846</td>
<td>1.04</td>
<td>1.08</td>
<td>0.850</td>
<td>0.23</td>
</tr>
</tbody>
</table>
Crash prediction models are common instruments in road safety research to investigate which factors might explain the differences between locations. We developed crash prediction models for roundabouts based on geometry, traffic and crash data for the available dataset of 148 roundabouts.

Table 4 Frequency statistics of crashes in the 148 roundabout dataset according to crash type

<table>
<thead>
<tr>
<th>Type of Crash</th>
<th>Counts</th>
<th>% of total</th>
<th>Avg/year/roundbt.</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-vehicle crashes</td>
<td>329</td>
<td>22.1</td>
<td>0.29</td>
<td>0.26</td>
</tr>
<tr>
<td>Multiple-vehicle crashes</td>
<td>1151</td>
<td>77.2</td>
<td>0.92</td>
<td>0.94</td>
</tr>
</tbody>
</table>

1 For 11 crashes the type is unknown

3. CRASH PREDICTION MODELS FOR ROUNDABOUTS

Crash prediction models are common instruments in road safety research to investigate which factors might explain the differences between locations. We developed crash prediction models for roundabouts based on geometry, traffic and crash data for the available dataset of 148 roundabouts.

Table 4 shows the average annual number of crashes per roundabout in the dataset, for each different road user type separately. The crashes were classified according to the same six road user groups as the traffic counts: light vehicles, heavy vehicles, motorcycles, mopeds, bicycles and pedestrians. Light vehicles were involved in 85% of all registered injury crashes at the investigated roundabouts. Bicyclists were present in 28% of the crashes and mopeds in 18%. No other user group occurred in more than 10% of the crashes. Since usually more than one road user is involved in a crash, the sums of the crash counts (column 1) and the percentages (column 2) in Table 4 exceed the totals in the first row.

Moped riders, bicyclists, motorcyclists and pedestrians were more frequently involved in crashes than would be expected based on their average share in traffic on the observed locations. Light and heavy vehicles were almost as frequently involved as expected.

Crashes were subdivided according to the number of involved road users. Almost eight in ten of the reported crashes at the roundabouts were multiple-vehicle crashes (0).
Regression modeling

Regression models were fitted using the available geometric and traffic variables. The dependent variable was the average annual number of crashes per roundabout (N=148). Poisson loglinear models were fit to explain crash rates at roundabouts.

The functional form of the chosen models was the following:

\[
E(\lambda) = e^{\alpha + Q_1 \beta_1 + Q_2 \beta_2 + \sum \xi_i + \gamma_i}
\]

(Eq. 1)

with \( E(\lambda) \) = expected annual number of crashes

- \( Q_1 = \text{ADT (motor vehicles)} \)
- \( Q_2 = \text{traffic volume for particular vehicle types (bicyclists, mopeds,...)} \)
- \( \xi_i = \text{other explanatory variables} \)
- \( \alpha, \beta_1, \beta_2, \gamma_i = \text{model parameters} \)

All models were fitted by using the GENMOD-procedure in SAS and made use of the log link function. Details about the adopted modeling approach are provided in Daniels et al. (2010).

The results are provided in Table 1. The first column of Table 1 presents the most general model, the one for all crashes. The crash rate appears to be influenced by two exposure variables: the motor vehicle exposure ADT and the bicyclist exposure (BIC), although not significantly by the latter one. Furthermore, the presence of a cycle path influences the number of crashes negatively and more crashes occur at roundabouts with three legs. Specific models were subsequently fit for crashes with particular road users: bicycles, mopeds, motorcycles, heavy vehicles, light vehicles and pedestrians. The models for crashes with light vehicles showed strong similarities with the models for all crashes, which was not unexpected due to the dominancy of crashes with light vehicles in the entire dataset. However, one extra variable enters the model for crashes with light vehicles: the presence of a bypass, which correlates with a higher number of crashes.

Crashes with bicyclists are explained by the ADT and the volume of bicyclists, both in the Poisson and gamma models. Furthermore, the number of crashes with bicyclists turns out to be lower on roundabouts with separate cycle paths. The number of crashes with mopeds is, apart from the exposure variables, dependent on the construction year of the roundabout (YEAR) and seems to be higher on roundabouts with 3 legs (3LEGS). Furthermore, fewer crashes with mopeds occur at roundabouts where the central island is raised than those where this is not the case (ELEV). Apart from the exposure variables (ADT and MCY), the crash rate for motorcyclists was dependent on the shape of the central island: fewer crashes seemed to occur at oval roundabouts (OVAL).

Only exposure and the year of construction seemed to have an effect on the crash rate for trucks. Crashes with pedestrians seem to be influenced by the ADT and by the pedestrian volume (PED). Furthermore, the number of crashes with pedestrians seems to be higher at roundabouts inside built-up areas (INSIDE) then on roundabouts outside the built-up area.

Furthermore separate models were fit for single-vehicle crashes and for multiple-vehicle crashes. The results are provided in Table 1. The number of single-vehicle crashes turns not longer out to be only explained by the ADT. A larger diameter of the central island (CENTRDIAM) is correlated with a higher single-vehicle crash rate. The presence of a cycle path (CYCLPATH), the presence of an oval central island (OVAL) and roundabouts that were located inside built-up area (INSIDE) were correlated with fewer single-vehicle crashes. Multiple-vehicle crashes are affected by the ADT, by the presence of bicyclists and furthermore by the variables CYCLPATH, 3LEGS, YEAR, BYPASS and ZEBRA which are the same variables as in the existing dataset.
<table>
<thead>
<tr>
<th>Variables</th>
<th>All crashes</th>
<th>Crashes with light vehicles</th>
<th>Crashes with bicyclists</th>
<th>Crashes with mopeds</th>
<th>Crashes with motorcycles</th>
<th>Crashes with heavy vehicles</th>
<th>Crashes with pedestrians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-10.05 (&lt;0.01)</td>
<td>-9.27 (&lt;0.01)</td>
<td>-11.01 (&lt;0.01)</td>
<td>-15.47 (&lt;0.01)</td>
<td>-12.61 (0.03)</td>
<td>-10.97 (0.06)</td>
<td>-19.90 (0.02)</td>
</tr>
<tr>
<td>LN(ADT)</td>
<td>1.06 (&lt;0.01)</td>
<td>0.99 (&lt;0.01)</td>
<td>0.91 (&lt;0.01)</td>
<td>1.46 (&lt;0.01)</td>
<td>1.10 (0.07)</td>
<td>0.70 (0.35)</td>
<td>1.62 (0.07)</td>
</tr>
<tr>
<td>LN(BIC)</td>
<td>0.05 (0.18)</td>
<td>0.26 (0.01)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LN(MOP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.23 (0.07)</td>
</tr>
<tr>
<td>LN(MCY)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.10 (0.48)</td>
</tr>
<tr>
<td>LN(HEAVY)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.36 (0.35)</td>
</tr>
<tr>
<td>LN(PED)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.20 (0.37)</td>
</tr>
<tr>
<td>CYCLPATH</td>
<td>-0.45 (&lt;0.01)</td>
<td>-0.52 (&lt;0.01)</td>
<td>-0.54 (0.09)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YEAR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.15 (0.09)</td>
</tr>
<tr>
<td>3 LEGS</td>
<td>0.37 (0.04)</td>
<td>0.42 (0.03)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.47 (0.29)</td>
</tr>
<tr>
<td>INSIDE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BYPASS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.43 (0.04)</td>
</tr>
<tr>
<td>ELEV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.58 (0.17)</td>
</tr>
<tr>
<td>OVAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-1.72 (0.57)</td>
</tr>
<tr>
<td>AIC</td>
<td>369.10</td>
<td>340.79</td>
<td>179.18</td>
<td>140.11</td>
<td>76.14</td>
<td>81.21</td>
<td>52.68</td>
</tr>
</tbody>
</table>
Table 6 Parameter estimates and significance values for Poisson models with single/multiple-vehicle crashes

<table>
<thead>
<tr>
<th>Variables</th>
<th>Multiple-vehicle crashes</th>
<th>Single-vehicle crashes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-10.50 (&lt;0.01)</td>
<td>-5.84 (0.06)</td>
</tr>
<tr>
<td>LN(ADT)</td>
<td>1.04 (&lt;0.01)</td>
<td>0.44 (0.18)</td>
</tr>
<tr>
<td>LN (BIC)</td>
<td>0.12(0.05)</td>
<td></td>
</tr>
<tr>
<td>CYCLPATH</td>
<td>-0.32 (0.08)</td>
<td>-0.66 (0.05)</td>
</tr>
<tr>
<td>3 LEGS</td>
<td>0.45 (0.03)</td>
<td></td>
</tr>
<tr>
<td>YEAR</td>
<td>-0.09 (0.04)</td>
<td></td>
</tr>
<tr>
<td>BYPASS</td>
<td>0.41 (0.06)</td>
<td>-2.24 (0.15)</td>
</tr>
<tr>
<td>OVAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZEBRA</td>
<td>0.37 (0.05)</td>
<td></td>
</tr>
<tr>
<td>CENTRDIAM</td>
<td>0.03 (0.01)</td>
<td>-0.63 (0.15)</td>
</tr>
<tr>
<td>INSIDE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC</td>
<td>311.13</td>
<td>176.93</td>
</tr>
</tbody>
</table>

Exposure

The fitted crash prediction models show that the variations in crash rates at roundabouts are relatively small and mainly driven by the traffic exposure. Traffic volume (ADT) was a significant predictor in most of the fitted models. It was only less significant in those models where the number of observations was low such as in the models for pedestrians or heavy vehicles. Therefore it can be concluded that the ADT was technically by far the most important variable in the models, which corresponds with many earlier findings in traffic safety research. The coefficient for the motorized vehicle exposure (ADT) is not consistently above or below 1 in most of the models. A coefficient of 1 would suggest an increase in crash rate (crashes per year) that is proportional to the traffic volume, whereas a coefficient of above respectively below 1 would equal an increase that is respectively higher or lower than proportional to the traffic volume increase. Also the exposure variables for the specific road user types appeared to contribute significantly to the models. This was the case for the bicyclist volume and the number of moped riders, each time in the model for the respective group of road users. It can be noticed that all the parameter estimates for the specific road user types are considerably below 1, which could support the “law of rare events” (Elvik, 2006), stating that the more rarely a certain traffic hazard is encountered the greater its effect is on the crash rate. This law implies as well that the rarer some types of road users are encountered in traffic, the higher the risk of a collision with those road users per encounter. This provides a confirmation for the existence of a ‘safety in numbers’ effect for bicyclists, moped riders, motorcyclists, heavy vehicles and for pedestrians at roundabouts.
Geometry

In the investigated dataset, roundabouts with cycle paths are performing better than roundabouts with other types of cycle facilities, particularly in comparison with roundabouts with cycle lanes close to the roadway.

Three-leg roundabouts appear to perform worse than roundabouts with four or more legs. More crashes with light vehicles and more multiple-vehicle crashes (which are to a certain extent overlapping groups) seem to occur at roundabouts with bypasses for traffic in some direction. Fewer crashes seem to occur at more recently constructed roundabouts. The larger the central island, the more single-vehicle crashes seem to occur.

No confirmation is found for higher crash rates at double-lane roundabouts, which is rather unexpected. The variable TWOLANES (two-lane roundabouts) did not enter any of the models. However the mere fact that a certain variable is not significant must not directly lead to the conclusion that this variable could not be important. In statistical terms, the fact that the zero-hypothesis is not rejected should not lead to the conclusion that the zero-hypothesis has to be accepted (Hauer, 2004b). Nevertheless the modeling practice revealed that the variable TWOLANES was never coming close to significance, which makes it less likely that a further extension of the used dataset would suddenly show some effect of this variable. Further research on this topic is likely to be of importance.

Due to the nature of a cross-sectional study it cannot be excluded that significant variables in the dataset act as a proxy for other, influencing but unknown variables. This could have caused an omitted variable bias. For instance the unfavourable effect of roundabouts with bypasses for traffic in some directions (BYPASS) could be related to higher speeds on this type of roundabouts.

Some extra analyses revealed that vulnerable road users (moped riders, motorcyclists, bicyclists, pedestrians) are more often involved in injury crashes at roundabouts then could be expected based on their presence in traffic. Moped riders and motorcyclists are strongly overrepresented in single-vehicle crashes whereas moped riders, bicyclists and motorcyclists are overrepresented in multiple-vehicle crashes.

4. BEFORE-AFTER STUDY ON SAFETY FOR BICYCLISTS

Roundabouts generally have a favourable effect on traffic safety, at least for crashes causing injuries. During the last decades several studies were carried out into the effects of roundabouts on traffic safety. A meta-analysis on 28 studies in 8 different countries revealed a best estimate of a reduction of injury crashes of 30-50% (Elvik, 2003). Other studies, not included in the former one and using a proper design, delivered similar results (Persaud et al., 2001; De Brabander et al., 2005). All those studies reported a considerably stronger decrease in the number of severest crashes (fatalities and crashes involving serious injuries) compared to the decrease of the total number of injury crashes. The effects on property-damage only crashes are however highly uncertain (Elvik, 2003).

However less is known about the safety effects of roundabouts for particular types of road users, such as bicyclists. Therefore a before-after study was conducted on the effects of converting intersections into roundabouts on the number of crashes involving bicyclists. The main objective was to reveal whether the resulting effect would be the same as for crashes in general, both for the totality of injury crashes as for the severest crashes (crashes resulting in fatal or serious injuries). Supplementary questions were whether the effect would be different depending on some geometric characteristics such as the nature of the present cycle facilities.
Methodology

The adopted study design was that of an empirical Bayes before-and-after study (Hauer, 1997) with injury crashes involving bicyclists as a measurement variable. The use of comparison groups enabled to control for general trends in traffic safety and possible regression-to-the-mean effects.

For the purpose of this study only roundabouts that were constructed between the year 1994 and 2000 were taken into account. Crash data were available from 1991 until the end of 2001. Consequently a time period of crash data of at least 3 years before and 1 year after the construction of each roundabout was available for the analysis. For each roundabout the available crash data in the period 1991-2001 were included in the analysis. The comparison group consisted of 649 crashes with bicyclists at 172 intersection locations. The total number of crashes included in the treatment group (= roundabout locations) was 411, of which 314 with only slight injuries, 90 with at least one serious injury and 7 with a fatal injury (see 0).

Table 7 Number of considered crashes (before and after period together, 1991-2001)

<table>
<thead>
<tr>
<th>Nature of the severest injury in the crash</th>
<th>Roundabouts</th>
<th>Comparison group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight</td>
<td>314</td>
<td>486</td>
</tr>
<tr>
<td>Serious</td>
<td>90</td>
<td>142</td>
</tr>
<tr>
<td>Fatal</td>
<td>7</td>
<td>21</td>
</tr>
<tr>
<td>TOTAL</td>
<td>411</td>
<td>649</td>
</tr>
</tbody>
</table>

In the first stage, the effectiveness for each individual roundabout location was calculated. Subsequently, the results were combined in a meta-analysis. The effectiveness is expressed as an odds-ratio of the evolution in the treatment group after conversion into a roundabout compared to the evolution in the comparison group in the same time period. An effectiveness-index above 1 respectively below 1 indicates an increase, respectively a decrease in the number of crashes compared to the average evolution on similar locations where no roundabout was constructed, while an index of 1 equals the zero-hypothesis of no effect.

Results

0and 0show the results of the analyses for all injury crashes and severe injury crashes respectively. The best estimate for the overall effect on injury crashes involving bicyclists on or nearby the roundabout is an increase of 27% (p = 0.05). The best estimate for the effect on crashes involving fatal and serious injuries is an increase of 42% (p = 0.05-0.06). None of the partial results for any of the subgroups in 0is significant at the 5% level. It can be concluded that the data for the study sample suggest that the construction of a roundabout generally increases the number of severe injury crashes with bicyclists, regardless of the design type of cycle facilities.

Overall, the number of injury crashes at roundabouts with cycle lanes turns out to increase significantly (+93%, 95% CI [38 to 169%]). However, for the other 3 design types (mixed traffic, separate cycle paths, grade-separated cycle paths) the best estimate is a decrease of 17% in the number of crashes, although not significant (Eff. index 0.83 with 95% CI [0.59-1.16]) (result of a separate meta-analysis on the values for those categories, not reflected in the table).
Table 8 Results before- and afterstudy – all injury crashes.

<table>
<thead>
<tr>
<th>Nr. of locations</th>
<th>Effectiveness- index [C.I.] (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIXED TRAFFIC</td>
<td>9</td>
</tr>
<tr>
<td>CYCLE LANES</td>
<td>40</td>
</tr>
<tr>
<td>SEPARATE CYCLE PATHS</td>
<td>38</td>
</tr>
<tr>
<td>GRADE-SEPARATED</td>
<td>3</td>
</tr>
<tr>
<td>ALL ROUNDABOUTS</td>
<td>90</td>
</tr>
</tbody>
</table>

Table 9 Results before- and afterstudy – crashes with fatal and serious injuries.

<table>
<thead>
<tr>
<th>Nr. of locations</th>
<th>Effectiveness- index [C.I.] (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIXED TRAFFIC</td>
<td>9</td>
</tr>
<tr>
<td>CYCLE LANES</td>
<td>40</td>
</tr>
<tr>
<td>SEPARATE CYCLE PATHS</td>
<td>38</td>
</tr>
<tr>
<td>GRADE SEPARATED</td>
<td>3</td>
</tr>
<tr>
<td>ALL ROUNDABOUTS</td>
<td>90</td>
</tr>
</tbody>
</table>

Subsequently a meta-regression procedure was applied. Maximum likelihood linear regression models were fitted in order to estimate the relationship between the estimated value for the effectiveness per location and some known characteristics of the roundabout locations. The available independent variables were the variables INSIDE, SIGNAL, TWOLANE, MIXED, CYCLLANE, CYCLTYPE and GRADESEP like listed in 0

The estimated effectiveness per location (EFFl) was used as the dependent variable in the model. Possible second-order effects were checked by including a number of interaction terms in the models. A detailed description of the followed approach is available in Daniels et al. (2009).

Table 10 Regression results of LN(EFFl) for all roundabouts (N=90), all crashes with bicyclists

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Chi-Square</th>
<th>Pr &gt; ChiSq</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.51</td>
<td>0.14</td>
<td>13.24</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>CYCLLANE</td>
<td>1.05</td>
<td>0.19</td>
<td>31.54</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>SIGNALS</td>
<td>0.61</td>
<td>0.22</td>
<td>7.64</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Deviance = 67.86  df = 87
The main effects for CYCLLANE (1.05, p < 0.01) and SIGNALS (0.61, p < 0.01) were positive and significant. The sign of the revealed effect is positive, meaning that roundabouts with cycle lanes, compared with the other designs, have had a worse performance regarding crashes with bicyclists. Furthermore, the model shows that signal-controlled intersections that were converted into roundabouts have had a worse evolution than non-signal controlled.

In the data, a clear difference in the performance level was visible for roundabouts with cycle lanes compared to other types when all injury crashes with bicyclists are considered. The presence of cycle lanes correlates with a higher value of the effectiveness-index which indicates an increase in the number of bicycle crashes. This effect confirms the findings in the crash prediction models. It has been suggested earlier, e.g. by Brilon (1997). However, in their cross-sectional study, Hels & Orozova-Bekkevold (2007) found no significant effect of the presence of a cycle facility on the number of bicyclist crashes.

A Dutch before and after-study found no major differences in the evolution of crashes with bicyclists between three different roundabout design types (mixed traffic, cycle lanes, separate cycle paths) (Schoon and van Minnen, 1993). Regarding the numbers of victims however, it was concluded that at roundabouts with a considerable traffic volume, a separate cycle path design was safer than both other types. Therefore the authors recommended the use of separate cycle path designs. In a Swedish study it was concluded that the bicyclist crash rate at roundabouts with cycle crossings (i.e. roundabouts with a cycle path design) was lower compared to roundabouts with bicyclists riding on the carriageway (Brüde and Larsson, 2000).

5. CRASH SEVERITY AT ROUNDABOUTS

In a subsequent analysis, the focus shifted to the level of severity of crashes that were recorded at the roundabouts. Severity can be expressed as the probability that, given a crash happening, the outcome will be of certain seriousness. The severity of 1491 crashes on 148 roundabouts was examined in order to investigate which factors might explain the severity of crashes or injuries and to relate these factors to the existing knowledge about contributing factors for injury severity in traffic. Logistic regression and hierarchical binomial logistic regression techniques were used. A clear externality of risk appeared to be present in the sense that vulnerable road user groups (pedestrians, bicyclists, moped riders and motorcyclists) are more severely affected than others. Fatalities or serious injuries in multi-vehicle crashes for drivers of four-wheel vehicles are much rarer. Injury severity increases with higher age. Crashes at night, crashes outside built-up areas and crashes at roundabouts with grade-separated facilities for bicyclists are more severe. Single-vehicle crashes seem to have more severe outcomes than multi-vehicle crashes. However, systematic differences in the reporting rate of crashes are likely to exist and may have affected the stated results. Correlations with important, but unobserved variables like the impact speeds in the crashes might exist as well and could provide an alternative explanation for some results.

6. SOME POLICY RECOMMENDATIONS

The presented analyses could provide some useful elements that could be integrated in roundabout design guidelines and practices. These elements must be seen in the perspective of a gradually progressing scientific knowledge on some contributing factors to the safety performance of roundabouts. Together with previous results, they provide the current knowledge on this issue. Hopefully this knowledge will further develop in the future. Meanwhile, the best available knowledge should be reflected in design standards and practices.

The before-and-after analyses showed that the construction of a roundabout generally increases the number of injury crashes with bicyclists. The increase appeared to be mainly an issue on roundabouts with cycle lanes. Nevertheless, for the most severe crashes, the increase appeared to
be rather general. At the same time there is no reason to question the well established favourable effects of roundabouts on crashes in general. Consequently, the stated results in this thesis may raise a policy dilemma in the sense that it could be questioned whether the construction of roundabouts should be promoted or discouraged. A strictly rational approach would probably argue that an overall reduction of crashes should prevail, even if one particular subgroup (i.e. bicyclists) is not benefitting. But this approach might evoke strong counterarguments, not at least since the promotion of cycling is believed to fit in a policy on sustainable development (see for instance Banister, 2008).

Based on the stated results, a double policy recommendation can be given with respect to the issue of the cycle facilities. Firstly, it might be careful not to construct roundabouts at locations where cyclist safety is of particular concern. In those circumstances other types such as signal-controlled intersections are more preferable. Examples of such locations are intersections inside built-up areas in low speed zones with high shares of pedestrians and cyclists. Secondly, if a well-considered decision is made to construct a roundabout, this should be not a roundabout with cycle lanes close to the roadway.

Another policy question is what should be done with existing roundabouts with cycle lanes. A recommendation that no roundabouts with cycle lanes should be constructed does not necessarily imply that every existing roundabout with cycle lanes should be redesigned in the short term into something else. Apart from possible cost-benefit considerations, it must be stated that no straightforward evidence exists that simply converting roundabouts with cycle lanes to another cycle design type without adapting other geometric variables would improve the safety for bicyclists. For instance, when a roundabout with cycle lanes is converted into a mixed traffic roundabout only by resurfacing the road or by erasing markings, the roadway will become wider and is likely to enable higher speeds that could in turn be responsible for a worse safety record. The fact that roundabouts with mixed traffic in the present study perform better than the roundabouts with cycle lanes could does not contradict this last argument.

Other policy recommendations relate as well to geometric variables. The fitted models showed effects for some manipulatable variables such as the number of legs or the presence of a bypass. Bypasses correlate with more crashes. They should be avoided unless capacity requirements are not longer fulfilled. In that case, special attention should be given to possible conflicts between merging vehicles or conflicts between car drivers and crossing cyclists or pedestrians.

Three-leg roundabouts perform worse than roundabouts with four or more legs. I cannot imagine a real reason why a roundabout with three legs would show an intrinsic poorer safety record than a roundabout with more legs. Probably this type of roundabouts is often constructed with flaw approach angles and is therefore allowing higher speeds in some directions. From a safety perspective, it is therefore recommended to keep the angle of the approaches tight enough to reduce speeds sufficiently and to avoid heterogeneous speeds at roundabouts.

Larger central islands correlate with a higher number of single-vehicle crashes. However it is highly questionable whether reducing the size of central islands would result in a net benefit with respect to safety since –ceteris paribus - smaller central islands are related with higher speed at roundabouts due to the smaller imposed lateral deflection.

At least on the level of safety in the Flanders region where the investigated locations were all located, the stated results are valid for the whole population of roundabouts on regional roads. It is more unclear whether the results are valid for other countries and regions as well. One should be aware that the investigated design types are also used elsewhere and that an apparent overrepresentation of bicyclists in crashes at roundabouts was reported in several countries. At least, the results of the present work could serve as an appropriate indication for effects that are likely to occur in other country-settings as well.

Further research on different aspects of roundabout design and related safety performance will be required. Useful research directions are related to the extension of the existing models with extra data and variables. Other topics deserving further research are the safety effects of two-lane
roundabouts and defining the concept of ‘complexity’ on intersections. In-depth analyses of crashes on roundabouts could contribute to a better understanding of underlying reasons for the over involvement of cyclists in crashes at roundabouts. Ideally, any future research in this domain should be done in a cross-country perspective in order to incorporate better existing differences in roundabout design guidelines and practices. In the longer run, this may lead to more universal design guidelines.

7. REFERENCES

Title: EVALUATION OF BIKE BOXES AT SIGNALIZED INTERSECTIONS IN PORTLAND, OREGON, USA

Presenting Author: Jennifer Dill

Authors: J. Dill; C. Monsere

Affiliation
1. Urban Studies and Planning, Portland State University, Portland, OR, USA
2. Civil and Environmental Engineering, Portland State University, Portland, OR, USA

Abstract:
Bicycle use as a primary means of commuting to work increased 145% (American Community Survey, US Census Bureau) from 1996 to 2006 in Portland, Oregon; however, recent surveys have found that more than half of Portland residents limit their bicycling due to traffic safety concerns. In Portland, 68% of bicycle crashes occur at intersections, (PDOT, 2004) which is consistent with national trends (Hunter et al., 1995), and a common crash pattern is the "right-hook" where right-turning motorists collide with through or stopped bicycles. To partially address these conflicts between bicycles and right-turning motor vehicles, the City of Portland installed 12 "bike boxes" at signalized urban intersections. The box is located in front of the stop line for motor vehicles and behind the pedestrian crosswalk, and the typical installation consisted of an advanced stop line, green textured thermoplastic marking with bicycle stencil, intersection striping, and regulatory signage (including no-turn-on-red). These installations also include colored bicycle lane markings in the intersection, which is unique. This combination of traffic control is hypothesized to reduce conflicts between motor vehicles and bicyclists and make motorists aware of a potential conflict, with a secondary outcome of encouraging more bicycling by enhancing safety and priority at an intersection.

Such an application of bike boxes in the U.S. is unprecedented. Bike boxes and similar advanced stop lines are used extensively in the United Kingdom, the Netherlands, and Denmark. Comprehensive evaluations of bike boxes are rare. The Eugene box was evaluated, however, that application was so unique that it has limited transferability (Hunter, 2000). The only other recent and thorough studies of the effects of such boxes found were two studies conducted in London (Allen et al, 2005; Wall et al, 2003). These studies looked at both the capacity implications and the behavior of motor vehicles and cyclists. The study examining the driver and cyclist behavior (Allen et al, 2005) compared 12 sites with advanced stop lines (ASL) and two without. All data were collected after installation of the advanced stop lines. That study found few conflicts with or without the ASLs. The study also found that the ASLs reduced the share of motor vehicles and bicycles encroaching on the pedestrian crosswalk.

This paper will present the results of a comprehensive, classical, observational before-after study of the effectiveness of the installed experimental traffic control devices and responses of all system users impacted by the installation of the bicycle boxes. The research questions addressed include:
1. Do the bike boxes reduce conflicts or the potential for conflict between motorized vehicles and bicycles?
2. Do the bike boxes create any new or potential conflicts between motorized vehicles and bicycles?
3. How does motor vehicle driver and bicyclist behavior differ with and without the bike boxes?
4. What design features affect behavior and conflicts?
5. Do the bike boxes affect pedestrian safety?
6. What are the impressions of the drivers and bicyclists using the intersections about how the bike boxes affect safety and operations?

Two primary methods were employed: (1) before and after video surveillance; and (2) cyclist and driver surveys. The video surveillance includes 11 treatment intersections and four control intersections. Data were collected on bicyclist and motorist positions relative to the bike box, bike lane, and the pedestrian crosswalk areas, in addition to signal phase, presence of pedestrians, stopping behavior, and bicycle and motor vehicle counts. Inter-rater reliability was also assessed. The survey of bicyclists who rode through the bike boxes collected information on user perceptions and behavior. The motorist survey collected information about motorists understanding of the markings, along with perceptions and behavior.

Title: EMERGING TECHNOLOGY FOR ROADS, CROSSWALKS AND PEDESTRIAN SAFETY ZONES

Presenting Author: Arthur Dinitz

Authors: A. M. Dinitz 1;

Affiliation
1. Transpo Industries, Inc., USA,

Abstract:
Much time and effort has been spent in recent years to protect the safety of the motoring public with less emphasis on pedestrians and motorcycle riders. This paper will discuss three innovative products that are specifically designed with pedestrians and motorcycle riders safety in mind.

1. Skid Resistant Polymer Surfaces
Motorcyclists are vulnerable at sharp turns, exit ramps and other areas where slide outs occur. Most sharp ramps, high risk curves and bridge decks do not provide adequate skid resistance and two-wheelers need traction just to maintain balance and remain upright. When traction is compromised accidents happen.

Special Polymer surfacing materials which incorporate skid resistant aggregates help maintain traction in these dangerous areas. An application of a specialized polymer resin developed to withstand the detrimental effects of ultra violet rays and a broadcast of a wear resistant angular aggregate is designed to increase safety for both two and four wheel vehicles. This system is equally effective when applied to either concrete or asphalt surfaces.

2. Colored Pedestrian Crosswalks using Slip Resistant Polymer Materials
These new Polymer based coatings can be formulated in a variety of colors and can incorporate glass beads for nighttime retro-reflectivity and increased safety. There is minimal disruption to traffic during application and the product has long term performance. The no trip, skid resistant surfaces are safety enhancements and pedestrian friendly.

They are simple to apply, require no special equipment, rapid curing, durable and result in areas with high visible and safe roadway delineation. Positive demarcation for bike and walking paths, crosswalks and toll lanes can be easily accomplished with a low unit installation costs.

The specific properties of these materials and their appropriate applications for increased public safety will be discussed.

3. Safety and Work Zone intrusion Alarm
In 2008, the U.S. FHWA bought 2500 of this Safety Alarm unit and is currently in the process of tallying results for this emerging product.

This alarm which is activated upon impact or upon tilting of 90 degrees is ideal for the protection of pedestrians in a safety zone. It is easily moved and set up making it ideal for temporary or mobile safety needs.

The NCHRP 350 accepted alarm mounts on a typical barrier. When impacted or tilted the built-in CO2 powered horn blasts at 125db to signal pedestrians or workers that their protective zone has been violated, allowing them critical reaction time to move out of harms way. Placed on a
safety cone or any safety barrier the Sonoblaster is set to go and can simply be moved as pedestrian or worker safety indicate.

This system overcomes objections found in other intrusion alarms. It needs no electrical power to require maintenance, recharging or possibly even going dead. Critical unit alignment is not required as with beam and other type devices. No receiver is required since each unit operates independently and there are no false alarms from accidentally walking or driving through an ‘invisible’ beam.

The following is only a partial list of areas where the alarm can be used: Pedestrian Crossings, Security zones, Construction Zones, Maintenance Areas, Flagger Protection, Striping & Marking, Site Inspection/Repair, Paving and Grading, Survey Crews, Intra-Work Zones, Patching/Pothole Repair, Sweeping and Cleaning, Breakdown Lanes, RR Grade Crossings, Tree Trimming/Mowing, Equipment Loading, Snow, Removal/Deicing, Water Main Breaks, Runway Crews, Police/Fire Stations, Rescue Operations, Hazmat Scenes, Military Operations, Signal/Light/Sign Repair.

Along with the FHWA’s preliminary report, this product will be introduced and examined as a product easily incorporated into any safety program to save lives.
Title: THE INFLUENCE OF THE INDIVIDUAL'S RISK PERCEPTION AND ATTITUDES ON TRAVEL BEHAVIOR

Presenting Author: Wafa Elias

Authors: W.J. Elias 1; Y. Shiftan 1;

Affiliation
1. Civil and Environmental Engineering, Technion, Haifa, Israel,

Abstract:
Promoting sustainable transportation and the shift from car to public transportation (PT), walking and cycling are important for many reasons, including environmental, economic and public health. The encouragement of individuals' transition to PT necessitates changes in urban planning, transportation system and improved accessibility to the various activities by PT. In this paper we claim that changes in individuals' attitudes, beliefs and risk perception also play an important role in this transition in travel behavior. Reducing the use of the car necessitates provision of alternative transport modes. Road users must also believe that a transition to PT and walking will improve their wellbeing. To persuade road users to give up using their cars, the problem has to be presented as a visible and immediate threat. Our hypothesis is that road accidents and the risk of being involved in them are more visible and are perceived as a greater threat than is the negative environmental impact, so individuals tend to weigh road-accident risk more than air-pollution risk. This study analyzes the effect of individuals' risk perception and fatalistic beliefs, in addition to demographic and socio-economic characteristics, on their willingness to shift from car to public transportation and walking. It further examines the relationship between people's behavior and their attitudes and beliefs. Finally, it attempts to identify barriers in Arab communities to the transport system, urban planning, and accessibility of the various activities. In a case study of Arab cities in the Galilee region of northern Israel an integrated approach was taken comprising various methods: development of a theoretical framework, descriptive analysis, factor analysis to create attitudinal factors, linear regression to examine the effect of the individual's characteristics on travel time by car, and developing a mode-choice model for commute trips based on a stated-preference survey with attitudinal factors among the explanatory variables. This study is based on data from a survey of 342 individuals in one Israeli Arab town. The survey includes four parts: the first part includes socio-economic and demographic characteristics. The second part includes information about travel behavior including travel time and number of trips both in weekdays and in weekends by travel mode, and the third part includes stated preference experiment of mode choice with the purpose of identifying the individual's willingness to shift from private to PT and walking for various purposes. The final part of the survey inquired about 31 attitudinal variables that were used to measure environmental awareness, risk perception of road accidents, the belief in fatalism as well as sensitivity to various individual travel features such as travel time, privacy, availability and flexibility. The results support the hypothesis that perception of risk of being involved in road accidents positively affects sustainable travel behavior, as expressed by the willingness to use public transport, while concern for and knowledge of environmental problems exerts no significant effect on travel-mode choice. Additionally, despite participants' concern about environment problems they persist in using the car as the dominant travel mode; they prefer the car's advantages, especially the feeling of privacy, over health considerations. Trip purpose also plays an important role in travel-mode choice, and results showed that people tend to shift to public transport more for work trips and less for other purposes.
Title: PEDESTRIAN ROAD SAFETY IN THE ISRAELI ARAB MINORITY AND THE GENERAL POPULATION OF JORDAN

Presenting Author: Wafa Elias

Authors: W.J. Elias 1,2; D. Ragland 1; Y. Shiftan 2;

Affiliation
1. Institute of Transportation Studies, Berkeley University of California, USA, 2. Civil and Environmental Engineering, Technion, Israel,

Abstract:
Road accidents throughout the world, particularly within Arab communities in Israel and Jordan, have become one of the main causes of death among teenagers and children. In 2001, Israeli Arab drivers were involved in 26% of all severe and fatal accidents, although they constitute only 12 percent of the total driving population. The rate of death is 1.6 times higher among Israeli Arab drivers than among Jewish drivers. Furthermore, the rate of Israeli Arab children involved in traffic accidents is higher than that of Jewish children. Similarly in Jordan, traffic accidents are a major cause of death. Approximately 992 people died in car accidents in 2007 out of a total population of 5.7 million people. To address this problem, the proposed study will focus on two Arab communities in Jordan for comparison of pedestrian traffic accidents, one comprising the Israeli Arab minority, and the other, the general population of Jordan. The high rate of traffic accidents in both communities, in addition to the similar factors among the Israeli Arab minority and Jordanian society—culture, language, religions and sets of beliefs—make Jordan a unique country for comparison.

The objectives of the study are first, to understand the causes of pedestrian involvement in traffic accidents; second, to identify both common and contrasting accident causes between the two communities; third, to examine the relationship between the demographic and socio economic characteristics related to the risk of traffic accident involvement; fourth, to examine the effects of daily activity patterns on traffic accident risk; and finally, to examine the role of social and transportation policies in the improvement of pedestrian safety. This is the first study to address, in depth, comparison of pedestrian traffic accident causes between such communities. Based on data collected from various resources in Israel and Jordan—the Central Bureaus of Statistics, police files and surveys—a descriptive statistical analysis will be employed. The survey includes a household questionnaire in addition to trip diaries. The comparison between Israel and Jordan includes many variables, among those: road accident rate and severity, accident causes, road and traffic conditions at the accident location, and driver age, gender and experience. Additionally, the socio-economic characteristics and daily activity patterns of the drivers and pedestrians involved in traffic accidents will be analyzed.

Based on data analysis, there appear to be significant similarities between the characteristics of Israeli and Jordanian road users—both pedestrians and drivers—in involved in road accidents, as well as similarities in the causes of these accidents. The results of this research show that in addition to the demographic and socio-economic characteristics of the pedestrian or driver, his or her daily activity and travel patterns also have an impact on the risk of being involved in a traffic accident.
Additionally, findings indicate that both communities suffer from inadequacies in urban planning, transportation systems, and traffic control, and improper engineering design. Furthermore, data analysis showed that pedestrian safety problems, particularly those related to children, are more severe in Jordan than among Israeli Arab communities.
Title: LACK OF VISIBILITY OF MOTORCYCLES: A SENSORY CONSPICUITY PROBLEM AND/OR A COGNITIVE CONSPICUITY PROBLEM?

Presenting Author: Julie Ferretti

Authors: J. Ferretti 1,2; J. Rogé 1; F. Vienne 3; O. Laya 4; J.-C. Bougeant 2;

Affiliation
1. LESCOT, Institut National de la Recherche sur les Transports et leur Sécurité, 25 av F. Mitterrand 69675 Bron, France, 2. Laboratoire EMC, Université de Lyon, Lyon 2, 5 av. P. Mendès-France 69500 Bron, France, 3. LEPSIS, Institut National de le Rechercher sur les Transports et leur Sécurité/Laboratoire Central des Ponts et Chaussées, 58 bvd Lefebvre 75015 Paris, France, 4. LPC, Institut National de la Recherche sur les Transports et leur Sécurité, 25 allée des Marronniers F-78000 Versaille Satory, France,

Abstract:
In France, the proportion of motorcyclists who died in road accidents increased from 9.2 per cent to 16.6 per cent, between 1996 and 2005 (Guyot, 2008), and, 35.6 per cent motorists and motorcyclists’ collisions were a consequence of human error (MAIDS, 2005). Particularly, it was the motorist who failed to detect the motorcyclist. Nevertheless, motorists declared that having turned their head in the direction of the powered two-wheeler user (Williams & Hoffman, 1979).

Motorcyclists lack of visibility. This low visibility refers to the notion of conspicuity. Therefore, we focus on two possible types of conspicuities which could explain this lack of motorcyclists’ visibility.

Much research on visibility improvement has focused on the change in physical features of powered two-wheelers to increase their sensory conspicuity (Wulf, Hancock, & Rahimi, 1989). The sensory conspicuity refers to the extent to which an object can be distinguished from its environment and in which it is easily detected using its physical features (Engel, 1974). These physical features can be colour, size... but it is also possible that the motorcyclist is more or less easily detected by the motorist owing to their contrast with the road surface.

In our study, our hypothesis is a motorcyclist who has a high colour contrast level with the road surface is more rapidly detected by motorists than a motorcyclist who has a low colour contrast level.

However, there is another possible explanation. Some researchers think that the visibility could also depend on the cognitive process of information linked to powered two-wheelers made by the motorist. Therefore, motorists’ implication in collision with motorcyclists could be a consequence of an insufficient cognitive conspicuity (Brooks & Guppy, 1990). Particularly, this conspicuity depends on motorists’ experience and intentions (Hancock, Wulf, Thom, & Fassnacht, 1990). Certain motorists do not detect motorcyclist because they have a lack of interest or experience with this type of road-user. Indeed, motorists who have the motorcycle driving licence have less accident between light vehicle and motorcycle (Magazzu, Comelli, & Marinoni, 2006). Brooks’ study shows that motorists who have some friends or family members’ who are motorcyclists also have less accidents (Brooks & Guppy, 1990). It is the same when motorists have experience as a motorcycle passenger (Brooks & Guppy, 1990).

In our study, our hypothesis is motorists who also have the motorcycle driving licence are more able to detect motorcyclists than motorists who have only a light vehicle driving licence.

In our study, motorists drove in traffic and in different road situations (overtaking, crossed a road intersection...). And, they drove on different road types: highway and trunk road. The instruction was to detect powered two-wheelers. Then, motorists gave his/her responses to operate a lever behind the steering wheel as soon as they detected them. This task was carried out on a fixed-base car driving simulator. This simulator had two rear-view mirrors: the offside
wing mirror and the internal rear-view mirror.
We varied the colour contrast level of powered two-wheeler users with the road surface. The motorcyclist had a high colour contrast level (red) or a low colour contrast level (grey) with the road surface.
We compared the performance of two motorists’ groups. One group was made up of motorists who had only the light vehicle driving licence and a group who also had the powered two-wheelers driving licence.
We measured the ability to detect powered two-wheelers.
The analysis of data is in progress and we will have completed it by the date of the conference. We expect the results and the discussion to be ready for the conference.
This study carried out in the setting of 2-wheeler Behaviour and Safety European project (7th PCRD).
Title: ADVANCED YIELD MARKINGS AND DRIVERS' PERFORMANCE IN RESPONSE TO MULTIPLE-THREAT SCENARIOS AT MID-BLOCK CROSSWALKS

Presenting Author: Donald L. Fisher

Authors: D. L. Fisher 1; L. Garay-Vega 2;

Affiliation
1. Department of Mechanical and Industrial Engineering, University of Massachusetts, Amherst MA 01003, USA, 2. Department of Civil and Environmental Engineering, University of Massachusetts, Amherst MA 01003, USA,

Abstract:
This study compares on a simulator drivers' performance (eye fixations and yielding behaviors) at marked, midblock crosswalks in multi-threat scenarios when the crosswalks have advance yield markings and pedestrian crosswalk prompt signs with their performance in such scenarios when the crosswalks have standard markings. Uncontrolled mid-block crosswalks at multilane streets are associated with a type of pedestrian-vehicle conflict defined as a multiple-threat crash scenario. A pedestrian is struck by a vehicle (first threat) traveling in the same direction as a vehicle (second threat) that is yielding or stopped for a pedestrian in the crosswalk. Vehicles yielding or stopped too close to the crosswalks often block the driver's visibility in the approaching vehicle (traveling in the adjacent lane) of the pedestrian in the crosswalk. Vehicles yielding or stopped too close to the crosswalks often block the driver's visibility in the approaching vehicle (traveling in the adjacent lane) of the pedestrian in the crosswalk. Vehicles yielding or stopped too close to the crosswalks often block the driver's visibility in the approaching vehicle (traveling in the adjacent lane) of the pedestrian in the crosswalk. Previous field studies have shown that the use of advance yield markings and the “Yield Here for Pedestrian” prompt sign increase drivers' yielding distance while reducing the number of conflicts at multilane, midblock crosswalks. However, these changes might occur solely in scenarios where the pedestrian is visible in the crosswalk. There is no way to determine from the data whether any of the scenarios included multiple threats. To date, no studies have shown whether the use of advance yield markings and prompt signs actually increases the likelihood that drivers will look for pedestrians obscured by a yielding or stopped vehicle in an adjacent travel lane.

Thirty-six drivers participated in the study conducted in a driving simulator. Eighteen subjects were assigned to the control group (traditional markings) and eighteen to the advance yield markings and prompt sign group. The virtual environment consisted of a two-way/four-lane road with stop-controlled intersections and vehicles traveling in the opposite direction, approaching from the right or left, and entering/leaving parking lots. Participants followed a lead vehicle to an unknown destination. Advance yield markings and prompt signs were placed 30 feet upstream of the crosswalks to indicate the point at which the yield is required to be made. Traditional markings consist of stop bars located 10 ft before the crosswalk. The scenarios of interest include situations where the driver approaches an uncontrolled, mid-block crosswalk with an obstruction on either the right lane or left lane (i.e., three vehicles in queue, vehicles with turning signal activated). Two sessions were presented to each subject. Each scenario (obstruction on right or left lane) was included once within a session. Pedestrians were included in the simulation (e.g., pedestrians completing street crossings at selected intersections) to show the driver that it is possible to encounter such an event elsewhere in the simulation. However, a pedestrian was never present in any of the experimental scenarios included in the first session but always present in the last scenario of the second session.

In the first session, drivers in the advance yield markings group looked for pedestrians 69% of the time and drivers in the control group looked for pedestrians 47% of the time. The location of the obstruction (left versus right) did not affect the probability that a driver would look for a
pedestrian. In the second session, consider just the last scenario when a pedestrian emerged from behind a stopped vehicle in the travel lane. The time-to-crosswalk at which a driver first looked for a pedestrian was 2.2 seconds for the advance yield markings condition and 1.0 seconds for the standard markings condition, a difference which was statistically significant. Additionally, none of the subjects yielded for the pedestrian in the control group. However, when advance yield markings were used, 61% of the drivers yielded or stopped for the pedestrian. The difference (61%) is statistically significant. Thirty-six percent of the subjects that stopped completed an evasive maneuver to avoid a collision (steering left or sudden deceleration). This abrupt response is an unintended consequence that deserves further investigation since it may result in an increase in rear-end (vehicle-vehicle) collisions. In summary, advance yield markings and prompt signs in multiple threat scenarios lead to changes in drivers’ behaviors which are likely to reduce pedestrian-vehicle conflicts.
Title: SOCIO-SPATIAL CHARACTERISTICS OF CYCLISTS INVOLVED IN ACCIDENTS

Presenting Author: Dominique Fleury

Authors: D. Fleury 1; J. F. Peytavin 1; N. Bué 1;

Affiliation
1. INRETS - Marne la Vallée - France,

Abstract:
The ambition behind the “Road Risk Spaces” project undertaken in Lille is to produce an analysis of insecurity and of preventive actions at a comprehensive level. This was made possible thanks to cooperation between INRETS MA, the GEOSYSCOM laboratory at the University of Caen, CETE Méditerranée, CETE Nord Pas de Calais and the Lille Metropolitan Urban Community (LMCU). This project was the opportunity to compare a very large amount of spatialised data from different sources: LMCU, INSEE, the Directorate General for Taxes, the Regional Council, CETE, Teleatlas, etc. The accident data included in this project are the BAACs (Bodily Injury Accident Analysis Bulletins) comprising the national statistical database, the Urban Community’s file, which has the advantage of spatialising accidents, and the scanned accident reports. At this stage, this is powerful analysis tool which was developed to provide a territorial approach to risk.

In this project, we undertook a special research on cyclist safety, with a specific look at socio-spatial characteristics of the cyclists involved in the accidents. The study covered the territory of the Lille Metropolitan Urban Community (LMCU).

Results show the importance of the size of the towns on the density of accidents, the level of traffic, as well as the type of lay out. The influence of cycle roads, bus lanes has been studied.

Three quarters of the people involved are men, but this number greatly differed when looking at the age of the person involved.

Most of the people did not have a professional activity at the time of the accident and many of them were students. A comparison was made between the types of profession of the inhabitants of LMCU and of the persons involved in the accidents, showing different level of risk.

The type and the severity of injuries, as well as the part of the body involved, were studied according to the age. The fatal accidents were specifically analyzed.

The accidents were described: type of collision, manoeuvres of the drivers/riders, accident scenarios.

38% of the people were involved in an accident at less than 1000m of the place where they live. Even if the mean of the distances are the same according to the gender, the standard deviation is much larger for the male population. This is the result of specific behaviours of some men, 20 – 40 years old, especially those living in rural areas. The profession has also an impact on the distance between the place of residence and the place of the accident.
Title: BICYCLISTS’ BRAKING PROFILE ON SEVERAL TYPES OF URBAN PAVEMENTS

Presenting Author: Athanasios Galanis

Authors: A. Galanis 1; N. Eliou 1; E. Misokefalou 1; P. Lemonakis 1;

Affiliation
1. Department of Civil Engineering, University of Thessaly, Greece,

Abstract:
Bicycling is considered to be one of the sustainable transport modes and its use is going to rise in the future, in order to promote the sustainable mobility in the urban road environment. Many cities are not ready to deal with the rising necessity of a safe and functional bicycle road network, which is critical for the bicyclists’ safety. Bicyclists except for bikeways can ride their bikes on pedestrian areas, sidewalks or on road segments sharing the road with other vehicles. The purpose of this study is to investigate the necessary brake length and time until the bicycle is stopped, considering factors like the type of the road pavement and the speed of the bicycle. The study will take place in the city of Volos, which is a typical medium sized Greek city. In order to conduct the study, specific GPS based equipment (Video VBOX, Racelogic, UK) will be used. This equipment collects data like speed, length and deceleration, providing simultaneously real time video data. Furthermore, specific equipment that counts the friction of the pavement shall be used. A city model bike will be used, which is representative to the type of bicycles that are being used in the urban environment. Except of the equipment, a volunteer bicyclist that would be healthy and experienced was necessary to participate. The inclusion criteria for the participants should be: age 20-30 years old; healthy without serious cardiovascular or musculoskeletal disease; and commuting with bike more than three times a week for the past two years. The maximum bicycle speed at the braking time is chosen to be 15 km/hr (low), 20 km/hr (medium) and 25 km/hr (high). It is necessary that the study area should be clear of trees or high buildings that hamper the GPS signal from the satellites. Due to that fact, the field test shall be conducted in the University of Thessaly campus and the pedestrian area at the port of the city. Furthermore, the field test should be conducted under good weather condition, without winding or raining. In the selected areas, the bicyclist should ride the bike in specific designed routes on three different types of pavement: asphalt, cement bricks and cement plates. Before the beginning of each test, the participant should ride the bike for several hundred meters in order to get used to it. Starting the field test, the bicyclist accelerates to the chosen speed and after keeping it for several seconds moving in a direct line, he reaches the braking point. As soon as he reaches that point, he will suddenly apply the brakes with maximum force until the bike will completely stop. After each testing route and the data collection, the data will be exported to a laptop with the use of a compatible card-reader for further analysis.

During the data analysis process, the data will be analyzed using specific software. The results of our study will be the finding and evaluation of speed-length and speed-time diagrams for each type of pavement. After that, we will be able to precisely count the braking length and deceleration for each pavement type and compare them according to the three tested speed levels.

In summary, in the present research, the main target is to find out the braking profile of typical city bicycles in representative pavements of urban road infrastructure, where a bicyclist could normally move and evaluate them for the bicyclists’ road safety improvement.
Title: INCREASING PTWS' DETECTABILITY BY USING PHI-PHENOMENON

Presenting Author: Pnina Gershon

Authors: P. Gershon 1; M. Gadian 1; D. Vintrob 1; D. Shinar 1;

Affiliation
1. Department of Industrial Engineering and Management, Ben-Gurion University of the Negev, Beer Sheva, Israel,

Abstract:
Background: The vulnerability of powered two-wheel (PTW) riders, as well as bicyclists and pedestrians, highly increases their risk of being killed when involved in road accident. The majority of the accidents involving PTWs are the result of perceptual human errors, including the failure to notice the PTW within the dynamic traffic environment, lack of drivers' attention, temporary view obstructions or low conspicuity and visibility. Objective: The current study evaluates the potential of a unique and novel display of two helmet-mounted lights that blink in an alternating manner to create movement illusion to increase PTWs' conspicuity and visibility. The study includes two experiments to evaluate this blinking light system (BLS): in the first experiment we evaluate whether the conspicuity of PTWs to unalerted viewers is increased by the BLS. In the second experiment we evaluate BLS' effects on the PTW's visibility to alerted viewers. Alerted and unalerted refer to the viewers' prior cueing to search for a PTW. Method: A total of 20 (10 male and 10 female) students will participate in experiment 1. The experiment is a within-subject design and includes three phases: demographic data collection, training session, and an experimental session in which every participant is presented with a series of 48 short movies, 24 with a PTW present and 24 without (controls). The 800 millisecond movie clips are displayed in a random order, after which the unalerted participant is asked to report the types of vehicles that were present in the short movie. Experiment 2 also includes 20 students (10 male and 10 female), and will incorporate the same short movies as in experiment 1. However, in this experiment the participants will be alerted to search for a PTW in the movie and to report its presence or absence as soon as they reach a decision. In this experiment reaction time is measured and the maximal presentation time of each movie is 2000 milliseconds, after which the movie will disappear. Preliminary results**: Preliminary results of experiment 2 indicate that the BLS increases PTWs' detectability by 33 percent compared to the control conditions. Moreover, the results indicate that the influence of the BLS is greater in the dusk (early evening) hours, where it increases the PTWs' detectability by approximately 14 percent (vs. 3 percent increment in daytime). In the experiment 2 the average reaction time required to identify a PTW by an alerted viewer decreased by 60 milliseconds when using the BLS. As expected, the difference in average reaction time during dusk (718 milliseconds) was shorter than in daytime (737 milliseconds). Conclusions: Overall, the preliminary results show that the BLS has a positive effect on the detectability of PTW. Previous studies on PTW conspicuity and visibility have shown that the conspicuity of a PTW rider can be increased by using an appropriate outfit that distinguishes the rider from the background scenery. However, due to the dynamic nature of the driving surroundings, it is nearly impossible to always meet this requirement. It seems that the BLS has the potential to increase PTW detectability regardless of the background especially, at dusk.

** This abstract represent work in progress, but the study will be completed by February 2010.
Keywords: Powered Two-Wheel (PTW), Visibility, Conspicuity.
Title: MOTORCYCLE’S CONSPICUITY AND VISIBILITY UNDER VARIOUS ENVIRONMENTAL CONDITIONS

Presenting Author: Pnina Gershon

Authors: P. Gershon 1; D. Shinar 1;

Affiliation
1. Industrial Engineering and Management, Ben-Gurion University of the Negev, Beer Sheva, Israel,

Abstract:
Background: Powered Two-Wheels (PTWs) are an important sector of the road traffic population. Their relatively small size makes them a practical solution for congested roadways. The majority of accidents involving PTWs occur in daylight, clear weather, and in light and moderate traffic. Nonetheless, compared to cars, PTWs are less detectable. We define their detectability in terms of conspicuity – the ability to detect a PTW when it is unexpected – and visibility – the ability to detect it while actively searching for it. Prior research showed that PTWs have a lower conspicuity and visibility in traffic compared to cars, and therefore improving them may provide a strategic means for improving PTWs’ safety. Objective: The current study included two experiments, designed to evaluate the influence of different PTW treatments on their conspicuity and visibility in different sceneries.

Method: In Experiment 1, 66 students were individually presented with a series of 72 pictures, 36 with PTW at any one of four distances from the viewer (camera) and 36 without PTW (control condition). The pictures were randomly displayed for 600 milliseconds, after which the participants were asked to report the types of vehicles that were present in the picture. In Experiment 2, 64 students viewed the same pictures, but this time they were instructed to search for a PTW in each of the pictures and report its presence or absence as soon as they reached a decision. In this experiment reaction time was measured and the maximal presentation time of each picture was 10 seconds after which the picture disappeared.

Results: Experiment 1 results indicated that the detection of a PTW was a function of the interaction between its distance from the viewer, the driving scenery and rider’s outfit. At a close distance, the PTW was almost always identified, regardless of the influence of the driving scenery and rider’s outfit. However, when the PTW was far from the viewer, the different outfits affected its’ conspicuity. The detectability of the PTW in both reflective and white clothing increased linearly as the PTW distance decreased. This was especially true in urban congested streets where the color of the background surroundings of the PTW was more multihued (varied). Conspicuity was greater for the reflective and white outfits than for the dark clothing condition. In contrast, on open inter-urban roads, where the background was mostly bright skies, the dark outfit provides an advantage for the detection of the PTW. For the same distances, the detection of the PTWs by the alerted viewers in experiment 2 in all conditions was nearly 100 percent (99.83%). For an alerted viewer, a 10-second period was more than enough to identify the PTW regardless of the test conditions. The average reaction time to detect a PTW was 1.51 seconds. As in the results of experiment 1, in urban crowded environments the reflective and white clothing provided an advantage to the detection of the PTW. For the same time, the reaction time decreased linearly as the distance from the viewer decreased.

Conclusions: The conspicuity of a PTW rider can be increased by using an appropriate outfit that distinguishes him from the background scenery. Unfortunately, detectability – especially conspicuity – is compromised by the perceptual characteristics of the environment that changes continuously along a route. Thus, to increase detectability both the riders need to be aware of the perceptual aspects of their environment, and drivers need to increase their level of expectancy concerning a possible rider on the road (as drivers with high expectation obtained nearly 100 percent...
detection rates). Present research is directed at enhancing conspicuity in a manner that would relevant to multiple environments.

Keywords: Powered Two-Wheel (PTW), Visibility, Conspicuity.
Title: MAPPING PATTERNS OF PEDESTRIAN FATAL ACCIDENTS IN ISRAEL

Presenting Author: Victoria Gitelman

Authors: V. Gitelman 1; C. G. Prato 1; S. Bekhor 1;

Affiliation
1. Ran Naor Research Center, Technion, Haifa, Israel,

Abstract:
Yearly, over 400 people are killed and thousands more are injured on Israeli roads, with foreseeable costs to society in terms of human lives, property damages, delays for roadway users, etc. Around 150 victims are pedestrians, a staggering number in terms of fatality rates in comparison with other developed countries. This study intends to provide a broad picture of pedestrian traffic accidents in Israel by uncovering their patterns and underlying their recurrent characteristics. As the literature in accident analysis shows, there is a growing interest in the individuation of accident patterns and characteristics in order to design preventive measures, to address specific situations and to target specific population groups with the ultimate objective of reducing the number of fatalities and accidents.

This study analyzes 603 pedestrian fatal accidents occurred in Israel during the four-year period between 2003 and 2006. The analysis focuses on fatal accidents since, without discarding the relevance of road crash injuries, the number of fatalities is clearly the indicator that represents the most the country situation over the years. The four-year period is long enough to limit random fluctuations in the accident counts and short enough to control for changes in road and traffic conditions. Data contain details about modality, location, infrastructure conditions, environment conditions, vehicles and persons involved in each pedestrian fatal accident, as reported by the Israeli police and coded by the Israeli Central Bureau of Statistics.

This study applies Kohonen neural networks for pattern recognition purposes, after discarding three alternative approaches used frequently in the literature. A priori determination of the clusters, factorial analysis of correspondence and rough set theory require a large amount of assumptions prior to the data analysis, a practice that did not seem suitable to uncover accident patterns from a large database and a large set of accident characteristics. Kohonen neural networks are unsupervised self-organizing maps, namely the networks are presented with data and the correct output that corresponds to that data is not pre-specified. Kohonen neural networks are very practical because they are relatively simple to construct, can be trained very rapidly and can be applied to linearly separable problems. Their structure consists only of an input and an output layer of neurons without any connecting hidden layer. Categories of the pedestrian accident characteristics constitute the input neurons and clusters constitute the map of output neurons. As the algorithm connects each of the input neurons to each of the output neurons and weighs each connection in order to choose a single output neuron as the “winner” output for each case, the result is the assignment of each accident to one output neuron cluster.

Results show the existence of five major clusters of fatal pedestrian accidents. The first cluster includes accidents where elderly pedestrians crossed on zebras far from intersections in urban areas, mainly in the Tel Aviv metropolitan area. The second cluster contains crashes where pedestrians crossed the road suddenly or from hidden places and collided mainly with two-wheel vehicles in urban sections, prevalently inside one of the three main metropolitan areas. Similar modality of collision, even though with cars and not motorcycles or bicycles, is observed for the third cluster, where mostly male pedestrians crossed rural sections at night, and the fourth cluster, where mainly young male pedestrians crossed large road sections in both urban
and rural areas at night. The fifth cluster consists of accidents where mostly young children and teenagers crossed narrow roads in small villages in the north of Israel. The most important variables uncovered by the Kohonen networks are accident location, width and presence of median barrier in road sections, modality of the crash, period of the crash, and age and population group of the victims. In particular, specific population groups in specific areas appear subject to be involved in fatal pedestrian accidents. From a policy perspective, these results could suggest the necessity to target these groups and these areas with campaigns that increase the public awareness of the problem and interventions that improve for example crossing conditions for elderly and youngsters in specific areas of the country.
Title: NATIONAL OBSERVATIONAL SURVEY OF PEDESTRIAN BEHAVIOUR AT CROSSWALKS

Presenting Author: Victoria Gitelman

Authors: V. Gitelman 1; D. Shinar 2; S. Levi 2;

Affiliation
1. The Ran Naor Road Safety Research Center, Technion, Haifa, Israel, 2. Israel National Road Safety Authority,

Abstract:
Pedestrian injury is one of the major road safety problems in Israel where pedestrians typically present a third of the total road accident fatalities and about a tenth of the total injuries. Improper infrastructure characteristics, unsafe pedestrian behaviour, vulnerability of certain pedestrian groups or improper interaction between pedestrians and crosswalk arrangements appear among factors contributing to pedestrian accidents. Observational surveys are one of the ways for studying these factors. A national observational survey of pedestrian behaviour was initiated in Israel aiming at characterization of pedestrian behaviour at crossings and providing a basis for long-term monitoring.

As pedestrian behaviour is infrastructure dependent, it is common to define the survey for different types of locations. The Israeli survey's framework included three types of pedestrian crossing sites: signalized junctions, non-signalized junctions and street sections - because, according to a recent study of pedestrian accidents in Israel, these types of locations are associated with a significant share of both fatalities and injuries. The survey is focused on urban sites as those are responsible for 75% of pedestrian fatalities and 95% of pedestrian injuries in Israel. For each location type, a stratified sampling of sites was applied, based on the population size and types of Israeli towns and accounting for geographic areas of the country. In addition, in selecting the sites an equal subdivision of crosswalks on divided and undivided roads was provided. The final sample included 59 sites distributed throughout the country, of which 19 were at signalized junctions, 19 at non-signalized junctions and 21 at street sections.

At each site, the observations continued for 4 hours. The survey was focused on the pedestrian behaviours such as: compliance with traffic lights at signalized crossings; stopping prior to crossing; checking vehicle traffic prior to crossing; place of waiting to cross; finishing crossing during green; crossing within the crosswalk boundaries; using distractions (earphones, mobile phones) by pedestrians; pedestrian-vehicle conflicts. The survey was carried out in November 2008; the sample included 6613 pedestrians.

The data analysis demonstrated the extent of unsafe pedestrian behaviours according to crossing types, e.g.:
- At signalized junctions, 12% of the pedestrians do not stop prior to crossing and 17% cross on red, of whom 20% - outside the crossing boundaries.
- At non-signalized junctions, 57% of pedestrians do not stop prior to crossing and 15% of those who stopped, wait on the carriageway; 20% of those who did not stop cross outside the crossing boundaries.
- On street sections, 41% of the pedestrians do not stop prior to crossing and 23% of those who stopped wait on the carriageway; 33% of those who did not stop cross outside the crossing boundaries.

Moreover, "a chain" of unsafe behaviours is identifiable: among those who cross on red and do not stop prior to crossing, typically higher shares of crossings outside the boundaries, not checking the vehicle traffic and crossing on red/ outside the boundaries at the second half of the crossing, were observed.
Comparing the age groups, high shares of unsafe behaviours were observed for younger pedestrians (until 18) than for adults (19-65). On the other hand, elderly pedestrians (aged 65+) are typically strict to observe safe behaviour rules, more so than other ages. Nevertheless, they experience higher shares of not finishing crossing on green and of vehicle-pedestrian conflicts at signalized junctions. The survey’s data enabled comparisons of pedestrian behaviours at various traffic arrangements. It was found that e.g.:
- at signalized crosswalks without a separation versus similar crosswalks with a separation, more pedestrians did not check the traffic prior to crossing;
- comparing non-signalized crosswalks, more pedestrians did not stop prior to crossing at junctions than on street sections;
- crosswalks on single-carriageway streets are associated with the highest shares of pedestrians crossing outside the boundaries among those who did not stop and of pedestrian-vehicle conflicts.

The scope of pedestrian distraction was not high: on all types of crosswalks, 9%-12% of pedestrians were observed with earphones, 1%-4% with mobile phones. Additional insights into pedestrian behaviours of populations groups: religious sectors, the Arab population – is provided.

The findings are useful for planning safety interventions (publicity and enforcement campaigns, public education) and for re-considering typical pedestrian crossing arrangements in Israeli towns.
Title: SCHOOL TRANSPORTATION SAFETY: AN OBSERVATIONAL STUDY OF DRIVERS AND PUPILS ON THE SCHOOL BUS

Presenting Author: Sharon Goldman

Authors: S. Goldman 1; K. Peleg 1,2;

Affiliation
1. The Center for Trauma & Emergency Medicine Research, Gertner Institute, Israel, 2. The Multi-disciplinary Program for Emergency and Disaster Management, Tel Aviv University, Israel,

Abstract:
Introduction: The safety of children traveling to and from school is a global issue. The school bus is a common means for children to travel to and from school, both locally and globally. In Israel, 90% of the pupils living in rural communities travel daily by school transportation. School bus safety is dynamic, in that regulations are often changing. As of September 1, 2006, in all vehicles used for school transportation in Israel, not only is the number of pupils limited, but also seatbelts are mandatory. This policy was the response to a single mass casualty event, in which three pupils were killed and 40 were injured after a school bus and jeep collided on the way home from school on the last day of the 2004 school year.

Objective: To observe seatbelt usage, pupil and bus driver behavior and potential safety hazards on buses used for school transportation.

Methods: An observational study on vehicles used for school transportation in the general education system in rural communities in Israel. A questionnaire was designed for data collection, and was completed by observers who were on the bus ride from the beginning to the end of the route. The study focused on student, bus driver, and chaperone behaviors as well as vehicle and bus stop related hazards.

Findings: Observations were performed on 362 bus rides, using 125 buses on which 11,000 pupils traveled to and from school. Seatbelt use among the pupils was scarce: On 42% of the rides none of the students fastened seatbelts. Pupils in elementary were more likely to fasten seatbelts compared to middle/high school students (80% and 26%, respectively for not fastening seatbelts p<.0001). Precarious pupil behavior was greater on afternoon bus rides (OR:3.2, 95%CI:2.1-5.3), on routes with 5 or more bus stops (OR:4.1;95%CI 2.5-6.5) and on rides with elementary school pupils (OR:1.8; 95%CI:1.2-2.9). Older buses (over 10 years) were almost four times more likely to have a hazard than new buses. Bus drivers were observed using a cellular phone while driving (11%), allowing students to get on/off the bus using the rear door (10%), allowing young students to sit in the first seat (35%) and disobeying traffic laws. In addition, students were observed boarding or get off the bus at non-designated bus stops and were left in the bus without supervision while the engine was running. Drivers who drove the route once a week or less were more likely to engage in risky behavior compared to permanent drivers.
Conclusions: This study is the largest study of its kind to observe on-bus behaviors. Government regulations and seatbelt availability are not enough to confirm seatbelt usage among pupils. Furthermore, it is not realistic to require the bus driver to enforce seatbelt use and tackle pupil misconduct, while being expected to drive safely. In an effort to increase pupil safety, innovative strategies for improving pupil behavior on the school bus needs to be developed and implemented, while bus driver conduct and driving skills need to be regularly monitored. Finally, rules and regulations need to be implemented on the basis of evidence based research and not the outcome of one tragic mass casualty event.
Title: A METHOD TO IDENTIFY CHANGES IN PEDESTRIAN AND CYCLIST COLLISION RATE

Presenting Author: Offer Grembek

Authors: O. Grembek 1; D. R. Ragland 1;

Affiliation
1. Traffic Safety Center, University of California, Berkeley, CA, USA,

Abstract:
The identification of high collision locations is well-studied in transportation safety. However, insights regarding high collision locations are not always downward scalable when collision counts are orders of magnitude smaller, as in the case of pedestrian and bicyclist collisions. The problem with such small numbers is that for an individual intersection, an annual increase of one or two collisions could be the only indication that an intersection’s underlying risk has changed. It is therefore very difficult to determine what collision count would mandate further investigation. This is important because it may lead to inefficient use of resources. The objective here is not to predict high collision locations, but rather to identify locations that indicate a systematic change in the underlying pedestrian and bicyclist’s collision rate.

In this study we use actual collision counts to create a longitudinal confidence region around the minimum collision rate of an intersection. This procedure takes into account both the mean and the variance of the collision counts to estimate the minimum underlying collision rate. However, we have shown that the variance for an individual intersection may still be too large to identify any statistical change in risk. Therefore, intersections are subsequently clustered and confidence intervals are constructed for each cluster.

We begin by explaining how we construct a confidence region for a single intersection. We first choose an initial collision rate and construct upper and lowers bounds assuming a Poisson distribution. We then follow the same procedure to construct the bounds around an average of two Poisson random variables and so on up to an average of 20 Poisson random variables. The result is a continuously decreasing confidence region around the initial collision rate. We then plot the actual collision counts for an intersection and check if they all fall within the boundaries. We developed an algorithm to modify the initial condition and determine the smallest collision rate that would contain all observations. When this happens we have obtained an estimate for the minimum collision rate as indicated by the collision data. Any future observations that fall within these boundaries are not statistically different from historical data, for a specific level of confidence. Since our bounds only represent the minimum collision rate we cannot determine if observations outside the bounds actually indicate a change in collision rate. However, we can alleviate some of this deficiency by systematically clustering intersections.

To cluster the intersections we obtain the confidence region around the minimum collision rate for all intersections of interest. We use K-means cluster analysis to cluster the intersection by similar collision rates and construct an aggregate confidence interval for each of the clusters. We use these clusters to evaluate whether future collision counts represent probabilistic variation or require further investigation by the responsible agency.

We tested this technique using annual collision counts from 1997 to 2007 for a 14 intersection section along San Pablo Avenue (a major arterial in the San Francisco Bay Area). The analysis showed that using four years of historical data can identify temporal changes in an intersection’s collision rate using only collision counts. These results mandate further development of this procedure to evaluate the performance of alternative clustering approaches that capture the natural tendency for spatial clustering and to evaluate what we can gain from introducing additional information about the intersection’s features.
The technique presented here serves two purposes: (i) identify when an intersection’s collision rate is not statistically consistent with historical data; (ii) evaluate if modifications designed to affect the underlying collision rate resulted in a significant change in collision rate.
Title: DIFFICULTIES OF OLDER CYCLISTS AND THEIR COMPENSATION

Presenting Author: Carmen Hagemeister

Authors: C. Hagemeister 1; A. Tegen-Klebingat 1; L. Venz 1;

Affiliation
1. Department of Psychology, Dresden University of Technology, Germany,

Abstract:
Cycling is fun, cycling keeps fit, cycling is cheap, but what happens when cyclists become older and less strong, less motile, see and hear worse than before? How do cyclists cope with these difficulties in such a way that they still can use their bike? Does the compensation impair or improve their safety?

Thirty cyclists were interviewed (in the three groups 60 to 69 years of age, 70 to 79 years, and older); they lived in the city of Dresden or in towns with good public transport or in rural areas with insufficient public transport in flat areas of Saxony. In in-depth-interviews they were asked for their cycling habits and how they deal with different situations in traffic.
They reported for physical and sensory problems which impair them when cycling and how they cope with them. Most interviewees use their bike for errands, visiting friends and the like, two thirds also use it for cycling tours.

Most participants avoid weather conditions like rain and snow. Most do not cycle in the dark simply because they usually are at home when it is dark. Many cyclists tend to avoid dense traffic and like to cycle on cycle paths. The opinion towards cycling on the footpath is divided: Some cyclists feel safer away from passing cars, others see the danger at intersections and gateways where car drivers do not expect them and the fact that they might be a nuisance for pedestrians. Two thirds do sometimes cycle on the footpath when it is not allowed, some use cycle paths in the wrong direction; some run red lights, some cycle in the wrong direction in one-way streets.

When a gradient is too steep the interviewees get off the bike and push it. Four persons reported that they have more difficulties cycling straight ahead than before; two of them have also problems with their balance when walking or hiking. Some persons reported that they have difficulties to move as they would like to do. Some feel impaired when they have to look over their shoulder for traffic, others have problems to get on or off their bike and use “ladies’ bikes”. Still others experience cycling as easier than walking, especially when they are not as fit as usual. Those persons taking medicine said that the medicine does not affect their ability to participate in traffic.

All interviewees wear glasses but some only need them for reading. Some have troubles with their glasses when they cycle in the rain because of drops or mist. Others have problems with their varifocal lenses when cycling. Two thirds reported difficulties when cycling in the dark, two thirds reported difficulties with glare. Some interviewees reported problems with hearing but not all of them feel that they affect them in traffic. Some cyclists feel less secure because of their hearing problems and compensate for them by always looking over their shoulder properly.

Technical equipment which might make cycling easier for older cyclists is not very common; this holds for electric support, tricycles, rear mirrors and so on.
Those cyclists whom we interviewed generally have good health and feel relatively little impaired. They can continue to cycle as they are able to compensate for their difficulties. Just as older car drivers older cyclists are more choosy concerning the conditions under which they cycle, which they see as a privilege for those having more time. The opinions of older cyclists what is safe to do in traffic are divided just as they are in younger cyclists as well. Technical adaptation of bikes is not very popular.

At present we are constructing a questionnaire covering the above mentioned topics. This questionnaire will be completed by 210 older cyclists.
Title: WHY DO OLDER PERSONS GIVE UP OR REDUCE CYCLING?

Presenting Author: Carmen Hagemeister

Authors: C. Hagemeister 1; S. Koch 1;

Affiliation
1. Dresden University of Technology, Germany,

Abstract:
Cycling is a cheap and practical means of travel but older persons often reduce or give up cycling. Furthermore, moderate physical activity improves health. The aim of this study was to describe antecedents and consequences of reducing or giving up cycling in older persons. Whereas antecedents and consequences of reducing or giving up driving are well known, they have not yet been assessed for cycling. This study is to provide a first insight into this topic.

In in-depth interviews with 32 persons from 65 to 89 years of age we assessed their reasons for reducing or giving up cycling. On average these persons have been cycling very much and regularly: Two thirds have owned and used a bike all their life.

On average the persons interviewed cycle less, less often and shorter distances than before. They avoid busy times and dense traffic, cycling in the dark and in bad weather. Many persons named multiple reasons for reducing or giving up cycling: Only a quarter of the participants named only a single reason which was in most cases health-related. About two thirds of the participants mentioned health reasons among the main reasons, about one third was afraid of falls or accidents, about one quarter said that they felt in an age where persons need no longer cycle, one third said that their needs had changed, one third said that the traffic conditions had contributed, six persons mentioned their bike, four persons significant others. For about one third of the participants reducing or giving up cycling had not changed their life markedly. About one third felt restricted in their recreational activities. Some persons who also had troubles when walking felt markedly constrained in their daily life as they had to walk to public transport stops.

Health reasons are the most important problem making persons reduce or giving up cycling. Possible solutions are discussed, among them advice by well informed doctors, training under professional supervision to overcome physical difficulties or better cope with them, bike parking in garages or bicycle sheds and bike parts or a bike which fit the needs of older cyclists better than usual bikes.
Title: NEAR MISS STUDY AND MOTORCYCLES
A STUDY OF MOTORCYLISTS IN NORTHERN IRELAND, SOUTHERN IRELAND AND GREAT BRITAIN

Presenting Author: Elaine Hardy

Authors: E. M. Hardy 1;

Affiliation
1. Right To Ride Ltd, Northern Ireland, United Kingdom,

Abstract:
During the months of May through to July 2009, a survey of 257 motorcyclists in Ireland (Northern and Southern) and Great Britain was carried out through the internet. The purpose of the survey was to find out from motorcyclists, whether they had experienced situations in which they believed they could have crashed and/or been injured (but were able to keep control of their motorcycle) as well as the type of situations they had experienced.

Two approaches were used in the study. The first was a quantitative survey of motorcyclists in Northern Ireland, Southern Ireland and Great Britain (England, Scotland and Wales).

The questionnaire was developed using web based survey software, designed specifically for the internet. The survey was divided into three sections. The first section requested information about the rider, including age, sex, location of residence, type of license and testing/training. The second section asked questions about the motorcycle: category, type and make of motorcycle, mileage, years riding and seasons.

The third section asked the respondent whether he/she had been involved in a collision either with another vehicle or a single vehicle crash, with or without injuries as well as whether the rider had had a “near miss accident”.

The “near miss” questions gave a selection of 26 potential answers divided into four categories: skidding, loss of traction, loss of control and braking or swerving. A further question asked the respondent to comment on any other “near miss” experience

From the findings from this survey, 75 riders indicated that their motorcycle skidded and of these 34.7% (n.26) indicated that this was due to “to slippery or loose road surface (e.g. paint or worn asphalt), loose gravel” while 28% (n.21) indicated that this was “due to oil spillage on the road”

53 riders replied that they had lost the grip of their motorcycle and 45.3% (n.24) of these stated that this was due to potholes or grooves in the road; in equal measure 17% (n.9) commented that their loss of grip was due to lack of focus and travelling too fast for the conditions.

56 riders replied that they had nearly lost control of their motorcycle and of these, 32.1% (n.18) stated that this was due to road markings or over-banding), a further 30.4% (n.17) indicated that this occurred at a curve and a further 26.8% (n.15) indicated that this occurred at a junction.

165 of the 201 (82.1%) riders that replied to these questions answered that they had to either swerve and/or brake because of another vehicle or pedestrian entering into their space. In fact 40.6% (n.67) answered that they had to swerve and/or brake because another vehicle had
entered their path from either a side road, private driveway or opposite direction. This was followed by 15.2% (n.25) who stated that the other vehicle had changed lanes on the motorway in front of them and 13.9% (n.23) indicated that the other vehicle had crossed over into the rider’s lane and was coming towards them.

In September 2009, a focus group of expert motorcyclists including trainers, police, road safety officers and user group representatives was held to discuss the outcome of the study and to provide recommendations in areas such as training; error management technique; road infrastructure design; vehicle design; policy, regulations and legislation; and advertising campaigns.

The findings of the survey and focus group aim to support and compare to analysis of accident causation and prevention, in order to find solutions to reduce motorcycle casualties by identifying from the motorcyclists’ perspective, what are the more common points of collision and the causation of the collision between motorcycles and other vehicles as well as collisions between motorcycles and road furniture/infrastructure.
Title: OPTIMISM ABOUT SAFETY AND SELF-SERVING ATTRIBUTIONS OF RESPONSIBILITY FOR SAFETY AMONG PEDESTRIANS AND CYCLISTS IN RELATION TO ROAD USE UNDER LOW LIGHT CONDITIONS

Presenting Author: Narelle Haworth

Authors: N. Haworth 1; M.J. King 1; J.M. Wood 2; P.F. Lacherez 2; R.P. Marszalek 2;

Affiliation
1. CARRS-Q, Queensland University of Technology, Australia, 2. School of Optometry, Queensland University of Technology, Australia,

Abstract:
Drivers are known to be optimistic about their risk of crash involvement, believing that they are less likely to be involved in a crash than other drivers. However, little comparative research has been conducted among other road users. In addition, optimism about crash risk is conceptualized as applying only to an individual’s assessment of his or her personal risk of crash involvement. The possibility that the self-serving nature of optimism about safety might be generalized to group-level identity as a cyclist or a pedestrian, i.e. becoming group-serving rather than self-serving, has been overlooked in relation to road safety. This study analysed a subset of data collected as part of a larger research project on the visibility of pedestrians, cyclists and road workers, focusing on a set of questionnaire items administered to 406 pedestrians, 838 cyclists and 622 drivers. The items related to safety in various scenarios involving drivers, pedestrians and cyclists, allowing predictions to be derived about group differences in agreement with items based on the assumption that the results would exhibit group-serving bias. Analysis of the responses indicated that specific hypotheses about group-serving interpretations of safety and responsibility were supported in 22 of the 26 comparisons. When the nine comparisons relevant to low lighting conditions were considered separately, seven were found to be supported. The four comparisons which were not found to be consistent were spread relatively evenly between pedestrians and cyclists, and between items referring to low lighting conditions and more general items. The findings of the research have implications for public education and for the likely acceptance of messages which are inconsistent with current assumptions and expectations of pedestrians and cyclists. They also suggest that research into group-serving interpretations of safety, even for temporary roles rather than enduring groups, could be fruitful. Further, there is an implication that gains in safety can be made by rendering road users safer than they realize, such as through the adoption of visibility aids like biomotion, a central focus of the broader research project from which this study was drawn.

Keywords
Pedestrians, Cyclists, Self-serving, Optimism bias, Visibility
Title: POWERED TWO WHEELERS IN A CHANGING WORLD - CHALLENGES AND OPPORTUNITIES

Presenting Author: Narelle Haworth

Authors: N. L. Haworth 1;

Affiliation
1. CARRS-Q, Queensland University of Technology, Queensland, Australia,

Abstract:
Powered two wheelers (PTWs) come in diverse forms and are used for a range of purposes in very different parts of the world. In many parts of the world, the forms and uses of PTWs are changing, influenced by social, economic and population changes. This paper seeks to outline the challenges and opportunities within this complex and changing environment and to identify some potential ways forward.

It is estimated that there are 313 million PTWs in the world of which 77% are in Asia, 5% in Latin America, and 2% in North America (Rogers, 2008). Internationally, the number of PTWs is increasing, with the largest absolute and percentage increases in Asia. PTW use has traditionally been more popular among males than females but there is evidence that riding by women is increasing.

In very general terms, most of the challenges associated with PTWs relate to safety, while the majority of the opportunities relate to mobility. Much of the controversy surrounding PTWs relates to the different perspectives that individuals and organisations bring. Safety professionals see the challenges, while transport professionals and PTW enthusiasts embrace the opportunities.

The challenges for improving the safety of PTW users can be roughly categorised into those that relate to the PTW user, other road users, the road environment, the vehicle, data and research, and socio-political dimensions. The relative importance of particular challenges varies between developed and developing countries, and among developing countries according to whether PTWs are largely used for recreation or transport. For example, overloading of small motorcycles can be an important contributor to crashes in some Asian countries while lack of skills of older riders returning after many years of dormancy is relatively more important in countries such as the United States and Australia.

PTWs present a range of psychological, transport, economic and environmental opportunities to individuals and societies. The fun and excitement of riding PTWs is a major motivator for their purchase and use for recreational purposes, both off-road and on-road. The transport and economic advantages for the individual also need to be considered. In busy cities, filtering through stationary or slowly moving cars provides the opportunity for faster commuting, and PTWs are cheaper and easier to park. PTWs also offer a significant employment advantage to many poorer residents in developing countries who have little access to public transport for travel to work and cannot afford a car. At a societal level, research has examined the potential for increasing PTW volumes to reduce traffic congestion in major cities. The environmental benefits of reduced fossil fuel use by PTWs as a substitute for cars has been promoted, although little is known about the extent to which commuters are transferring to PTWs from cars versus from public transport. The paper will discuss the challenges and opportunities for an evolution from current PTW forms to other vehicles sharing similar benefits but with more
desirable safety characteristics.

The process of change is ongoing. This paper will discuss the implications for the generalisability of previous motorcycle safety research to the current situation, how much current research in developed world can help the developing world, and how much current knowledge can help in future planning.
Title: UNDERSTANDING AND USING SIGNALIZED CROSSINGS IN AUSTRALIA: THE PEDESTRIAN’S PERSPECTIVE

Presenting Author: Narelle Haworth

Authors: N. Haworth 2; K. M. Titchener 1; N. Brayley 2;

Affiliation
1. School of Psychology, Griffith University, Queensland, Australia, 2. CARRS-Q, Queensland University of Technology, Brisbane, Australia,

Abstract:
Pedestrian fatalities in developed countries comprise between 11% (USA) and 22% (Great Britain) of all road fatalities. This figure is much higher in developing countries where pedestrians comprise a large proportion of the road fatalities, with estimates ranging from 39% in Tanzania to 75% in Cote d’Ivoire. Observational research tells us how pedestrians behave while crossing the road but fails to tell us why pedestrians may adhere to or ignore signals at pedestrian crossings. The way in which pedestrians evaluate signalized crossings, how they perceive the signals, and how they choose to make use of the information presented is not well documented. The views of Australian pedestrians towards signalized pedestrian crossings are presented here.

Numerous factors have been suggested to influence pedestrians’ road crossing decisions, including; age, gender, waiting time before green, crossing location, and understanding the right-of-way rules. It is also necessary to establish what pedestrians believe the crossing signals mean and how they choose to act on them.

A survey was designed to provide pilot data with the aim of better understanding pedestrians’ crossing decisions at signalized crossings. 341 pedestrians (age range 18-64 years) who visit inner-city Brisbane, Australia, at least once a week responded to the online survey.

Results identified good levels of understanding for the steady red figure (do not cross) and the flashing red figure (do not commence crossing) with 96% and 95% respectively selecting the correct meanings. Although respondents believed they had a good to excellent understanding of the steady green figure (cross with care watching all traffic) only half the respondents (54%) selected the correct meaning. Adherence to the visual signals varied between different age groups with younger respondents more likely to cross against red signals than older respondents. In addition to watching the pedestrian signals while waiting to cross the road a number of other cues were highlighted, including watching the traffic signals and watching the vehicles themselves. Twelve percent of respondents stated they would cross during the red phase if an opportunity arose even though this behaviour is illegal in Australia. Adherence to pedestrian signals was also influenced by the respondent’s mood, traffic volume, the presence of children and other pedestrian’s behaviour.

Levels of patience were highlighted as particularly important. For example, 77% of respondents stated that they would cross inappropriately if the red signal (don’t commence crossing) begins to flash when they approach a crossing (rather than wait for the next green phase). Respondents were asked how long they would wait for a green walk phase before feeling impatient. Almost half (43%) indicated that they would wait for up to 60 seconds and 17% indicated being prepared to wait between one and two minutes before feeling impatient.
Of further interest were respondents’ perceptions of risk associated with crossing the road while engaged in distracting activities such as mobile phone use or listening to MP3 players. Older respondents generally felt such distractions were riskier than the younger respondents and reported engaging in these activities less while crossing the road.

In summary, the results have highlighted issues that may increase pedestrians’ risk while using signalised pedestrian crossings. For example, the length of waiting times before green phases can result in pedestrians choosing to employ their own crossing strategies and failing to adhere to the signals. Further, younger pedestrians were more likely to cross against the signals and to cross while engaged in potentially distracting activities such as mobile phone use than older pedestrians. The results also support previous international research suggesting that pedestrians are misinterpreting the green Walk signal to mean that they have the right-of-way and do not need to engage in precautionary behaviours such as checking for vehicles.

These results will guide the development of a larger survey to fully investigate pedestrians’ perceptions towards crossing signals currently in use in Australia. Identification of the way pedestrians are using signals alongside other information in their environment to inform their road crossing decisions will contribute to a broader knowledge base on which to build education campaigns or redesign signal technology or practices.
Title: SETTING PRIORITIES FOR RECOMMENDATIONS OF THE NATIONAL AGENDA FOR MOTORCYCLE SAFETY

Presenting Author: James Hedlund

Authors: J. H. Hedlund 1;

Affiliation
1. Highway Safety North, Ithaca NY, USA,

Abstract:
The National Agenda for Motorcycle Safety (NAMS) is a comprehensive plan to improve motorcycle safety in the United States in the 21st Century. The NAMS was developed by a Technical Working Group of representatives from a broad range of constituencies involved in motorcycle issues, led by the National Highway Traffic Safety Administration (NHTSA) and the Motorcycle Safety Foundation (MSF). The NAMS was published in November 2000. Its 82 recommendations address the full range of topics and strategies relevant to motorcycle safety: human, vehicle, environmental, and social factors to prevent crashes from occurring, reducing serious and fatal injuries in crashes, and providing for rapid emergency care to persons injured in crashes. The NAMS is available at www.nhtsa.gov.

Motorcycle traffic fatalities in the United States have more than doubled since 1996 and now contribute more than 14 percent of all traffic-related fatalities. Effective and scientifically-driven countermeasures to prevent motorcycle crashes and reduce serious and fatal injuries are critically important.

On September 11, 2007, the National Transportation Safety Board (NTSB) held a public meeting on motorcycle safety. Following the meeting, NTSB issued two recommendations to NHTSA:

H-07-35 Reprioritize the National Agenda for Motorcycle Safety recommendations based on objective criteria, including known safety outcomes.

H-07-36 Following completion of the reprioritization of the National Agenda for Motorcycle Safety requested in Safety Recommendation H-07-35, implement an action plan for States and others, such as federal agencies, manufacturers, insurers, and rider groups, to carry out those recommendations that are determined to be of high priority.

This paper documents the methods used to prioritize the recommendations as requested by NTSB. It defines three important characteristics of each recommendation, describes how the recommendations are classified according to each of these characteristics, and outlines the overall method used to in establish priorities.

The full study documents each recommendation’s priority. The study is under review at NHTSA and should be released shortly.
Title: WHAT INFLUENCE DO ROAD INFRASTRUCTURE PARAMETERS HAVE ON MOTORCYCLE CRASHES?

Presenting Author: Andreas Hegewald

Authors: A. Hegewald 1;

Affiliation
1. Bundesanstalt für Straßenwesen, Bergisch Gladbach, Germany,

Abstract: For several years the general development in the number of road crashes has consistently shown a positive trend. While in the last ten years the number of serious traffic crashes in Germany declined considerably, the number of crashes involving a motorcyclist remained nearly constant over the same period. Even though the population of motorcycles significantly increased in recent years, their proportion of the total mileage is almost negligible. However, the risk of a motorcyclist of being involved in a crash and suffering serious injuries is significantly higher than that of car occupants.

According to the official road crash statistics there were 327,984 injury crashes in Germany in 2006, 10% (32,933) thereof involving motorcyclist. Of these 32,933 crashes 63% (20,692) occurred on urban roads, 34% (11,296) on rural roads (roads outside urban areas without motorways) and 3% (945) on motorways. Overall, 793 motorcycle users (rider and passenger) were killed in a crash, 25% (201) of them on an urban road, 69% (544) on a rural road and 6% (48) on a motorway. These figures clearly indicate that the vast number of motorcycle crashes occur on urban roads; these crashes, however, are characterized by a relatively low crash severity. In contrast, the relatively few motorcycle crashes on rural roads are characterized by a high crash severity. Against this background, this study focuses on motorcycle crashes on rural roads.

The first step in the selection of road sections to be investigated was the preparation of a road map of Germany, which illustrated the share of motorcycle crashes with personal injuries of any personal injury crash in 2006. According to the map, there is a particularly high proportion of crashes involving motorcyclists in the federal states of North Rhine-Westphalia, Rhineland-Palatinate and Bavaria. This is because these federal states have extensive highlands, which are particularly attractive for motorcyclists. Therefore the further investigation is limited to rural roads in the federal states of North Rhine-Westphalia, Rhineland-Palatinate and Bavaria.

At first road sections with a disproportionately high average daily traffic (ADT) of motorcycles were selected in the three investigation areas. The crash density of motorcycle crashes was calculated for these road sections and, depending on the result, they were then divided into two categories. Road sections with a very low crash density were assigned to the first category whereas road sections with a high crash density were assigned to the second category. Using a measurement vehicle of the Technical University of Dresden different road infrastructure parameters were recorded for the road sections of both categories. These parameters include road geometry data (design elements of the horizontal and vertical plan), road cross-sectional data (number of lanes, lane width, road side design, cross fall), road equipment (marking, traffic signs and safety devices) and road condition data (patching, crazing and transverse evenness - rut depth and water film thickness in ruts). In addition further road condition data (general unevenness, skid resistance) were extracted from the road database.
On the basis of the so-obtained road infrastructure parameters, the data were analyzed in a comparison between the two road section categories (low crash density versus high crash density). As a result, conclusions were gained, that, for example road sections with a low crash density are generally also characterized by a lower curvature change rate than road sections with a high crash density. So, one result of the analysis is that the curvature change rate has a decisive influence on the number of motorcycle crashes.

Finally, road sections with high crash density were investigated specifically for peculiarities in the immediate vicinity of the motorcycle crash. This enabled statements regarding the alignment respectively the curve linearity ahead of the crash site.
Title: PEDESTRIAN ACCIDENTS IN FRANCE: A DESCRIPTIVE ANALYSIS BASED ON FATAL POLICE REPORTS

Presenting Author: Thierry Hermitte

Authors: T. Hermitte 1; V. Phan 2;

Affiliation
1. LAB, NANTERRE, FRANCE, 2. CEESAR, NANTERRE, FRANCE,

Abstract:
The number of fatalities and injured people on the world’s roads remains very badly known. The publications of the WHO of 2009 state 1.2 million persons killed and 50 million injured a year. These worrying figures probably underestimate the reality because in number of countries the information about the causes of mortality and morbidity is rudimentary, even non-existent. Furthermore all the studies match to assert that the road mortality is gradually going to climb in the coming 20 years. Among the exposed population, the vulnerable road users are the most concerned and especially the pedestrians (about 27 % in the world) with large disparities between countries (13% in Australia, 33% in Israel and Japan, 12% in US and 20 % in EU27). In France, the pedestrian mortality represents 13 % of all road fatalities in 2008 but with a light increase during last years. In order to have a better knowledge on these accidents, we set up a specific study based on fatal pedestrian accidents. The sample consists of 243 accidents sorted randomly from the fatal police reports between 2001 and 2003. Each case has been analyzed and coded by experts with a particular attention on the estimation of the collision speed and location of the first head impact.

Among the main characteristics we observed that 44 % of the pedestrians are of 65 and more years old; 62 % of the killed pedestrians are men; 56 % are located in urban area and 60 % occurred at night. In 69 % of these accidents, the driver was confronted with a crossing pedestrian. In this study, the first pedestrian’s impact and the head impact locations on the vehicle were studied. The results showed that in 47 % of the cases the first impact was located on the right-hand side of the vehicle, in 26 % on the left and in 18 % on the center. For the pedestrian’s head impact, 65% are located on the windscreen (30 % windscreen, 19 % on the rigid side, 10 % on the lower frame and 6 % on the upper frame). The analysis of the driving speeds, showed an average 68 km/h in urban area, and 90 km/h in rural area. For 35 % of vehicles this driving speed was above the speed limit and for 58% of them this velocity exceeded the speed limit by more than 10 km/h. The impact speeds analysis showed that the average was around 65 km/h, with 49 km/h in urban area and 84 km/h in rural area.

Fatal accidents with an impact speed lower to 40 km/h represented 18 % of the sample. Among these cases, pedestrians were mainly involved in frontal impacts (77 %). Most of these frontal impacts were located on the right-hand side of the vehicle (53 %). Concerning the age, 71 % of the pedestrians killed below 40 km/h were at least 65 years old. This study has some limits essentially due to the lack of information in police report. In order to improve our knowledge on the accidental and injury mechanisms, a new project has just been set up. This project concerns the collection and the analysis of a hundred pedestrian accidents studied on the spot and in-depth. First results are expected in 2011.
Title: EVALUATION OF AN INTELLIGENT CURVE WARNING SYSTEM DESIGNED TO ENHANCE MOTORCYCLE RIDING SAFETY

Presenting Author: Véronique Huth

Authors: V. Huth 1; Ó. Martín 1; F. Biral 2; R. Lot 3;

Affiliation
1. Accident Analysis and Human Factors Department, Cidaut Foundation, Boecillo, Valladolid, Spain, 2. Mechatronics Group, Department of Mechanical and Structural Engineering, University of Trento, Italy, 3. Motorcycle Dynamics Research Group, Department of Innovation DIMEG, University of Padova, Italy,

Abstract:
The SAFERIDER project, funded by the European Commission, studies the potential of the integration of Advanced Rider Assistance Systems (ARAS) on motorcycles, implementing efficient and rider-friendly interfaces in order to enhance the safety of motorcycle riders. Motorcycle accidents are a major issue for road safety, as they represent almost 20% of the road fatalities in Europe and, opposite to other road users’ accidents, have shown an increasing trend in the last few years. In terms of frequency as well as severity, bend accidents are an area of particular concern. Within SAFERIDER accident analyses, almost 25% of motorcycle accidents have been found to happen on bends. Among the causes of such accidents human error is prominent, consisting of inappropriate speed or over-braking in most of the cases. In order to avoid this type of accident, an intelligent Curve Warning System has been developed within SAFERIDER. The system calculates an optimal safe manoeuvre according to the road geometry ahead and compares it with the actual riding parameters. If the discrepancy reaches a threshold, the system alerts the rider.

A simulator study has been designed in order to perform a first evaluation of this Curve Warning System. The system is implemented in the riding simulator at the University of Padova, with two different HMI (human machine interface) devices which are alternatively installed. In one case, the warning is provided to the rider by a force feedback throttle, and in the other case a haptic glove transmits the warning signal by vibration applied to the rider’s wrist. A sample of N=20 riders performed three rides: one without any ARAS (serving as a baseline) and two experimental rides using the Curve Warning System, once with the force feedback throttle and once with the haptic glove. The order of the rides was counterbalanced, allowing thus to check for possible carry-over effects.

The evaluation of the two system setups includes the analysis of questionnaire data, measuring usability aspects of the systems, the riders’ acceptance and the subjective workload. On the other hand, objective data has been analysed in order to characterize the riders’ reactions to the warnings. While no differences in workload could be found between the three rides, the comparison of the riders’ opinion about the system reveals a preference of the Curve Warning with haptic glove. Yet, the perceived benefits of riding with the Curve Warning System are not sufficient for provoking a strong willingness to have and to pay for the system, regardless of the HMI element used to transmit the alert. A descriptive analysis of riders’ reactions to the warnings shows that the warnings provided by both system versions lead to earlier and stronger adaptation of the motorcycle dynamics to the curve than when riding without the system, indicating the objective potential of the system to enhance riding safety.

Further research activities will have to focus on possible effects on general riding behaviour as well as riding errors and safety-critical events. Moreover, it should be shown how the results may generalize across subject samples and research environments. Within SAFERIDER, the
Curve Warning System will be implemented on demonstrators, permitting to obtain external criteria from tests with real motorcycles. The long-term effects (usage behaviour and behavioural adaptation) should to be investigated in more extensive studies, and inter-individual differences between riders should be taken into account. Finally, a systematic analysis of the specific influences of the HMI design on acceptance and riding behaviour should be considered in future research.
Title: SYSTEMATIC IMPROVEMENT OF TRAFFIC SAFETY OF CHILDREN IN BELGRADE: CASE STUDY - CAMPAIGN “PROTECT THE CHILDREN IN TRAFFIC”

Presenting Author: Dejan Jovanov

Authors: K. Lipovac 1; D. Jovanov 2; M. Nestic 1;

Affiliation
1. Academy of Criminalistic and Police Studies, Zemun, Serbia, 2. TSM – Association for road Traffic Safety Management, Belgrade, Serbia,

Abstract:
The scope of the paper is to present the results of ten years long research and the progress of traffic safety for the most vulnerable category of road users namely children, in the city of Belgrade, Serbia.

The main part of paper is dedicated to the presentation of the results of the first scientific macroscopic research of traffic safety for children in Belgrade (1999-2000), which was conducted by the authors of this paper, and shows the implementation of foreseen steps and preventive measures. This first research was followed up with two levels of microscopic researches, done on the most dangerous locations for children, through the analysis of the most dangerous zones and of specific school areas. In this part, the methodology and the flow chart of research work is presented, as well as major preventive measures: adjust the traffic surrounding to the children needs and increase the level of necessary education of children for safe participation in traffic.

The second part of paper explains the concept of systematic approach in increasing the traffic safety of children in Belgrade using a three way joint approach: work of city Secretariat for traffic and transport (2001 until now), activities of city Secretariat for education (2002 until now) and permanent informational campaign initiated by the city Secretariat for information (2001 until now). All major activities and measures that were undertaken are presented chronologically together with children’s accident statistics.

Finally, the third part of paper presents and evaluates the results achieved up to date in reducing the total number of accidents involving children in Belgrade. Indeed, during the last ten years, following the proposed measures, Belgrade authorities have managed to halve the total number of death and injured children. In particular, 2005 was the year without any death of children as pedestrian and during the last two years only two children died in accidents in Belgrade. Special attention is given to the measurement and evaluation of the impact of different measures on the safety of children. The paper concludes with necessary follow-up activities.
Title: VULNERABLE ROAD USERS IN MULTI MODAL TRANSPORT SYSTEM FOR DELHI: POLICY OPTION FOR BETTER MOBILITY

Presenting Author: Pawan Kumar

Authors: P. Kumar 1; S. Y. Kulkarni 2; M. Parida 1;

Affiliation
1. Centre for Transportation Systems, Indian Institute of Technology, Roorkee-247667, India, 2. Department of Architecture and Planning, Indian Institute of Technology, Roorkee-247667, India,

Abstract:
1. Vulnerable Road Users (VRUs) i.e. Bicyclists, Cycle Rickshaws and Pedestrians are directly associated with capacity and cost, intermediate technology, indigenous techniques, flexibility in services, affordability of users, etc. have significant role in Multi Modal Transport System for Delhi.

2. The National Urban Transport Policy of India, 2006 advocates for establishment of quality focused Multi Modal Public Transport System for seamless travel across modes. The Master Plan of Delhi 2021 also emphasizes multi modal transport as future mode of transport. Delhi Integrated Multi Modal Transit System Limited (DIMMTS) was constituted in 2006 which is responsible for implementation of multi modal network in National Capital Region of Delhi.

Wilbur Smith Associates conducted surveys in 30 Indian Cities in 2007. The report states that Pedestrians, Bicyclists and Intermediate Para Transit including cycle rickshaws have 20%, 12% and 6% of modal shares in Delhi respectively. Hence, various policy options are required for better mobility of these Vulnerable Road Users.

3. In India, transport is a State Govt. subject but several Acts and Rules which deals with urban transport issues, are administered by the Central Govt. Policy option related to bicyclists and cycle rickshaws must be in concurrence with National Urban Transport Policy 2006, as well as state and city level directives or strategy.

Mandatory or advisory measures are required to encourage bicycles and cycle rickshaws. Urban Local Bodies may adopt options: either segregate non-motorized vehicles (NMVs) and motorized vehicles (MVs) as far possible or allow NMVs to mix with MVs and reduce MV speed. Further, NMV measures can be implemented either on main transport corridors or on feeder routes. Similarly, facilities for NMVs can be implemented either on ad hoc basis or zonal basis.

Suitable legislation and traffic enforcement regulations are required to allow the operation of particular types of NMVs along specific routes along multi modal transport corridors in both peak and non peak hours.

Example: Municipal Corporation of Delhi has framed Delhi Municipal Corporation (Cycle Rickshaw) Bye-laws 1960. The bye-laws have provisions regarding prohibition of transfer of license, removal of cycle rickshaws, no. of cycle rickshaws to be licensed in a particular year, penalty, etc.
4. It is desirable that activities on footpath as street vendors, off street parking for bicycles, rickshaws at multi modal terminals must be properly controlled to secure pedestrian safety. “Level of Provision for Pedestrians” and allocation of road space to pedestrians must be considered in planning process to achieve the goals of the Mobility Plan of the city around multi modal transit corridors.

5. Learning Experience from Asian Best Practice is important. Asia typically shows high level of non-motorized vehicle uses. In Tokyo, the “National Bicycle Law” was enacted in 1980 which encouraged local governments to provide bicycle lanes, paths, parking facilities near railway station in order to promote the use the bicycle as a feeder mode for rail service. Tokyo Metropolitan Govt. also launched “Safe Bicycle Riding Promotion Plan” in January 2007 to improve bicycle traffic manners and bicycle mechanics.

6. Institute for Transport and Development Policy (ITDP)'s India Cycle Rickshaw Modernization project designed better rickshaws which further reduced the weight of the vehicles by more than 30% and a multi gear system made pedaling much easier. At present, our 300,000 modernized cycle rickshaws are operating in 9 of India major cities including Delhi, Agra, Bharatpur, Brindavan, Jaipur, Mathura and Chandigarh.

7. A Bicycle Master Plan for Delhi was prepared for better mobility of cycles in 1998. It suggested phase wise network level bicycle master plan for Delhi. The project brought out detailed design solutions for existing roads to improve flow of all modes of transport including non-motorized vehicles plying on the roads.

8. Under Govt. of India’s Jawaharlal Nehru National Urban Renewal Mission (JNNURM) Programme, the Govt. gives priority to construction of cycle tracks and pedestrian paths in all cities to enhance safety and thereby enhance the use of non-motorized modes. Cities are encouraged to explore the possibility of a “Public Bicycle Programme”. It is important to make non-motorized vehicles affordable for the poor, by subsidies, vehicle tax rebate, easy loans, etc.
Title: THE VULNERABLE PEDESTRIAN: A MULTI DIMENSIONAL PROBLEM BASED ON THE ISRAELI EXPERIENCE

Presenting Author: Sarit Levi

Authors: S. Levi 1; R. Zaieg 2; D. Shinar 3;

Affiliation
1. Israel National Road Safety Authority, Israel,

Abstract:
Economically Israel is considered a developed country. Yet its crash statistics are not consistently similar to those of other developed countries. Its pedestrian fatalities - at approximately 35% of all traffic fatalities - are abnormally high for its level of motorization. Analysis of pedestrian fatalities by age and gender shows high percentages of the very young and the very old relative to other age groups. At nearly all age groups males constitute a higher percentage than women. This is typical of most countries: over-involvement of the very young and the very old, with greater proportions of males than females. However, this pattern is not identical for different cultures within Israel, where approximately 80% are Jews and 20% are non-Jews (mostly Arabs). Analyses of fatality and injury rates indicate very different patterns for these two groups. Of the injured elderly (65+ years old) most are Jews, whereas of the injured young children (under 5 years old) most are Arabs.

We conducted in-depth analyses to compare the two groups in terms of their involvement in rural versus urban crashes, daytime versus nighttime crashes, time of day and behavior of the pedestrian immediately prior to the crash. The analyses look at the absolute numbers, the percentages within the age group the religious affiliation, and the rate relative to the size of the specific sub-populations in Israel. The results reveal that differences in crash involvement are due to both exposure variables (numbers in the population) as well as to demographic differences (level of urbanization and living conditions) and behavioral/cultural differences related to different social norms in the two groups. These differences require different countermeasures that include both infrastructure and behavior modification. Some of the countermeasures that have been employed are discussed. Because the Arabs have a much higher birth rate their relative proportion in the overall population is much greater in the very young than in the very old. In addition Arabs tend to live in more rural areas in detached homes with a large yard, where they typically park their vehicles and where their children tend to play without supervision even when they are less than one year old. Thus the prevalence of very young Arab pedestrian fatalities is due both to their prevalence in the general population as well as to their actual exposure to vehicular traffic. In contrast, most Jews live in apartment buildings that have fenced playgrounds nearby, and most Jewish mothers do not let their young children play unattended – thus reducing their exposure to vehicular traffic.

When analyzing the distribution of urban pedestrian fatalities by crossing location in the years 2002-2009 we note that there is a stark contrast between Arab and Jewish fatalities: 42% of Arab children fatalities occurred while they were not crossing the street at all (i.e. walking on or playing in the roadway). The majority of the time, they were actually in the unfenced yard of their home. In comparison only 22% of Jewish children fatalities occurred when they did not cross. Analyzing elderly fatalities show a similar outcome: 47% of all Arab elderly fatalities occurred when they did not cross the road while the Jewish elderly comparable fatality rate is only 13%. The abnormally high difference can be explained by both different cultures, and the surrounding architecture of the towns.

To combat this problem beginning in 2007 the National Road Safety Authority initiated different programs to educate pedestrians of both the Arab and Jewish sectors, with specific targeting by
age group. These programs were varied to meet the challenges from the different "at-risk" groups. For example, a special program was designed for the Arab and Bedouin populations, targeting parents to better educate and protect their children around their home. The projects for the Jewish groups were specifically tailored towards the elderly, with advertisements and instructions in clubs and health clinics. For example, one project aimed solely at the children of the orthodox community. In addition to these special projects, there were presentations made at schools throughout the country. In this paper we will also analyze the differences of these "at-risk" groups before and after the inception of the new programs.
Title: BEHAVIOR OF CHILD PEDESTRIANS AND BICYCLISTS IN FOUR CITIES

Presenting Author: Sharon Levi

Authors: S. Levi 1; L. Endy-Findling 1; D. Yogev 1;

Affiliation
1. Research & Policy, Beterem – Safe-Kids Israel: National Center For Children`s Safety And Health, Hasivim 18, Petach Tikva Israel,

Abstract:
Road traffic injuries are the leading cause of injury-related death in children age 1-17 in Israel as well as a leading cause of death and disability in the entire European region. Between 2005 and 2007 child pedestrian injuries accounted for 62% of the road traffic crash fatalities and serious injuries for children age 0-14 in Israel, followed by 29% as vehicular passengers, and 8% as bicyclists.

Children are vulnerable road users in the urban area as both pedestrians and bicyclists. Children are exposed to road traffic injuries close to home while travelling to and from school, parks and other neighborhood destinations. Developmental characteristics including limitations in cognitive, behavioral, and physical abilities make them more susceptible to injuries and limit their capacity to evaluate risk.

Information on the behavior of child pedestrians and bicyclists is necessary in order to work on road safety issues and reduce traffic injuries of children in urban areas. Observation surveys and trip surveys were conducted in four cities to assess the behavior of child pedestrians and bicyclists in the community.

This work is part of a larger research effort conducted by BETEREM to evaluate a series of Child Road Safety Indicators in Urban Communities. The goal of the pilot project, under way in four cities in Israel, is to provide municipalities with measures that will enable them to identify and resolve road safety issues. The indicators also include knowledge and attitude surveys, municipal safety management analysis, measurements of urban walkability, and injury data analysis.

A representative sampling of urban areas was conducted for each of the four pilot cities using two primary sources of data: relevant urban, road, and traffic characteristics of the areas from local inventory data and local professional's traffic knowledge and socio-demographic measures from the Central Bureau of Statistics. The sample of urban areas served as the basis for selection of observation sites of child pedestrian and bicycling behaviour.

Children were observed as they approached schools in the urban areas in the morning. Indicators examined include mode of travel, age, pedestrian crossing behavior and bicycle helmet use. Additional observations of child bicyclists were conducted after school hours at various site types. Data was collected on age, gender, bicycle type, helmet use and on accompaniment by adults or peers.

Trip surveys were conducted with students in a sample of primary schools in the four cities. Students were instructed on completing a travel diary of trips taken on the previous day. Origin, destination, time of day, mode of travel, purpose and accompaniment were recorded.
The different data collection efforts provide real world information on travel patterns and behavior of child pedestrians and bicyclists. Close to 3000 children were observed traveling to school, over 1300 bicyclists were observed after school, and 210 trip surveys were completed in the four cities.

Results presented will include information on demographic characteristics, travel modes, and safety issues for child pedestrians and bicyclists. The analysis conducted for each of the four cities and overall, provides a snapshot of behaviour in urban settings in Israel. Trends indicated in the research enable city road safety, engineering, and transportation specialists to identify and resolve issues to prevent child injury in their communities.
Title: SUSTAINABLE ROAD SAFETY: A NEW(?) NEIGHBOURHOOD ROAD PATTERN THAT SAVES VRU LIVES

Presenting Author: Gordon Lovegrove

Authors: G. R. Lovegrove 1;

Affiliation
1. School of Engineering, Faculty of Applied Science, UBC Okanagan, Kelowna, BC, Canada,

Abstract:
Both the UN (2007) and World Health Organizations (2004) have declared the enormous social and economic burden imposed on society by injuries due to road collisions as a major global problem. While the road safety problem is not new, this prominent global declaration sends an important signal of frustration regarding progress to date on reducing road collisions. It is clear that governments, communities, businesses and the public must discover ways of reducing this burden, especially as it relates to vulnerable road users. Recent comparisons of global VRU collisions statistics suggests that, in addition to mixed land use density, the layout of neighbourhood roads plays a vital role in the encouragement of walkable, safe and quiet, yet accessible and sustainable communities. This presentation will focus on three objectives: 1) Lessons that VRU engineers and planners can learn from global VRU success stories; 2) Empirical results of research employing those VRU lessons; and 3) Implications going forward for ways that governments can sustainably reduce the social and economic burden of road crashes in their countries, at the same time as addressing the emerging environmental issues.

A review of North American and European land use and transportation provides some important clues regarding ways to make our communities safer. Since the turn of the 20th century in North America, the two most prevalent neighbourhood patterns built include low density, single land uses superimposed on: 1) Traditional neighbourhood layout (Grid network), popularized in the early 1900’s, and, 2) Conventional Suburban layouts (Loops and Culs-de-Sacs), developed after 1950. This contrasts with much denser, mixed land uses and non-linear ‘village’ road networks across most of Europe. In particular, the Dutch Sustainable Road Safety (SRS) Program has produced a number of innovative land use and transportation initiatives for vehicular road users as well as non-vehicular VRUs. Moreover, results of research on two newly developed neighbourhood road patterns – 3-way Offset, and Fused Grid – which were based on European and the successful Dutch SRS program suggest a potential to result in over 50% fewer road collisions than the prevalent patterns.

Several studies were conducted to test the merit of these claims, related to accessibility, mobility, and safety. Analysis using standard methodology and transportation planning software revealed that they would maintain both mobility and accessibility. A methodology to evaluate the road safety of these neighbourhood road patterns was recently developed at the University of British Columbia, Canada. Using community-based macro-level collision prediction models, their level of road safety was compared with three other neighbourhood patterns, including: Grid, Culs-de-sac, and Dutch Sustainable Road Safety (SRS) (or limited access) networks. Results confirmed that these novel patterns indeed hold potential to significantly improve road safety levels above prevalent neighbourhood road patterns, as follows:

• Patterns with a high proportion of 3-way intersections operate at a higher level of safety.
• Shortcutting has the most dominant negative impact on road safety in a neighbourhood.
• In congested urban areas, conventional grid road patterns should be traffic calmed to reduce shortcutting and to provide a reasonable level of road safety.
• A neighbourhood road pattern that incorporates all of the factors which optimize safety,
such as the fused grid or 3-way offset patterns can be reasonably expected to experience from 30% fewer to over 60% fewer road collisions than conventional road patterns.

• The 3-way offset and fused grid road patterns should serve as starting points to guide land use and transportation planning of new or retrofitted existing neighbourhoods. It is important to note that these results ignore the use of off-road pedestrian and bike trails to shift mode choice from auto to non-auto VRU modes. This paper will also present results of research that is now underway on the added road safety benefits of walkable communities.
Title: PERCEPTUAL LOAD AT CENTRAL AND PERIPHERAL REGIONS AND ITS EFFECTS ON PERFORMANCE

Presenting Author: Hadas Marciano

Authors: H. Marciano 1; Y. Yeshurun 1;

Affiliation
1. IIPDM, University of Haifa, Haifa, Israel,

Abstract:
As we drive, information from different regions of the visual scene continuously reaches our eyes; only some of it is relevant for safe driving. The ability to allocate attention only to the relevant information is a crucial factor in many car accidents. Lavie (1995) claims that this ability is affected by the perceptual load. With high perceptual load, selectivity is high and attention is allocated only to the relevant information, but with low perceptual load selectivity is low and irrelevant information is also processed. Previously only load levels at the center of the visual field were manipulated. In the current study we tried to broaden the perceptual load model to include different levels of load at peripheral regions and not merely at central region, as was done before (Lavie and Cox, 1997). Specifically we explored the effects of perceptual load on general performance and on attentional selectivity at both regions: central and peripheral. We believe that the broader model would be more relevant to real-life situations because many real-life situations, including driving, consist of varying load conditions at both regions of the visual field. In four basic experiments, using simple stimuli, we systematically manipulated the load levels at the center and at the peripheral regions of the visual field. The experimental display included central and peripheral circles of letters. The target was one of the letters on the central circle and the participants had to indicate, as quickly and accurately as possible, whether the target letter was Z or N, while ignoring any other stimuli presented in the display. There were six load conditions: a) low central load with no peripheral load; b) high central load with no peripheral load c) high central load with low peripheral load; d) low central load with high peripheral load; e) high load at both regions; f) low load at both regions. As we expected, the effect of peripheral load on general performance was modulated by the level of the central load: When central load was low, the high peripheral load condition resulted in slower response times than either in the low peripheral load condition or in the no peripheral load condition. However, when the central load was high there was no difference between the various conditions of peripheral load. This result may reflect the effect of perceptual load on the allocation of attentional resources: under low central load, there are available resources to process the irrelevant peripheral information, and therefore the level of load at peripheral regions affect performance. Under high level of central load, the capacity of the perceptual system exceeds its limits, irrelevant information can no longer be processed, and therefore the load of peripheral region has no effect on performance. These findings have important implications for traffic safety, and especially the safety of pedestrians. They demonstrate that both the levels of load on the road and on the sidewalks are important and affect the driver's ability to react to events that takes place at the sides of the road. Moreover, it is plausible that the ability of drivers to pay attention to peripheral regions, such as sidewalks with pedestrians, is modulated by the load on the road. Specifically, if the level of load on the road is relatively low the levels of load on the sides of the road (e.g., the number of pedestrians, the number and diversity of buildings, parked cars etc.) are an important factor determining the driver's response to peripheral events. However, if perceptual load on the road is high it is much harder to pay attention to the peripheral zones, regardless of the peripheral load. Yet, this interpretation must be explored in more realistic conditions, such as divided attention between the two regions (as actually
happens while driving) and even in more practical conditions such as actual or simulated driving. These two topics are currently explored in our Lab.
Title: MOTORCYCLISTS: A SURVEY OF ATTITUDES, OPINIONS AND BEHAVIOURS

Presenting Author: Kyla Marcoux

Authors: W. G. M. Vanlaar; K. D. Marcoux; R. D. Robertson

Affiliation
1. Traffic Injury Research Foundation, Canada

Abstract:
Recent information about motorcycling in Canada is limited. Most of the literature on the topic is based on data from the U.S. Available data reveal that although the overall number of motor vehicle crashes is decreasing, the number of motorcycle crashes is growing in both Canada and the U.S. Given the vulnerability of motorcycle riders and the increasing number of motorcycle sales in Canada, concern is warranted. The objective of this paper is to help improve the safety of vulnerable road users by studying opinions, attitudes and behaviours of the public regarding the issue. More specifically, the purpose of this paper is to provide information that can help improve safety of motorcycle riders in particular and other road users in general. The data used in this study were gathered by means of a public opinion poll among a representative sample of 1,201 Canadian drivers. The interview was administered by telephone to a random sample of Canadian drivers by Opinion Search Inc., in September, 2008. Criteria for inclusion were having a valid driver’s license and having driven in the past 30 days. Data were weighted according to region, gender and age to avoid bias. Univariate frequency distributions, their 95% confidence intervals, and Chi-square statistics were calculated taking account of the stratified and weighted sampling design. Also, multivariate logistic regression analysis was used, accounting for the design effects of the sampling design. The majority of survey respondents who ride a motorcycle were male. The majority were also aged 40-49, followed by those aged 50-59, and those aged 30-39. This is consistent with research that shows increases in motorcycle ownership for those aged 40 and above. While the overall picture regarding unsafe riding behaviours suggests that riders are not necessarily behaving more or less risky than drivers, there is room for improvement. For example, 25.5% of Canadian motorcyclists ride well above the speed limit, 10.5% weave in and out of traffic, 9% pass other vehicles when it is not safe to do so, 8.5% perform stunts on public roads, and 3.1% ride a motorcycle without wearing a helmet. In terms of the public’s attitudes toward riding a motorcycle in general, only 16.6% of Canadians indicated that riding a motorcycle is risky. Over half the respondents (55.3%) reported high levels of concern about motorcyclists performing stunts on public roads. Compared to other road safety issues, this is relatively low and can be explained by the fact that few motorcyclists actually perform stunts on public roads. Canadians were also asked how often they see motorcyclists engaging in risky riding behaviour. The majority of respondents indicated that they do not frequently see motorcycles passing other vehicles when it is not safe to do so (58.6%). Likewise, the majority of respondents reported that they do not frequently see motorcycles weaving in and out of traffic (60.9%). As for the remaining risky riding behaviours, the majority of Canadians indicated that they do not see motorcyclists performing stunts on public roads (83.6%), or motorcyclists riding without wearing a helmet (91.1%). Among those who were seen riding without wearing a helmet, young riders were seen more often than older riders. However, in contrast, those who admit to frequently riding a motorcycle without wearing a helmet were significantly more likely to be older than those who do frequently wear a helmet. Finally, Canadians were asked to what extent they agree with various road safety measures to deal with risky riding behaviour. Results indicated that 72.9% agreed that motorcycles should be impounded for performing stunts on public roads; 66.2% agreed that there should be increased fines for the non-use of helmets for motorcyclists; and 51.8% agreed that there should be an
engine size limitation for new motorcycle riders. Interestingly, both riders and other road users were equally supportive of increasing fines for not wearing a helmet. Furthermore, compared to drivers, motorcycle riders are more likely in agreement with engine size limitations for new motorcycle riders. In conclusion, Canadians do not appear to be overly concerned about unsafe motorcycle riders. However, crash data and self-reported behaviour from this study attest that concern is warranted.
Title: PEDESTRIANS AND BICYCLISTS: A SURVEY OF ATTITUDES, OPINIONS AND BEHAVIOURS

Presenting Author: Kyla Marcoux

Authors: W. G. M. Vanlaar 1; K. D. Marcoux 1; R. D. Robertson 1;

Affiliation
1. Traffic Injury Research Foundation, Ottawa, Ontario, Canada,

Abstract:
Pedestrians and bicyclists are among the most vulnerable road users. Despite the risks to pedestrians and bicyclists on the road, walking and bicycling should be encouraged, as they improve health and have environmental benefits. Therefore, ways to improve safety of vulnerable road users is timely and pertinent. The objective of this paper is to help improve the safety of vulnerable road users by studying opinions, attitudes and behaviours of the public regarding the issue. The data used in this study were gathered by means of a public opinion poll among a representative sample of 1,201 Canadian drivers. The interview was administered by telephone to a random sample of Canadian drivers by Opinion Search Inc., in September, 2008. Criteria for inclusion were having a valid driver's license and having driven in the past 30 days. Data were weighted according to region, gender and age to avoid bias. Univariate frequency distributions, their 95% confidence intervals, and Chi-square statistics were calculated taking account of the stratified and weighted sampling design. Also, multivariate logistic regression analysis was used, accounting for the design effects of the sampling design. The survey revealed that Canadians are not overly concerned about pedestrians and bicyclists behaving unsafely on the roads. Bicyclists' behaving unsafely on the road was rated as second last and pedestrians behaving unsafely on the road was rated as third last out of a list of 11 road safety behaviours. Likewise, jaywalking was perceived as the second least risky compared to other road behaviours. While the majority of respondents (87%) indicated that they do not think that pedestrians and bicyclists involved in collisions are frequently under the influence of alcohol, research shows that alcohol is a major contributing factor in pedestrian crashes. To illustrate, pedestrians under the influence of alcohol accounted for 12.3% of alcohol related road deaths in Canada in 2006. Among all pedestrian fatalities in 2006 in Canada 59.5% were tested for alcohol. Of those tested for alcohol, 41.9% had been drinking. With regards to self-reported pedestrian behaviour, less than one quarter of respondents (23.1%) indicated that they frequently jaywalk, 12.2% indicated that they frequently cross the street while listening to an mp3 player or CD-player, or using a cell phone, and 11.8% frequently cross at a crosswalk when a vehicle has the right of way. Of the 1,201 survey respondents, 493 or 41.2% reported that they ride a bicycle. Of those, 8.9% admitted to frequently crossing the street while listening to an mp3 player or CD-player, or using a cell phone, 8.5% admitted to frequently weaving in and out of traffic while riding their bicycle on the road, and 8.3% of bicyclists admit that they ride their bike at night when they are not easily visible to traffic. With regards to collisions, 98.5% of respondents indicated that they have not been in a collision with a pedestrian or bicyclist in the last 12 months. The remaining 1.5% did report being in one or more such collisions. Canadians were also asked about ‘near misses’ and it was found that nearly three quarters of respondents (71.4%) have not come close to being involved in a collision with a pedestrian or bicyclist in the last 12 months. Nevertheless, 13.1% of respondents reported that they have come close to being involved in a collision with a pedestrian or bicyclist on one occasion, and 15.5% have come close on two or more occasions in the last 12 months. Canadians were also asked to what extent they agree with various measures to increase pedestrian safety. Results indicated that 53.3% agreed that all pedestrians involved in serious crashes should be tested for
drugs/alcohol; 29.3% agreed that there should be increased fines for jaywalking; and 28.4% agreed that there should be penalties for pedestrians who fail to walk toward oncoming traffic when there are no sidewalks. In conclusion, Canadians do not appear to be overly concerned about the safety of vulnerable road users. However, crash data and self-reported behaviour from this study attest that concern is warranted. It seems there is room for improvement both on the part of drivers and vulnerable road users.
Title: AUTOMATED PEDESTRIAN DETECTION: ASSESSING DEVICE EFFECTIVENESS AND POTENTIAL BARRIERS TO ACCEPTANCE IN NORTH AMERICA

Presenting Author: Frank Markowitz

Authors: F. Markowitz 1; J. Montufar 2; M. Steindel 2; J. Foord 2;

Affiliation
1. Sustainable Streets Division, Municipal Transportation Agency, San Francisco, California, USA, 2. Transport Information Group, University of Manitoba, Winnipeg, USA,

Abstract:
The 2008 U.S. Federal Highway Administration Pedestrian Safety Report to Congress emphasized the potential of automated (or passive) pedestrian detection to improve safety. However, it also found that these technologies “require additional research and extensive field testing to demonstrate and evaluate the benefits of deploying the systems.” It pointed to concerns about costs and reliability, as well as the gap between limited U.S. experience and broader European and Australian acceptance of these devices.

This paper presents the findings of the Institute of Transportation Engineers (ITE) Technical Committee on Automated Pedestrian Detection (APD), which is developing an informational report describing the range and effectiveness of such devices, used to control traffic signals or warning devices at street crossings. The committee is also assessing liability, maintenance, and accessibility issues that may pose barriers to greater device acceptance in North America.

In association with the University of Manitoba Transport Information Group, the ITE committee conducted an on-line survey of local agencies in the U.S. and Canada. This indeed found a high level of concern about reliability and maintenance needs. However, most respondents did not report personal experience installing or evaluating these detectors.

In contrast to this level of concern in North America, there is widespread acceptance in the United Kingdom of automated detection for “Puffin” (Pedestrian User Friendly Intelligent) crossings. Puffin installations have grown at a rate of 7.6% in each of the last two years in the U.K., used now at over 3,100 crossings, primarily midblock. A majority of British local agencies surveyed indicated that 100% of future pedestrian crossing facilities in their jurisdictions will use Puffin technology.

This paper analyzes why there is such a difference in the British and North American approach to pedestrian safety and assesses likely future directions. However, there are a number of factors that will tend to promote serious consideration of automated detection in North America. There is increasing interest in promoting safe walking to improve public health, promote air quality, combat climate change, and reduce congestion. Proposed U.S. MUTCD (Manual on Uniform Traffic Control Devices) amendments requiring longer signalized crossing times may also increase agency interest in using automated detection of pedestrians to “fine tune” crossing times to individual walking speeds.

A major decision looms on whether to invest in on-board (in-vehicle) pedestrian detection and collision avoidance technologies or in roadside APD. Such a decision is complicated by rapid changes in technology, not only in detector technology per se, but also in wireless vehicle-to-vehicle communications that would allow a single “probe” vehicle to transmit warnings to adjacent vehicles about pedestrian conflict situations.

This paper finds that the research record available is inconsistent and often inconclusive. Additional research is needed to address the benefits, costs, and problems with APD via intensive and comprehensive field research. Laboratory or controlled experiments are also needed to compare different technologies thoroughly and fairly. Researchers need to develop...
standardized and comprehensive methods of assessing APD and quantifying the benefits. These should consider not just detector accuracy, but broader criteria for impacts on safety and mobility, cost, ease of installation, maintenance record, support by the public, and ability to gather other data. Legal, maintenance, and accessibility guidance would also be highly valuable in the decision of whether and how to use APD. Greater coverage of APD in engineering standards and technical publications will help to support their use, in part by reducing liability exposure. The most common causes of APD malfunction were identified by the ITE on-line survey as vandalism/accidental damage, inclement weather, and installation flaws. These can partly be addressed through technical guidance and greater diffusion of case study experience. While APD is unlikely to replace accessible pedestrian signals (APS) at signalized intersections, it could be a valuable supplement. The presence of APD should ideally be communicated to visually impaired pedestrians so they can make most effective use of the devices.
Title: DEVELOPMENT OF COMPUTATIONAL MODELS AND DATABASES TO INVESTIGATE PEDESTRIAN RELATED ACCIDENTS

Presenting Author: Bruno Martins

Authors: J. M. Dias; B. A. Martins;

Affiliation
1. Mechanical Engineering Department, Technical University of Lisbon, Lisbon, Portugal,

Abstract:
The number of accidents with pedestrians in Portugal has been decreasing in the past years; however it’s still a problem. Having this in mind, a study was made about these accidents between 2006 and 2008; an observation study regarding the behavior of drivers and pedestrians when confronted with the time intervals of signals, on signalized crossroads; a questionnaire to drivers and pedestrians to determine their knowledge, behavior and risk evaluation skills. Using Microsoft Access, two databases were created applying the PENDANT and ANSR models of info gathering. The main goals were to interact with information in a much easier, safer and organized way, particularly in case of a statistical analysis. Examples of real accident reconstructions were presented. This made possible to show the variety of parameters that influence this kind of work. Using an existent model of an accident with a pedestrian with multibody and FEA on MADYMO, the influence of the pedestrian speed on the post-impact dynamics and on the injuries sustained was studied. One concludes that the fact of just knowing how to behave on the road isn’t sufficient to prevent accidents. This was not only detected on the statistical analysis but also was detected while assessing the results of the questionnaires. On the observation study became clear that one of the causes for risk behavior is linked to the signal times on crossroads. It was determined that there’s a link between pedestrian speed and both his injuries and his first body part that hits the ground.
Title: A VOICE FOR WALKING: PEDESTRIAN ADVOCACY IN LOW- AND MIDDLE-INCOME COUNTRIES

Presenting Author: Katie Matchett

Authors: K.E.C. Matchett 1;

Affiliation
1. University of California, Los Angeles, USA,

Abstract:
Despite its critical importance to mobility in low- and middle-income countries, the pedestrian environment has largely been neglected by policymakers. To help address this problem activists in several countries have created advocacy groups to address concerns about safety, health, equity, and traffic congestion. This paper explores the nature of these groups, documenting their structure, size and budget, and the activities they use promote better pedestrian access. Although most groups are small with limited funding, many have had success using new media such as websites, blogs, and online forums to further their cause.
Title: STATISTICAL AND GEOSTATISTICAL ANALYSIS OF ACCIDENT DATA FOR DEVELOPING INJURIES FORECASTING MODELS

Presenting Author: Alessandro Mazzella

Authors: A. Mazzella 1; F. Pinna 1; C. Piras 1;

Affiliation
1. University of Cagliari, Italy,

Abstract:
During the last years the road safety has become increasingly important because of the number of dead and injured people and therefore the economically and socially costs associated. The most recent international studies about the number of accidents show that most of them happen in urban areas. In these accidents more than 50% of victims are vulnerable users (i.e. cyclists, motorcyclists and/or pedestrians).
Clearly the dangerousness of urban areas accidents is much higher than that in rural areas. This is mainly due to the major vulnerability of vulnerable users compared to other road users. Analyzing the accident data in urban and rural areas trough the Statistics and Geostatistics, our research focuses on the definition of the accidents causes (in relation to road characteristics, traffic flow conditions, etc..) and defining algorithms for predicting the risk of accidents (for which vulnerable users could die and/or be injured).
Internationally, the most popular models regarding the accident forecast were built upon statistical techniques. The innovativeness of the proposed work arises precisely from the use of geostatistical techniques for the analysis of the accident data. In particular Geostatistics, created historically in mining field in order to solve problems concerning the correct evaluation of the ore bodies, supplies a collection of techniques addressed to the study of the correlation between experimental values of a specific variable (which represents the phenomenon in study) and for the definition of unknown values through interpolation which takes account of that law (i.e. kriging).
The study is structured as follows:
• data collection about accidents where vulnerable users are affected;
• identification of “danger” road sections characterized by a high number of accidents;
• study and analysis of speed and traffic flow nearly these “danger” sections;
• definition and analysis of all the geometric and the design features for the roads affected by the accident;
• construction of a database for storing the speeds recorded for each section (of vehicles and vulnerable users distinguished by category), flows of traffic (vehicles and vulnerable users, distinguishing them by category), road-related defects related to planimetric or cross-section;
• preliminary and exploratory analysis of collected data through statistical techniques;
• study and modeling of the correlation law between the accident data and the road characteristics through geostatistical techniques;
• definition of forecasting geostatistical models;
• forecasting models validation.
Title: DRIVING DISTRACTION OF ATTENTION AUDIT OF MOTORCYCLE AND BICYCLE USERS IN URBAN AREAS. CASE STUDY IN THE CITY OF VOLOS, GREECE

Presenting Author: Eleni Misokefalou

Authors: E. Misokefalou 1; N. Eliou 1; A. Galanis 1;

Affiliation
1. Department of Civil Engineering, University of Thessaly, Volos, Greece,

Abstract:
The significance of the road safety audit in the urban road environment during the last years includes apart from the vehicles’ drivers, the motorcycle and the bicycle ones. Not only motorcycle, but also bicycle users share the road network with other vehicle users like car, bus and truck drivers. The providence of a safe and functional bicycle urban network is in many cities a matter of luxury. Consequently, the question of the road safety audit for motorcycle and bicycle users, which are considered to be vulnerable road users, should be examined in all available aspects. This paper studies the available methodologies and techniques for the examination of motorcycle and bicycle drivers’ distraction of attention in urban road environment and advances in the application of research in a typical medium sized Greek city.
The distraction of driver’s attention during the implementation of the driving task is not simply a theory. It is a procedure which is continuously activated and developed, depending also on many factors. It is detected in all drivers with floating rate and frequency of appearance. In each case, the results of this distraction of attention are critical for the driving task, the driver’s safety and finally the rest of road users. Thus, in this study we refer to a rising problem of road safety with reasons, variables, factors of influence and results. For this reason, in order to accomplish an objective and effective research of drivers’ distraction of driving attention, it is necessary to examine the motorcyclists’ and bicyclists opinion and behavior as well.
In order for a researcher to achieve an integrated research, all the essential types of data should be used. In our study, we will examine all the available sources and methodologies for the data collection process. These can be field observations in a certain point of the vehicle’s route or inside the vehicle, in order to determine the frequency of distraction of attention during the driving process. Also, data collection can be achieved during researching process in an accident’s place. Moreover, the use of a simulator or the use of a vehicle equipped with special measurement data equipment, could be possible and under consideration. Finally, sampling vehicle drivers in order to answer a proper questionnaire is a useful methodology to achieve our goal. But during an audit process the road environment characteristics should be also examined with the use of a proper checklist.
After the examination of the available methodologies of data collection of the drivers’ distraction attention, we concluded that the proper one for motorcycle and bicycle drivers is the use of questionnaires. Concerning this the present study deals with the creation of a questionnaire suitable for motorcycle and bicycle drivers and a safety audit checklist for the urban road environment. In order to achieve that, the questionnaire and the checklist will be applied in the city of Volos, which is a typical medium scale Greek city, in selected urban segments and intersections. A proper number of motorcycle and bicycle users will be sampled and a specific number of trained bicycle auditors will take place.
In summary, in the present research, the main target was to find out and evaluate the main factors of distraction of motorcyclists’ and bicyclists’ attention in urban road segments and intersections.
Keywords: Attention distraction, bicyclists, motorcyclists, road safety audit, questionnaire, checklist.
Title: DENSITY, LAND USE MIX OR STREET CONNECTIVITY: WHICH MATTERS MOST FOR WALKING AND CYCLING?

Presenting Author: Mika Moran

Authors: M. Moran 1; P. Plaut 1; O. Baron Epel 2;

Affiliation
1. Faculty of Architecture and Town Planning, Technion, Haifa, Israel, 2. School of Public Health, The University of Haifa, Haifa, Israel,

Abstract:
Background:
Worldwide, the most vulnerable road users are pedestrians and cyclists, as more people die in motor vehicle collisions while walking and cycling than while driving. Previous empirical research demonstrates that the safety of pedestrians and cyclists is positively related to their number; that is, where more people walk and cycle, their risk of getting injured in car accidents decreases. From here it follows that encouraging walking and cycling serves as an important goal in increasing pedestrians and cyclists safety.

In recent years growing bodies of empirical evidence supports positive associations between walking and cycling and three main attributes of the built environment - land use mix, density and street connectivity. Correspondingly, the combination of these attributes frequently serves as a base of comparison between high- and low-walkable neighborhoods. However, the unique contribution of each one of these attributes to walking and cycling is yet to be determined. This is not an easy task given the relative homogeneity of built environments in many western countries where studies usually take place. For example, typical North American suburbs consist of low levels of density, land use mix, and street connectivity, while neo-traditional neighborhoods consist of high levels of the three aforementioned attributes. This is not the case in Israel, where built environments are relatively heterogeneous to include different combinations of these attributes, such as: areas of high density and land use mix, but low connectivity; and areas of high density and connectivity but low land use mix. Such built environments provide an opportunity to examine the unique and independent contribution of each built environment attribute to walking and cycling. This study, first of its kind in Israel, aims at identifying the relative weight of density, land use mix and street connectivity in determining walking and cycling.

Objectives:
The overall objective of this research is to examine the relative weight of density, land use mix and street connectivity in explaining walking and cycling. Additional objectives are to match specific built environment attributes with walking and cycling for different purposes (transportation, leisure).

Methods:
Study design: This study employs a cross-sectional design including an environmental sampling approach, neighborhood audits, and short intercept surveys.
Sampling approach: Neighborhoods will be selected to include various combinations of the three main independent variables: density, land use mix, and street connectivity (e.g. areas of high density, high land use mix, and low street connectivity, vs. areas of high density, low land use mix, and high street connectivity). Based on this typology, six neighborhoods will be selected matched for their size and socio-economic characteristics. In each neighborhood, representative street segments will be selected for audits.
Measures: (1) GIS and census data will be used for neighborhood selection; (2) Street audits will be conducted to evaluate micro-scale built environment attributes (e.g. traffic calming, sidewalks availability and quality, architectural form); (3) Behavior audits will be conducted to evaluate the prevalence of walking and cycling; and (4) Brief intercept surveys will be conducted among observed walkers and cyclers in order to determine the purpose of those trips and other relevant data (frequency of trips, area of residence, perceived safety etc.).

Analysis:
Data analysis will be employed to identify the relative weight of the three main independent variables - density, land use mix and street connectivity - in explaining walking and cycling. Given the multi-level nature of the data, a multi-level analysis approach will be employed to identify the relative influence of macro- and micro-scale built environment attributes on walking and cycling for transportation and leisure.

Results:
Data is currently selected from two neighborhoods in the city of Rishon LeZion. This data will be presented according to the aforementioned analysis.
Title: IMPLEMENTING A “SAFE ROUTES TO SCHOOL” PLAN IN KALAMARIA, GREECE

Presenting Author: Theodoros Natsinas

Authors: T. Natsinas 3; M. Grigoriadou 1; I. Sarigiannis 2;

Affiliation
1. Technical Services, Kalamaria Municipality, Greece, 2. Anatoliki S.A., Development Agency of Eastern Thessaloniki, Thermi, Greece, 3. Civil Infrastructure Engineering Department, Alexander Technological Educational Institute of Thessaloniki, Greece,

Abstract:
Kalamaria is one of the largest municipalities in the Thessaloniki Greater Area, which is the second most populous urban conurbation in Greece. Since the 1970s population growth, rising car ownership rates, higher living standards, and urban sprawl have resulted in acute traffic congestion. Especially acute is traffic congestion in the vicinity of schools during the drop-off morning and pick-up afternoon periods. The increase of traffic volumes and congestion has resulted in a worsening of the traffic safety and air pollution situation. The combination of the above factors has led to a decrease of walking trips to school, in line with similar international experience, which, apart from exacerbating the above problems is, also, contributing to the serious obesity levels among Greek children.

This paper will report the results of a pilot project attempting to address the problem of decreasing walking to school. The project was carried out in the 2008-2009 academic year, as part of two EU projects: “e-TREAM” and “mobinet”. Both projects aimed at introducing measures to encourage a shift in modal split away from private vehicle to more sustainable modes. Within the “mobinet” project, a municipal mobility center started operating in Kalamaria, which continues to function with significant success promoting sustainable travel modes. The pilot project, which is the subject of this paper, aimed to determine the travel modes used and the factors that influence school travel mode choice by pupils and parents in two public elementary schools in the Kalamaria Municipality; to assess the level of difficulty associated with walking to school; to form a “Safe Routes to School” plan; and to test the viability of a “walking school bus” idea. A walking school bus involves volunteers walking with children to and from school following a set walking route. The surveys among pupils and parents showed a dramatic decrease in walking to school between the two generations and an equal dramatic increase in trips by private vehicle. It, also, established the major barriers to walking to school which, in the majority of cases, confirm the findings of international research, i.e. perceived crime levels and traffic safety that necessitate an escort; the distance between home and school; the weight of school bag. Travel to school by bus is minimal as public schools in cities do not own or hire school buses. Public transport buses are not used because their routes are not convenient for such trips. No student reported cycling to school and the car-pooling share was low.

The surveys determined that a majority of the respondents would be willing to change their travel mode and adopt walking if their safety concerns were addressed. This finding stresses the value of programs like “Safe Routes to School” for local authorities. The more common safety concerns were the lack of satisfactory sidewalks and the existence of dangerous crossings of major road arteries. The project has resulted in a number of proposals related to improving the situation which include the designation of school sites; the drawing of school district boundaries; the walking environment quality near schools and on the routes to the schools. However, the “walking school bus” did not materialize because of insufficient support of the idea by the parents. The paper concludes with an examination of the major reasons that the
“walking school bus” was not able to generate enough support among the parents. Societal, cultural and infrastructure differences between Greece and the other countries, where walking buses have been implemented with success, are presented and proposals for more country-specific ways of implementing the idea are put forward to inform future similar attempts in Kalamaria and, generally, in Greece.
Title: A NEW INFORMATION AND NAVIGATION SYSTEM ASSISTING VISUALLY IMPAIRED PERSONS IN INDEPENDENT MOBILITY

Presenting Author: Nurit Neustadt

Authors: N. Neustadt 1;

Affiliation
1. Hebrew University, Jerusalem, Israel,

Abstract:
A technology recently developed in Israel to alert visually impaired and blind persons of hazards and obstacles and offer information in urban as well as in rural and recreation environments.

The friendly user and inexpensive system consists of two units: activator held by the users and bases placed at points of interest, provide to independent visually impaired pedestrians the ability to receive vital and critical navigation information and general information required for decision making along the route at key locations.

Results of an initial study evaluating the efficacy of the system in navigation, recognition of points of interest and receiving valid information will be presented.

The presentation will be supported by PPT and a short DVD.
Title: INJURED PEDESTRIANS IN SWEDEN - SURFACE CONDITION

Presenting Author: Gudrun Öberg

Authors: G. Öberg 1;

Affiliation
1. VTI, Linköping, Sweden,

Abstract:
In Sweden earlier studies have shown that pedestrians are the road user group that are most injured when slippery road conditions. (Nilsson, 1986; Öberg et al, 1996). Out of all injured people during one year pedestrians were about one third of the injured people in traffic environment but when it is slippery almost two thirds (Nilsson, 1986). Compared to summer conditions the injury risk is about 6 – 8 times higher when slippery. Seniors (> 65 years old) have a very high injury risk when slippery (Öberg et al, 1996).

At bare road conditions in summer it is not so big difference in injury risk between different standard on the surface but for cyclists the accidents increase when the standard decrease. According to pedestrians this depends probably mainly of adjusting speed, way to walk etc. So it is important not to give a false feeling of high standard. If the surface is in principle even it is important that there is no unevenness (Öberg et al, 1996).

Because of the results from earlier studies it was important to get more information about the cause of why these accidents happen. Luckily in Sweden a new accident database STRADA (Swedish Traffic Accident Data Acquisition) exists. It is a national database including injured people reported by police and hospitals and since 2003 covering the whole country and in 2009 about 70 % of hospitals with emergency treatment report to STRADA. This means that a lot of data is easy of access. In the earlier studies some hospitals were involved in the research projects and reported for the project about injured people which means less data. In this research study injured pedestrians coming to public medical service and reported to STRADA have been analyzed. Only pedestrians injured on streets, roads and foot paths are analyzed but not accidents in school or private yards, petrol stations etc. Data from the years 2003 – 2008 gives almost 30 000 injured pedestrians.

In a wider definition of pedestrians also people using in-lines, wheel chair, skateboard, scooters and kick sledges were included. They were just about 1 000 and are not included in the following figures.

The number of injured pedestrians hit by a motor vehicle is just about 13 % of the number injured when falling by themselves (single accident). The surface condition is very important. Slipperiness caused by ice or snow stands for 43 % of the injuries and 7 % is caused by uneven surface. As much as 35 % had no cause reported. In 7 % it is reported that surface had no importance for the accident.

When looking at what time the accidents happen the most accidents happen during day time with most accidents between 17.00 and 19.00 in the evening. There is also a difference between days with less injured on Saturdays and Sundays. Looking at both time and days of the week more accidents happen in the night between Friday-Saturday and Saturday-Sunday than during other nights.
Out of the almost 30,000 injured people about 20,000 were females and just 10,000 males. Sweden is said to have equality between men and women but at least according to walking and injured the women are in the majority and especially for middle age and old women with up to four times more injured.

Acknowledgements:
The project is financed mostly by Skyltfonden but also by VTI (Swedish National Road and Transport Research Institute) and SALAR (Swedish Association of Local Authorities and Regions).

References:

Title: PREPARING RIDERS TO S.E.E. BETTER: MSF TOOLS FOR IMPROVING HAZARD PERCEPTION

Presenting Author: Ray Ochs

Authors: R. L. Ochs 1;

Affiliation
1. Motorcycle Safety Foundation, Irvine, CA, USA,

Abstract:
Research has shown that the more experienced riders scan the road better and recognize much earlier the clues that show a hazardous situation is developing and therefore start to take action before the danger occurs. The MAIDS study confirmed that one of the main contributing factors to motorcycle crashes is perceptual errors. Both the UK and Australia have added a hazard perception component to their licensing process. The Motorcycle Safety Foundation has been working on several new MSF programs to address this key issue. The programs, designed to provide training in hazard perception, will be available to training providers and will be used in the landmark Discovery Project. Dr. Ochs will overview Street Smart: Rider Perception (a 90-minute classroom-only program which includes modern visual technology and classroom activities), its accompanying On-Line Hazard Awareness Module (self-paced hazard awareness on line module), and SMARTrainer Class – Traffic Awareness (a classroom and SMARTrainer experience). Course materials as well as results of pilot and field tests may be reviewed.
Title: WHICH CHARACTERISTICS OF HELMETS LIMIT THE COGNITIVE ABILITIES OF MOTORCYCLE RIDERS?

Presenting Author: Chiara Orsi

Authors: C. Orsi 1; A. Morandi 1; A. Stendardo 1; A. Marinoni 1; D. Otte 2; J. Chliaoutakis 3; M. Gilchrist 4; T. Lajunen 5; T. Ozkan 5; J. M. Pereira Dias 6; G. Tzamalouka 3;

Affiliation
1. Interdepartmental Centre for Studies and Research on Road Safety (CIRSS), University of Pavia, Italy, 2. Medical School of Hannover, Germany, 3. Technological Educational Institute of Crete, Greece, 4. University College Dublin, Ireland, 5. Middle East Technical University, Ankara, Turkey, 6. Technical University of Lisbon, Portugal,

Abstract:
In road accidents which involve two-wheeled vehicles the helmet plays a fundamental life-saving role. The driver’s perception can be influenced by some features of the helmet: noisiness, temperature, ventilation, field of vision, size.
PROHELM (Accident Prevention Options with Motorcycle Helmets) study has been conducted across Italy, Germany, Greece, Ireland, Portugal, and Turkey to investigate the role of the helmet in accidents and to increase the knowledge of how helmets can be improved and better used in preventing injury.

Objective
The objective is to evaluate the relationship between:
• having been involved in an accident and the perception of discomfort in wearing the helmet
• the cognitive capacity of the driver and the objective features of the helmet.

Method
It is a case-control study: the cases are drivers of motorized two-wheelers who have been involved in accidents; the controls are drivers of motorized two-wheelers who circulate in the same area and were not involved in the accidents studied. The variables concern information about the driver, the vehicle and the helmet, perceptions and use of the helmet and accident circumstances.
To evaluate the relationship between satisfaction with the helmet (or lack of) and being involved in an accident, subjects who expressed at least one complaint about the level of comfort of the helmet in relation to dimensions, visor, fastener, ventilation or noisiness were judged to be dissatisfied with the helmet.
Various aspects have been considered to evaluate the relationship between the cognitive ability of the drivers and the objective features of the helmet, comparing objective variables (measurements and surveys of the helmet) with the perception of the helmet on behalf of the driver: complaints related to hearing problems or to the noisiness and to the malfunction of the ventilation system have been compared with the type of ventilation; complaints relating to the fastener have been compared with the type and the geometry of fastener; complaints relative to the visor have been compared with the quality of the visor.
To evaluate the relationships, logistic regressions were carried out.
Results
The study enrolled 208 cases and 390 controls. The drivers who report situations of discomfort using the helmet are 70.1% and there is no association with having been involved in an accident. Among the cases, men, overweight or obese subjects, subjects having eyesight defects and motorcycle ≤125cc are proportionally prevalent, but there are no significant associations. An age ≥25, using a jet helmet and having previously had an accident are significantly associated with having been involved in an accident.

45.2% of drivers complain of problems with hearing or consider the helmet to be too noisy. Such problems are complained about more frequently by those who wear a helmet with ventilation both on the head and on the chinbar, men, subjects aged >25, drivers of vehicles >125cc, subjects wearing integral helmets. No association is significant.

The ventilation system is considered to work improperly by 28.0% of the drivers: the percentage is higher amongst those who wear a helmet with ventilation only on the head or only on the chinbar, people aged ≥25 and, in a significant way, drivers of vehicles ≤125cc. 14.4% of drivers find the chinstrap uncomfortable: the most criticized type is the “clamp-roller” and the least criticized the “helmet-spoiler”; the chinstrap that tilts to the back is considered less comfortable than the vertical one. Discomfort is felt more by women, young people, drivers of vehicles ≤125cc.

37.1% of drivers complain about the visor, either because it often steams up or because it distorts the view. The complaints are most frequent among those who have a helmet with a non-optimal visor, men, young people and, with significant differences, drivers of vehicles ≤125cc and who wear integral helmets.

Conclusions
These results suggest that the criticisms of the features of the helmet are independent of having been involved in an accident. The most frequent complaint relates to noisiness, followed by visor. This is particularly true for drivers with integral helmets and who also find the ventilation system uncomfortable. These results provide useful information about the design features and the components of the helmet which can be improved to increase the pleasure, comfort and effectiveness of the helmet wearer.
Title: INJURY PROTECTION AND ACCIDENT CAUSATION PARAMETER FOR VULNERABLE ROAD USERS BASED ON GERMAN IN-DEPTH-ACCIDENT-STUDY GIDAS – PEDESTRIANS VERSUS BICYCLISTS VERSUS MOTORCYCLISTS

Presenting Author: Dietmar Otte

Authors: D. Otte 1; M. Jaensch 1; C. Haasper 2;

Affiliation
1. Accident Research Unit, Medical University Hannover, Hannover, Germany, 2. Department of Surgery, Medical School Hannover, Hannover, Germany,

Abstract:
For the present study accident data from GIDAS (German In-Depth Accident Study) was used. GIDAS is the largest in-depth accident study in Germany. Since mid 1999, within GIDAS on-scene accident cases has collected in the areas of Hannover and Dresden. The investigated accidents can be declared as representative on the basis of the selection criteria and the statistical random and weighting procedure.

A hierarchical system ACASS Accident Causation Analysis with Seven Steps was developed in GIDAS, describing the human causation factors in a chronological sequence from the perception to concrete action, considering the logical sequence of basic human functions when reacting to a request for reaction.

The basis of the study is a 10-years accident documentations from 1999 to 2008. 10030 vulnerable road users were selected as pedestrians n=2373, motorcyclists n=2657 and bicyclists n=5000 and analyzed on 3 sample groups of VRU distinguished in collisions with cars on one hand and with trucks on the other hand as well as VRU alone.

The paper will describe the methodology of the new coding system on causation factors ACASS as a special tool for data collection within in-depth-investigation. Also relevant influence parameter on the causation of accidents will be shown based on the statistical based data collection for vulnerable road users. This information is given for accidents of pedestrians, bicyclists and motorcyclists in comparison.

Nearly one third of VRU are not guilty (36%), 45% have caused the accident in sole responsibility. In 19% of the cases also the collision partner contributed with guilty. Remarkable is that motorcyclists with the age 60+ were in 73% not guilty compared to 31% of young motorcycle drivers.

The most frequent influence parameter on accident causation could be seen for the VRU on human factors (70 to 80%), i.e. on a wrong assessment of the own vehicle in motorcycle accidents (24%) and in wrong exception (11%). Compare to this bicyclists have an higher wrong exception (16%) and for these a large number of failures in infraction of rules (17%). Pedestrians could be seen with wrong payed attention in 27%, internal deviation (15%) and vehicle behaviour misunderstandings (18%).

It is remarkable that motorcyclists and bicyclists have nearly the same kind of failures mainly on the assessment of the situation and defaults in planning of their driving action (together approx, 60% of causation factors). In contrast to this group pedestrians have the main kind of failures in recognition and observation of the flowing traffic. For motorcyclists causation factors of the infrastructure and environment can be seen too (16%).

The paper will also give an overview of description of the injury pattern and injury mechanisms of accidents of VRU. The injury frequencies and severities are pointed out considering different collision types and protective measures of helmet and clothes of the human body. The impact points are demonstrated on the car shape as well as on the trucks, following to conclusion of protective measures on the vehicle. Those parts following in severe injuries are special
discussed.
50% of pedestrians, but only 36% of bicyclists and only 17% of motorcyclists are registered with head injuries. The effectiveness of the motorcycle helmet as well as the bicycle helmet can be pointed out with the results. The impact zones on the helmets are shown. With bicycle helmet a lower risk of head injuries (with helmet 72% uninjured, without helmet 60.9%), more uninjured situation to the head (minus 28%), reduced severity of head injury AIS 3+ (minus 33%), fewer skull and base of skull fractures minus 45.5% and brain lesions or cerebral hemorrhages could be found by 58 respectively 62% reduction. Also the protective effect of clothes will be discussed. The lower extremities are the most frequent body area for all vulnerable road users (approx. 70% of VRU).

With this paper countermeasures and recommendations are given, divided into measures for protection in car accidents, in truck accidents and for the VRU themselves.
Title: CRASH CHARACTERISTICS OF TWO-VEHICLE FATAL CRASHES INVOLVING MOTORCYCLES – SIMILARITIES, DIFFERENCES AND RESOLUTIONS

Presenting Author: Oliver Page

Authors: O. Page 1;

Affiliation
1. University of Michigan Transportation Research Institute, Transportation Safety Analysis Dept., USA,

Abstract:
The objective of this paper is to analyze trends and crash characteristics through the identification of differences and similarities of two-vehicle crashes involving at least one motorcycle in the U.S. from 1998 to 2007. Understanding the historical interactions of two-vehicle fatal crashes may provide greater insight into planning effective highway and vehicle safety programs. Temporal distributions and the manner of vehicle interaction in the crash are also examined, modeled and analyzed.

Overall, the proportion of two-vehicle fatal crashes involving at least one motorcycle constituted just under one-half of all fatal crashes involving a motorcycle. The periods experiencing the highest occurrences of two-vehicle fatal crashes involving at least one motorcycle were the summer months of June, July and August; weekends and the hour 5 to 6 p.m. The application of a general linear model to capture the cyclical nature of disaggregated monthly two-vehicle fatal crashes offered a better alternative to simple linear regression confirmed by a significant increase in the R² value. The vehicle role data analyzed overwhelmingly indicated that the motorcycle more often than not was the striking vehicle in a two-vehicle fatal crash. Approximately 3 in 4 motorcycles involved in a motorcycle and passenger car or motorcycle and light truck two-vehicle fatal crashes were the striking vehicle compared to 4 in 5 motorcycles in motorcycle and large truck two-vehicle fatal crashes giving rise to the significantly increased odds of over 100 percent with respect to motorcycles being the struck vehicle in motorcycle and passenger car or motorcycle and light truck compared to motorcycles in motorcycle and large truck two-vehicle fatal crashes. However, the striking of the partner vehicle by the motorcycle may be the only plausible outcome and such an outcome need not necessarily imply that the motorcyclist was at fault.

Resolutions put forward were: 1) increased understanding of the purchaser or borrower of a motorcycle before riding the streets; 2) effective training programs and correct licensure; 3) increased visibility of the motorcycle and its rider; and lastly 4) the continued incorporation of advanced vehicle safety devices accepting their affordability and crash mitigation potential. Nevertheless, the development of various training and highway safety programs and the limited adoption of vehicle-safety technologies over the years the absolute numbers of two-vehicle fatal crashes involving at least one motorcycle have been increasing. This suggests that the resolutions advocated may not have kept pace in meeting the divergent needs of aspirant, actual or returning riders. However, to counter this supposed shortcoming, one has to realize that crashes are caused by people and no matter how innovative the device, material or training program the lack of a helmet worn by an operator is a factor that significantly increases the likelihood that a two-vehicle crash involving at least one motorcycle becomes a fatal one or at least results in some degree of injury or property damage.
Key words: Motorcycles, Highway Safety, Traffic Crash, Vulnerable Road Users
Title: HELMET WEARING REDUCES CYCLING

Presenting Author: Francis Papon

Authors: F. Papon 1;

Affiliation
1. Dest, Inrets, Noisy-le-Grand, France,

Abstract:
Helmets are proposed as a secondary safety measure to protect bicyclists from head injuries and deaths. This proposal can be implemented at different levels: as the cyclist’s personal choice, as a promotion campaign by different groups (health professionals, helmet manufacturers, government), or as a mandatory regulation for certain groups or in certain places. A number of research actions have already occurred to assess the efficiency of helmets. The efficiency of helmets at protecting cyclists from serious head injuries and deaths when they are victims of an accident is widely admitted and proved in case-control studies, with for example a reduction in the range 63-88%. But the effectiveness of helmet programs and helmet legislation is more disputed. Some epidemiological studies find an effect of helmet laws or programs, but with a much lower reduction rate of injuries. Other authors find no effect. This difference between the protection effect and the effectiveness of policies is due to several counter-acting factors. The risk compensation effect may increase risk taking by helmeted cyclists, and by motorists vis-à-vis helmeted cyclists. Helmet policy could reduce the number of cyclists, and then make the remaining cyclists less safe (safety by number). Also less cycling would reduce the health benefits of cycling, benefits that generally far offset accident risks. The aim of this paper is to make a contribution to the effect of helmets on the level of cycling.

The data used are those from the National Travel Survey passed in France in 2007-2008 to a sample of approximately 20,000 households including 45,000 individuals. For each individual, a question was asked to know whether the individual cycled, regularly, occasionally or never, and for those who cycled, whether they wore a helmet, always, regularly, occasionally or never. With these two questions, the cacy variable, combining the regularity of cycling with the frequency of wearing a helmet, will be built. On average, 77% of cyclists never wear a helmet. More detailed descriptive statistics on cycle use and helmet wearing according to individuals’ demographic, social, and geographic and health characteristics will be provided, the most important variable being age. Moreover, for one randomly sorted “Kish” individual in each household, the survey provides the description of all trips performed on two days (weekday and weekend). This allows the calculation for each “Kish” individual of three interesting variables for one selected day: the realization or not of a bicycle trip on that day, the number of bicycle trips on that day, and the total time cycling on that day. Statistics about the specificity of cycling trips performed by helmet wearers will also be provided as regards the geographic area, travel time, trip length, trip purpose.

From there, it is possible to study the amount of cycling according to the wearing of helmet in two stages. In the first stage, tables crossing the average value of each of the three bicycle travel variable by the cacy variable and by some demographic and geographic variables will be built, to determine, by category, whether helmet wearers cycle more or less. In the second stage, regression models with different specifications (linear, exponential or logistics) will be estimated to accurately control for all relevant variables and determine the effect of helmet wearing on cycle use. The helmet wearing variable will be introduced separately, or combined with the cycling regularity variable as in the cacy variable. Results will reveal that helmet wearers perform three times less cycling trips than non wearers, and this is true for nearly all categories, and that, on average, they significantly cycle for a shorter time per day.
Finally, the implication of this behavioural outcome for the effectiveness and design of helmet programs will be discussed.
Title: HELMET IMPORTANCE IN PTW ACCIDENTS AND DEVELOPMENT OF A SAFER HELMET USING FINITE ELEMENT ANALYSIS

Presenting Author: Tiago Paulino

Authors: T. M. Paulino 1; J. M. Dias 1;

Affiliation
1. IST-IDMEC Instituto de Mecânica, Instituto Superior Técnico, Lisbon, Portugal,

Abstract:
In Portugal, the accidents with PTWs represent about 27% of all fatal victims in road accidents. The study of helmets safety in case of accident is of extreme value and may play an important part in the reduction of the degree of injuries.

A statistical study concerning these accidents was performed in order to determine its number of resulting victims in Portugal over the year 2005. The study intended to identify and single out some of the main factors behind their occurrence, such as vehicle and human related factors, establishing an analogy with the use of the helmet.

In addition, two reconstitutions of real accidents involving these vehicles, in the scope of legal and litigious processes, were developed with the aid of computational models allowing the verification of the influence of the helmet in the severity of the drivers’ injuries.

In order to obtain a Portuguese and European perspective of in-depth data sampling on cognitive aspects of motorcycle helmets (project COST357 PROHELM), information was collected in various countries in an attempt to indentify and compare some aspects and inherent problems of the use of the helmet.

The constituting parts of the helmet were also object of study and analysis, as well as the basic anatomy and injury mechanisms of the human head.

Based on the previously collected information, a generic model of a helmet was developed on CAD 3D, followed by its conversion into finite elements, all in order to perform impact tests that would help improve the helmet’s safety.

Lastly, and basing on the obtained results, it was possible to reach important conclusions regarding the influence of foam material in the helmet. It was also possible to realize that the simple introduction of another foam layer in the interior of the helmet allows the reduction of the acceleration to which the head is exposed.
Title: DISABLED, PEDESTRIANS, BICYCLISTS IN FRANCE 2010: A STRONG AND LASTING TREND TOWARDS SAFER AND CAR - FREE TRIPS... FOR ALL

Presenting Author: Hubert Peigne

Authors: H. Peigne 1;

Affiliation

Abstract
1950 – 2000...
Urban and economic growth based upon cars and roads from the years 50’s on, French society and authorities (both national and local) gave priority to the car and road system, ignorant of pedestrians, unfriendly to cyclists, and actually forbidden to disabled. This system, loosing its importance, remains predominant.

Oil crisis (1973, 1979) and some first strong road safety measures allowed trends to reverse... slowly and with a lack of adoption by local authorities and players.

Some change occurred around 1973:

the number of road traffic casualties, had increased to almost 18 000 per year. First measures were taken, speed limits, mandatory seat belts, alcohol limit... Gains were positive – 13 500 casualties in 1980 – but became rather slow afterwards - 9 000 casualties in 2002.

some new and interesting measures in the 80’s and 90’s : pedestrian areas, zones 30, measures for cyclists in the highway code ; test-places for the « safer cities – neighborhoods without accidents » programme... But many cities did not want to implement them - and they could ! The French way of political decentralization in 1983 – transfer of responsibilities, means and resources from the State to the local authorities – also played a negative role (loss of shared objectives), especially in cities, with a State unwilling to be their partner (if not a « guide ») in the corresponding areas.

2002 - ....
Road and street safety : a new policy.
Cities cutting car – dedicated space, and rediscovering their vulnerable citizens

From 2002 on, the State launched a renewed and strengthened road safety programme. Among others : the installation of automatic radars (including automatic fines), now a few thousands.

Numerous cities undertook urban policies for vulnerable and disabled people, a bigger bike use, various kinds of public transports, for more traffic calming streets and public spaces... They begin to use recent measures created in our highway code – first result of the « street code » approach in a July 2008 decree: pedestrian priority zones; generalisation of two-way cycle traffic in one-way streets of pedestrian priority zones and zones 30.
Results:

4,200 road casualties in 2008.
cycling is now clearly increasing (x 3 in Lyon over 8 years; x 2 in Paris and Bordeaux over 6 years...), while the numbers of killed (250 in 2000; 150 in 2008) and injured people kept on decreasing.

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This presentation will be able to:

show the recent measures 2002 – 2009 aiming at both safety and quality of local life for vulnerable people;
relate the development of new prioritised PT (Trams, BRT...).
underline the importance of the « accessibility act » (February 11, 2005) – mandatory full accessibility of PT in 2015, accessibility programme for streets, roads and public spaces of each city to be set up in December 2009.
detail the « Code de la rue – street Code » approach, launched in April 2006, with a first decree (cf. supra) in July 2008, and other measures being tested (in some places, bikes can turn to the right at junctions when « their light » is red) or already almost written.
give some examples of big, lasting and growing successes (50% to 80% of bike use among the 600 pupils of a school – 11 to 16 years – near Montpellier; 25% modal shift to bike and PT due to the travel plan of St Microelectronics in Grenoble; high bike modal share in Strasbourg etc.).
present the recent national policy for the development of bike use.
and mention some other actions (« walking » schemes in some cities...).

This presentation will also be able to present some – still – strong difficulties:

the opposition of the car lobby.
the mistaken opinion of politicians and technicians who don’t see, don’t admit that the great majority of the French population is ready to change their way of living and travelling if they are offered some good alternative.
their professional practice of considering traffics and not people first (with priority to the poor and disabled).
others...
and, in some large cities (including Paris), the special problem of motorised Two Wheelers.
Title: ADULT RECREATIONAL BICYCLISTS: CHARACTERISTICS, USE OF SAFETY EQUIPMENT, AND INJURY

Presenting Author: Kobi Peleg

Authors: K. Peleg 1,2; M. Siman-Tov 1; A.M. Lipsky 1; D. H. Jaffe 1;

Affiliation
1. Israel National Center for Trauma and Emergency Medicine, Gertner Institute for Epidemiology and Public Health Policy, Tel-Hashomer, Israel, 2. Department of Disaster Management, School of Public Health, Tel Aviv University, Israel

Abstract:
The aim of this study was to characterize bicycle riders, bicycle-related injuries and utilization of protective equipment among adults (18+ years) in Israel in order to identify higher risk groups.

A cross-sectional survey was performed using questionnaires completed by cyclists aged 18 years and older. Data were collected in 10 major bicycling areas in Israel during two weekends in May 2008 and focused on riding characteristics, bicycle-related injuries, and use of protective equipment. Comparisons were performed based on primary type of riding activity – park, on-road and off-road.

Questionnaires were completed by 622 cyclists. Off-road and on-road cyclists compared to park cyclists had more years of cycling, tended to ride in groups rather than alone (95% vs. 75%, respectively) and rode more often during the week (40% vs. 24%, respectively) and for longer periods of time. The use of protective equipment (helmet, protective glasses, gloves, etc.) was generally higher among off-road and on-road cyclists and lower for park cyclists (e.g., helmet use: 98%, 99%, and 85%, respectively), though injury rates and severity were higher among the non-park cyclists (34%, 44%, and 23%, respectively). Half of the on-road cyclists reported injuries over the past three years and they were 2.6 times more likely to be injured compared to park cyclists. In addition, we found differences in reported injury characteristics according to cycling type: on-road cyclists were 6.5 times more likely to have had a head injury compared to park cyclists.

This study is the first in Israel to describe bicycle rider characteristics, and their safety equipment use and injuries. Policy makers should use the study findings as a basis for developing and targeting appropriate intervention programs in an effort to reduce bicycle-related injuries.
Title: COMPARISON OF BLOOD ALCOHOL LEVELS WITH BREATH ALCOHOL LEVELS MEASURED USING THE DRAGER 7110 MKIII BREATHALYZER

Presenting Author: Kobi Peleg

Authors: K. Peleg 1,2; D. H. Jaffe 1; M. Siman-Tov 1; S. Almog 3; D. Shinar 4;

Affiliation
1. Israel National Center for Trauma and Emergency Medicine, Gertner Institute for Epidemiology and Public Health Policy, Tel-Hashomer, Israel, 2. Department of Disaster Management, School of Public Health, Tel Aviv University, Tel Aviv, Israel, 3. The Institute of Clinical Toxicology and Pharmacology, Tel-Hashomer, Israel, 4. Israel National Road Safety Authority, Jerusalem, Israel,

Abstract:
Background: Over the past century the breathalyzer has become an indispensable tool for identifying alcohol levels among drivers. This instrument measures breath alcohol concentrations and is correlated with blood alcohol levels at a 2100:1 partition ratio. Recent uncertainty with this association has resulted in a legal standstill in the conviction of drunk drivers.

Objective: The study objective was to assess the correlation between breath alcohol, as measured using the Drager 7110 MKIII breathalyzer, and blood alcohol concentrations (BAC).

Methods: A blinded study was performed using conditions that were as similar as possible to those in the field. The study took place on the Sheba Hospital campus on 28/7/2008. Sixty-one healthy men and women between the ages 21-37 years participated in this study. The study was performed in four sets throughout the day each set comprising between 13-16 volunteers. Participants were administered between 0.89-1.16 g alcohol/kg bodyweight according to sex of 95% alcohol mixed in juice. Blood and breath alcohol measurements were performed prior alcohol ingestion and served as a control measure for each person. Three additional sets of breath/blood measures were performed approximately 20-30 minutes after alcohol ingestion with 20-30 minute intervals between tests. Blood and breath measures were taken as near to simultaneous as possible by police officers trained in the use of the breathalyzer. Blood samples were taken by study personnel to the laboratory for toxicology at Sheba Hospital for analysis. All blood and breath measurements were coded and researchers were blinded to the administered alcohol concentration or test times. Pearson correlations were used to assess the degree of association and sensitivity and specificity were measured.

Results: A total of 242 valid blood/breath tests were performed on 61 participants. The correlation coefficient between breath and blood alcohol levels was high (r=0.983). The regression equation for the prediction of breath alcohol was equal to 10.224 + 4.292*blood alcohol. Sensitivity of the breathalyzer instrument was 97% and specificity was 93%.

Conclusions: Using field conditions we showed a high correlation between the Drager 7110 MKIII breathalyzer and BAC. The results of this study were used in the courts as evidence for the strong association between BAC and breath alcohol levels.
Title: USING THE DRIVING RELIABILITY AND ERROR ANALYSIS METHOD (DREAM) TO UNDERSTAND POWERED TWO-WHEELER ACCIDENT CAUSATION

Presenting Author: Vuthy Phan

Authors: V. Phan 1; M. Regan 2; M. Moutreuil 1; R. Minton 3; M. Mattsson 4; L. Leden 5;

Affiliation
1. CEESAR, France, 2. INRETS, France, 3. TRL, United Kingdom, 4. University of Helsinki, Finland, 5. VTT, Finland,

Abstract:
In 2008, the European Commission funded the 2BESAFE project (2-wheeler Behaviour and SAFety).

The overall aim of this project, which involves almost 30 partners, across Europe, Israel and Australia, is to understand the behavioural and ergonomic factors that contribute to crashes and incidents involving motorcycle and scooter riders and, using this information, to formulate options for countermeasures to improve rider safety.

The project is divided into 8 work packages, one of which (Work Package 1) is concerned with understanding in detail the causal factors that contribute to powered two-wheeler accidents.

In this Work Package, four accident causation models were used to analyse and classify accident data derived from in-depth studies of PTW crashes previously conducted in the United Kingdom, Finland and France.

The first model, which we refer to as the Driver-Vehicle-Environment system description model, documents detailed factual information relating to the rider (eg. the rider’s professional status, family status, age, gender, etc), to the other party involved in the crash, to the vehicles involved (eg. vehicle type, vehicle age, vehicle defects, etc) and to the environment (eg. type of road, road geometry, traffic density, etc).

The second model documents factual information relating to each phase in the evolution of the crash – the normal driving phase, the precipitating event, the emergency phase, the crash phase and the post-collision phase (Brenac, 1997; Fleury et al., 2001).

The third model, the Human Functional Failure model (Van Elslande and Fouquet, 2007), classifies factors, characterizing the state of the system and their interactions, which explain human failures that contribute to crashes. This model considers that the driver, when driving, performs several sequential and inter-linked functions: detection, diagnosis, prognosis, decision and action. A rupture of one link in the chain can create an imbalance in the system; for example, a crash.

The final model, which is the focus of this paper, is the DREAM 3.0 model (Driving Reliability and Error Analysis Method; Warner et al., 2008). DREAM 3.0 provides a way to systematically classify and record accident causation information which has been gathered through in-depth crash investigations. It provides a structured way of sorting the accident causes into defined categories of contributing factors. Failures at the “sharp” end as well as at the “blunt” end are taken into consideration.

Each model has a different approach to the understanding and classification of the causal
factors which contribute to crashes and incidents. All of the models, however, are complementary and, from each, it is possible to aggregate the classified data in order to provide an overall summary of causation factors.

This paper describes how the DREAM 3.0 model was used, for the first time, to analyze and classify accident data derived from in-depth studies of PTW crashes conducted in the United Kingdom, Finland and France. More than 400 in-depth crash reports were reviewed. The paper will introduce and describe the DREAM 3.0 model, explain the manner in which it was used, summarize the results that emerged from use of the model, and discuss unique issues that arose in using the model given that it has not been used before to analyze PTW crash data.

Topics: Methods and tools for analysis, Evaluation research, research methods, and best practices, In-depth crash investigations and crash cause analysis.
Title: A COMPREHENSIVE SAFETY STRATEGY FOR PTW RIDERS AND RELEVANT RESULTS ACHIEVED IN SAFETY IN MOTION (SIM) PROJECT

Presenting Author: Marco Pieve

Authors: M. Pieve 1; M. D. Santucci 1;

Affiliation
1. Scooter Technical Innovation, Piaggio & C. SpA, Pontedera, Italy,

Abstract:
Besides the strong need of individual mobility in European countries, Powered-Two-Wheelers vehicles (PTW) are an effective solution to solve traffic congestion and to reduce pollutant emissions. Nevertheless PTW riders are considered one of the most vulnerable road user category because the risk of being involved in an accident is several times higher than the risk for a car occupant and the consequences are more severe.

The present paper describes the comprehensive approach adopted by Piaggio & C. S.p.A, leading manufacturing company in the field of motorcycles and scooters with the aim of improving PTW rider safety on the road, and the relevant results in terms of technological solutions developed in EU research projects in which Piaggio is involved.

First, an overview of different aspects of motorcycle safety is provided, describing current situation of PTW’s use, the critical aspects that need to be improved as well as an example of suitable and integrated safety strategy for PTW in order to avoid road accidents and mitigate their consequences. On such a basis and according to the Plan for Action 2006-2010 proposed by ACEM, Piaggio took the responsibility to lead the Safety In Motion Project from 2006 to 2009.

Safety In Motion (SIM) project is a research project (funded by the European Commission under the 6th Framework Programme) performed from 2006 to 2009, in which the following tangible results have been obtained:
- One integrated safety concept vehicle equipped with the most relevant safety systems
- Measurement and comparison of the performances of selected safety systems through on road tests and crash tests.

SIM vehicle prototype is based on the innovative and unique tilting three wheelers scooter, Piaggio MP3, selected as the most promising vehicle research platform because of the safety intrinsic characteristics of its vehicle architecture.

PTW safety strategy has been identified for all safety areas (active, preventive and passive) starting from the results of previous accidentology studies (e.g. MAIDS and APROSYS EU projects) and through an in-depth analysis on accident scenarios aimed at evaluating the effectiveness of most promising safety systems applicable to PTWs.

The following safety devices have been implemented in the same vehicle platform (Piaggio MP3):
- Active Brake System;
- Stability management by traction control;
- Semi-Active Suspension System;
- Frontal airbag;
- Inflatable device worn by the rider;
- Information Management concept for motorBikes (IMB);
- Enhanced Human Machine Interface (HMI) made of ergonomic handlebar controls, wireless communication and Head-Up display fitted in the helmet.

Comparative tests have been conducted on SIM prototypes for evaluating the enhancement of
active safety level in terms of handling and stability control, both in laboratory and on road. In preventive safety area, tests on the effectiveness of HMI Information Management concept for motorbike in enhancing the PTW rider’s awareness and comfort have been conducted. Concerning passive safety, a frontal airbag fitted on PTW (protection against primary impact) and an inflatable wearable device (mainly for the secondary impact) have been implemented while an activation algorithm has been developed. Their effectiveness has been measured through sled tests and full scale crashes in selected configurations. The reduction of dummy injuries has been compared within the same configurations with and without the presence of safety devices. SIM project is not only a concrete example of safety enhanced technologies applied to PTW (mainly in terms of active and passive safety) but the obtained results such as the innovative HMI layout and the electronic vehicle management provide the basis for preventive safety solutions to be investigated and developed in other on-going EU research activities focused on PTW rider safety enhancement. Within this research activity, Piaggio’s commitment in the field of PTW safety is also addressed to Vehicle-to-Vehicle and Vehicle-to-Infrastructure communication systems (i.e. WATCH-OVER and SAFESPOT EU projects) as well as the HMI optimization, Advanced Rider Assistance System and On Board Information Systems (SAFERIDER EU project) that are for sure a key issue for PTW rider’s comfort and safety.
Title: EVALUATION OF THE HCM PEDESTRIAN LOS METHODOLOGY IN CAGLIARI (SARDINIA, ITALY)

Presenting Author: Claudia Piras

Authors: C. Piras 1; F. Pinna 1;

Affiliation
1. University of Cagliari, Italy,

Abstract:
The United State Federal Highway Administration (FHWA) has published the Highway Capacity Manual (HCM) that provides procedures for analysing uninterrupted and interrupted pedestrian flows on walkways (Rouphail et al., 1998). Interrupted pedestrian flows refer to pathways intersected by traffic lights and other mechanisms to halt pedestrian flow for vehicular traffic. Since most of the walkways in National Parks in Victoria are exclusively pedestrian facilities, this report will only review the work relating to uninterrupted pedestrian flows.

The features of pedestrians are very important to examine: who is walking on sidewalks highly influence the performance of them and the characteristics of their traffic flow.

In the Highway Capacity Manual (HCM), published by the Transportation Research Board (TRB), there is a method to calculate and analysis level of service (LOS) in the USA. In order to estimate sidewalk comfort for pedestrians it is calculated the pedestrian level of service (LOS). It is used to design new sidewalks, to test the performance of an existent sidewalk, to decide its redesigning, to improve its width, to analyze its capability after a change, and so on. The HCM presents a measurement, that is adaptable, with indexes linked to places and times, to different sites.

However some international studies show that the HCM measurement of pedestrian LOS does not consider the complex pedestrian background under different situations: like, for example, environmental, and psychological factors which affect their travel expectations and needs. After surveying international literature and collecting and analyzing pedestrian data, our research group studied the HCM methodology and its application on Italy urban roads. The target of this article is to evaluate the HCM pedestrian LOS methodology in terms of its suitability for pedestrian planning in Italy, to compile a pedestrian features database, and to study pedestrian LOS analysis in Italy.

This study was concentrated in Cagliari (Sardinia, Italy). Cagliari is the largest city in Sardinia (a big island of Mediterranean sea), but it is not a very big city. According to the census, about 170,000 people lived in Cagliari. In the city there are different kinds of people: citizens, students (who live there for studying, because there is the largest University of Sardegna), businessmen and workers (who only works in Cagliari but live apart), tourists, and so on.

This study is divided in two main parts. The first one is addressed to analyze the appropriateness of the HCM pedestrian LOS methodology for Cagliari. The second one aims to measure the factors that congestion the pedestrian flow on the sidewalks.
Title: STUDY ON SAFE WAY TO SCHOOL IN ITALY

Presenting Author: Claudia Piras

Authors: C. Piras 1; F. Pinna 1;

Affiliation
1. University of Cagliari, Italy,

Abstract:
Every year thousands of accidents which occur involving children aged between 2 and 14 years are recorded mainly on the way to school. The way to school is the first and most important approach for children with the use of urban space. The most evident response to the risk of road is provided by the parents’ behavior: they go to school with their children. Last statistics have shown that in Italy on the urban road network accidents and injuries have grown over 80% and a little less than 2/3 of deaths from road accidents. The described situation is heavy with pedestrian-vehicle conflicts, in which speed is the main factor in the severity of the accident, especially when children are involved. Medical studies indicate that the increased exposure of children to the dangers of the road is related to their incomplete development compared to the standard features of the adult. Hence the need to plan safe way to school.

The paper is divided into the following parts:
• general overview of the urban area;
• construction and analysis of the O/D matrices on the paths of children;
• analysis of key issues and critical;
• explanation of proposed projects.

For the organization and planning of the ways to school we used a careful analysis of the interested areas and urban paths. When the school is located in residential neighborhoods, we verified, for example, the feasibility of a "30 zone". In the outside of the “30 zone” we proposed several design solutions to lead the children towards school paying attention to crosswalks. Another solution that we considered was the creation of a “residential zone”, in which the car drivers give priority to the pedestrians and the motorized traffic is deterred. When the design of “30 zone” or “residential zone” was not possible, we designed the ways to school along urban roads. Another solution was the design of “restrict traffic zone” next to school, at least during time entry and exit of the children, so that there are not cars in front of school.
Title: ANALYSIS OF THE DRIVER AND PEDESTRIAN BEHAVIOR NEXT TO CROSSWALKS

Presenting Author: Claudia Piras

Authors: C. Piras 1; F. Pinna 1;

Affiliation
1. University of Cagliari, Italy,

Abstract:
Pedestrians are vulnerable road user. In this research we present a study about the relationship between drivers and pedestrians behaviour at crosswalks in Italy. The pedestrians have a lot of difficulties in crossing because most of the drivers don’t care for the waiting pedestrians. Pedestrians are mainly exposed to the risk of traffic accidents when they cross a street in urban areas. The crosswalks are the sites where the pedestrians leave the sidewalk and enter the roadway. In this case the path of the pedestrian crosses that of the cars.
The pedestrian crosses safely if there are not cars or the driver detects him with sufficient time to stop his car. Often the drivers do not stop even if they detect the pedestrian nearly to crosswalk. A lot of drivers go at high speed also next to pedestrian crossing. This driver behaviour is very dangerous for vulnerable road users.
The target of this research is to analysis the driver and pedestrian behaviour next to crosswalk areas. In order to verify the driver and pedestrian behaviour a television camera and two speed detectors were used. The television camera permitted to collected pedestrian characteristics, environmental characteristics, flow characteristics, while the two speed detectors allowed to collect vehicle speed in two sections (one of them was located several meters from crosswalk section, the other was located next to crosswalk section). A radar instrument was used to reveal the instant speed of the vehicles. We want to evidence that this type of instrument was also chosen for its characteristic of being easy to hide from the drivers view and to install on a vertical mobile support at any site. In addition, the shape of the instrument is such that even if seen by the driver, it is not recognized as a survey or radar instrument. In this way it is possible do not influence driver behaviour.
The method to collect pedestrian characteristics and speeds in the different conditions is described. The video capture and analysis procedure, which is used to study pedestrian and driver behaviour next to crosswalk, is detailed.
Title: MOTORCYCLE CONSPICUITY DEPENDING ON SIGNAL PATTERN OF THE FRONTAL LIGHT CONFIGURATION

Presenting Author: Lars Roessger

Authors: L. Roessger 1; K. Hagen 1; J. Krzywinski 2; B. Schlag 1;

Affiliation
1. Traffic and Transportation Psychology, University of Technology Dresden, Germany, 2. Center for Industrial Design, University of Technology Dresden, Germany,

Abstract:
Motorcycle accidents show specific characteristics. On the one hand, motorcyclists are involved in single accidents to a disproportionately high extent. On the other hand, “right of way” - violations at junctions represent a particular problem for riders in multiple vehicle accidents. Various studies show that in majority of multiple vehicle accidents motorcyclists’ right of way is violated by the other vehicle. Failures respectively delays in recognition of motorcycles by other drivers are seen as one of the crucial factors contributing to this kind of accidents. One often discussed reason for these perception and attention failures is that motorcycles are less conspicuous to other road users. Two aspects should be distinguished: visual conspicuity refers to the ability to attract the visual attention by the physical attributes of motorcycles and cognitive conspicuity hints to the top-down processes involved in the recognition and perception of motorcycles which are highly influenced by expectations and knowledge of other drivers about motorcycles.

The present paper investigates the conspicuity of motorcycles depending on their frontal light configuration. We aim for identifying a front signal pattern through altered and/or additional light sources which makes motorcycles clearly and fast distinguishable for other vehicle drivers, and hence, facilitates the processes of localization and identification of motorcycles (MC). In association with this, we assume that such a unique front signal pattern enables driver to build-up a perceptual set which supports the drivers in their decision processes whether a MC is present or not.

Within a first experiment, two new signal patterns (T-configuration, T-configuration with additional helmet lights = 2 experimental groups) were considered in respect of their conspicuity and compared to the conventional lighting of MCs (with headlamp, control condition). Subjects (N=56) were randomly assigned to one of the three groups. A series of pictures were presented to the subjects showing typical intersection situations. Only 20% of the pictures contained MCs to avoid wrong expectations by the subjects. The picture series were completely identical in order and content across the experimental and the control group except the appearances of the MCs with different lighting configurations. For each picture within the series subjects had to decide as quickly as possible which vehicles were present. Gaze data were obtained during the presentation by an eye-tracking device. They provided conspicuity indicators such as the latency time of the first target fixation and the number of fixations on the target. The reaction times for decision-making served as a further indicator of the conspicuity. Additional control variables were obtained such as license status (only car driver or holding dual licenses).

A second experiment dealt with the question: what specifications of a frontal light configuration are sufficient to be recognizable under different lighting conditions? N = 50 subjects proceeded a simulated driving task outdoor and had, according to an auditory signal, to respond in certain time intervals to an experimental lighting installation in 100 meters resp. 50 meters distance. The experimental installation contained a MC headlamp, a MC turn indicator and a position light between headlamp and turn indicator. The position light served as part of a possible new MC frontal light configuration. The subjects had to indicate how many lights were presented.
Thereby, we varied the distance between position light and headlamp (to the turn indicator respectively), the luminous intensity of the position light and the daytime of the trial. The response time to react and the correct recognition of certain light configurations served as dependent variables. In a second part of that experiment subjects got the task to adjust themselves the just noticeable distance between headlamp and position light. Within that second part we varied the distance of the installation (100 m, 50 m) and the daytime of the trial. Both experiments provide interesting results and valuable hints about how the poor conspicuity of MCs could be improved by frontal light design. Practical implications and further investigations will be discussed.
Title: LACK OF VISIBILITY OF POWERED TWO-WHEELERS FOR CAR DRIVERS DURING LANE SPLITTING MANOEUVRES

Presenting Author: Joceline Rogé

Authors: J. Rogé 1; J. Ferretti 2; M. Duraz 3;

Affiliation
1. LESCOT, Institut National de la Recherche sur les Transports et leur Sécurité, France, 2. LESCOT, Institut National de la Recherche sur les Transports et leur Sécurité and Laboratoire EMC, Univers, 3. Laboratoire Exploitation, Perception, Simulateurs et Simulations, INRETS/LCPC, France,

Abstract:
In France, motorcyclists are twenty times more likely to be killed in a road accident than car drivers. The most frequent types of accidents are collisions between a motorcyclist and a car driver. The characteristics of accidents involving a motorcyclist (recorded in several European countries) have been analyzed in detail by experts (MAIDS, 2005). Of those accidents where human error was identified as the primary cause of the collision, 35.6% were the result of a lack of attention and/or perception on the part of the car driver (compared with 11.9% caused by error on the part of the motorcycle rider). In these cases, the car driver failed to detect the motorcyclists in time to avoid the collision, despite the fact that the driver’s visual field was not obstructed in any way. One possible explanation is that the motorcyclists lack visibility for car drivers because of their physical characteristics. This means that they have a low sensorial conspicuity for car drivers. Another possible explanation (which does not exclude the other one) is that the motorcyclists are not detected because of limited attentional abilities of car drivers when the driving situation is complex.

In this study, we are interested in the ability of car drivers to detect motorcycles riding at unexpected parts of the road (as is the case when motorcycles are performing splitting maneuvers on the highway) and when car drivers have to overtake in order to follow a car in traffic.

Our first hypothesis is that the modification of the colour contrast between the powered two-wheelers and the traffic could have an effect on the ability of car drivers to detect these vulnerable road users appearing at unexpected parts of the road. Our second hypothesis is that the visual attentional ability of car drivers (estimated with the extent of their useful visual field during driving) has an effect on the ability to detect the motorcyclists on the road.

Twenty drivers (40.6 years old) carried out two simulated car driving tasks. The size of their useful visual field was first estimated during the driving when they are following a vehicle on the highway. The participants had to detect some changes of colour of a circle which appears briefly on the rear window of the vehicle they follow. The area in which they can detect some signals appearing at the same time on several eccentricities defines the extent of their useful visual field (Rogé 2009). Each participant has been identified, according to their performance in this test, as a motorist with a rather extended useful visual field or as a motorist with a rather limited useful visual field.

The second task was to follow a car (lead vehicle) in heavy traffic, which consisted of streams of vehicles (motorcycles, cars and lorries) on a 2X2-lane. Because this lead vehicle overtook in traffic, the participants had to perform a complex driving task including maintaining a safe gap with the vehicle in front of them, choosing safe gaps in order to insert in traffic in the left lane and paying attention to the lead vehicle performing overtaking maneuvers. While following this car, the participants also had to detect on their mirrors motorcyclists who were performing lane splitting maneuvers. To modify the sensorial conspicuity of the powered two-wheelers, the
colour of the body of the motorcycle, the clothes and the helmet of the motorcyclist were modified in order to have a high level of contrast (red) or a weak one (white) with the traffic (which could be cars or lorries with white body).

The statistical analyses of the visibility temporal gap of the motorcyclist (temporal gap between the participant and the motorcyclist when the latter was detected) indicate that a high level of contrast could enhance the motorcyclists’ visibility on mirrors in some specific conditions of traffic (i.e. when motorcyclists were performing filtering maneuvers in a stream of cars) only for car drivers who have an extended useful visual field in driving.

Some outcomes of these results concerning the detection of these vulnerable road users performing lane splitting maneuvers in a driving situation involving divided attention are considered in terms of road safety, sensorial conspicuity and cognitive conspicuity.
Title: FEAR AND DANGER APPRAISALS OF A ROAD CROSSING SCENARIO: A DEVELOPMENTAL PERSPECTIVE

Presenting Author: Tova Rosenbloom

Authors: T. Rosenbloom 1, 2; D. Nemrodov 1; A. Ben-Eliyahu 1; U. Eldror 1;

Affiliation
1. Research Institute of Human Factor in Road Safety, Academic Studies, College of Management, Rishon Lezion, Israel, 2. Interdisciplinary Department of Social Sciences, Bar Ilan University, Ramat Gan, Israel,

Abstract:
One of the most important cognitive tasks performed by pedestrians is visual timing, i.e. evaluating of a vehicle time-on-arrival, comparing it with one's own crossing time, resulting in the decision whether to cross or not (Thomson, Tolmie, Foot, & McLaren, 1996). Children's actual performance of this task is possibly deficient, due to their relatively inferior visual, motor and physical skills, resulting in an overreliance on the distance factor, and road-crossing training programs focusing on the speed, distance and time elements result in questionable improvement in performance. Children’s safe-crossing programs usually rely on verbally focusing children on these elements, tapping their conceptual aspects rather than the actual perceived stimuli. Such programs frequently utilize fear of the danger associated with traffic accident, causing children to avoid inappropriate crossing behavior. Although findings indicate that when children are made aware of the danger of traffic accidents, they identify and fear the situational danger, they apparently do not view traffic accidents as eminent, probable dangers and therefore neither worry about them nor take any preemptive measures to avoid them (Demetre and Gaffin, 1994; Hill et al., 2000). Thus, for a children’s safe crossing program to become effective, it need both to improve children’s detection of visual timing factors, and then to make them identify the risks these factors present.

In view of possible gaps between knowledge and its actual implementation (Miller, Austin, and Rohn, 2004), the current study avoided direct evaluations of speed and distance (and naturally, direct risks), instead focusing on conceptual, rather than perceptual, examination of the visual timing elements of distance and speed, as integrated into appraisals of risks related to a traffic scenario. Preschool children, 3rd grade children and adults appraised pedestrian fear and danger associated with four scenarios conceptually depicted using a table-top model. Each scenario described either a child or an adult pedestrian approached by a vehicle at various distances (near/far) and speeds (slow/fast). Results indicated preschoolers conceptualized speed to be the primary risk factor compared to distance, and with a more pronounced deficiency for danger appraisals. They provided similar ratings for child and adult pedestrians indicating a failure to realize children’s underprivileged pedestrian status. Third graders conceptualized both speed and distance as risk factors, yet usually relied on the more salient factor, yet failing to integrate both concepts in their appraisals. Like preschoolers, third-graders also failed to differentiate between the risks posed to children compared to adults. Adult subjects integrated the danger and fear appraisals by giving separate weights to both distance and speed concepts.

These finding suggest that increasing the amount of traffic safety information available to the children may not be enough to improve their safety. Even if the risk factors were to be pointed out by the adults, children’s risks assessment may still be inadequate. Furthermore, as children seem to be oblivious to their higher-risk levels, further emphasis is needed to dissuade parents from over reliance on their children’s skills of handling even trivial traffic situations. Possibly, training methods combining knowledge components with emotional components (such as
arousing the negative affects of fear and danger) might yield more effective results.
Title: COMPLIANCE OF ULTRA-ORTHODOX AND SECULAR PEDESTRIANS WITH TRAFFIC LIGHTS IN ULTRA-ORTHODOX AND SECULAR LOCATIONS

Presenting Author: Tova Rosenbloom

Authors: T. Rosenbloom 1; A. Shahar 1,2; A. Perlman 1;

Affiliation
1. The Interdisciplinary Department of Social Sciences, Bar Ilan University, Ramat Gan, Israel,
2. Department of Psychology, University of Nottingham, Nottingham, UK,

Abstract:
Previous research findings indicated Israeli pedestrians in an ultra-orthodox environment committed as much as three-times the traffic violations of secular environment pedestrians, age and gender notwithstanding (Rosenbloom, Nemrodov, & Barkan, 2004). As religious society usually prioritize a religiously-sanctioned law over the state law (Yagil & Ratner, 2002), the traffic violations bias found in the ultra-orthodox environment is, presumably, the result of different sets of road crossing behavior norms in secular and ultra-orthodox environment.

As the previous study focused on the road behavior of pedestrians in their home neighborhood, the present study set to examine the influence of both in-group and out-group road crossing norms. Specifically, it focused on the road behaviors of pedestrians both in their own in-group environment and in an out-group environment, and observed whether ultra-orthodox pedestrian “give in” to secular crossing norms when crossing in a secular city; and vice versa, whether secular pedestrians adopt local crossing behavior when crossing at an ultra orthodox city crosswalk.

We observed the red light crossing behaviors of 995 pedestrians in the neighboring ultra-orthodox and secular Israeli cities of Bnei-Brak (ultra-orthodox) and Petah-Tikva (secular). The observed crosswalks were similar in terms of road formation, traffic and pedestrian volumes, and red light phase duration. A logistic regression was used to assess the tendency to cross on a red light as a function of estimated age, gender, religiosity, crosswalk location (religious/secular city), red light phase duration, and traffic and pedestrian volume.

The model significantly predicted the tendency to cross on red (omnibus chi-square (8, N = 995) = 108.65, p < 0.001) and accounted for 10.4% (Cox & Snell R Square) to 16.4% (Nagelkerke R Square) of the variance in tendency to cross on a red light, with an overall prediction accuracy of 80%. We did not find a significant difference between ultra-orthodox and secular pedestrians’ road crossing violations. However, we found an interaction between the crosswalk location and the pedestrian religiosity, such that in the ultra-orthodox city 44% of the secular pedestrian and only 21% of local ultra-orthodox pedestrians crossed on red (chi square = 7.14, df = 1, p < 0.05). The odds of crossing on a red light decreased as a function of both the number of people waiting at the curb (0.73) and the number of vehicles (0.95). Consistent with previous research, males crossed on red more often than females, regardless of religiosity and location.

The interaction found between pedestrian’s religiosity and crossing location suggests red-light crossing behaviour is affected by the crossing locale, to such extent that pedestrians in their own neighbourhood committed half the traffic violation than in a markedly different neighbourhood. Possibly, both pedestrian groups felt more comfortable breaking traffic laws when they weren’t in their own neighbourhood, because their in-group social norms were perceived as more lax, and less prone to social sanctions (Grasmick, Bursik, & Cochran, 1991).
Title: RISK FACTORS IN ROAD CROSSING AMONG ELDERLY PEDESTRIANS AND READINESS TO ADOPT SECURE BEHAVIOR - COMPARISON BETWEEN A MAIN CITY AND A PERIPHERAL CITY

Presenting Author: Tova Rosenbloom

Authors: T. Rosenbloom 1, 2; Y. Sapir-Lavid 1; U. Eldror 1;

Affiliation
1. Research Institute of Human Factor in Road Safety, Academic Studies, College of Management, Rishon Lezion, Israel, 2. The Interdisciplinary Department of Social Sciences, Bar Ilan University, Ramat Gan, Israel,

Abstract:
Elderly pedestrians are much more susceptible to being injured or killed in a car accident (The National Authority of Road Safety, 2002). Studies identified several factors involved in this phenomenon (for example, Oxley et al., 1995), relating either to the physical health of the elderly person, such as deterioration in hearing and in eyesight, or to psychological and cognitive conditions, such as poor decision making, difficulty in processing complex information, and difficulty in risk assessment. Zakay (2001) investigated road crossing behaviors of the older population in Tel-Aviv, and found that they were unaware of the risk factors in the road, and overestimated their ability to cross the road safely. He also found that many of them wanted to attend road safety training, lacked the opportunity to do so.

The current study intends to broaden the understanding of the factors involved in the risk taking procedure of the older pedestrian, and to identify factors related to the elderly person's willingness to adopt preventive behavior in this area. Based on the Health Promotion Behavior model (HPB), which has been used extensively in public health related studies, we compared the road-crossing behaviors and attitudes of elderly people living in a main central city and in a peripheral city, in order to identify the specific needs of each area based on its socio-demographical characteristics. The willingness to adopt safe road-crossing practices is assumed to be influenced by the factors identified in the literature, such as socio-economical status, immigration and education level, and cognitive-psychological factors such as self efficacy assessment.

The current study examined both behavioral observations of and self-assessment questionnaires. Crosswalk observations, both with and without traffic lights, were performed on three locations in Tel-Aviv (representing a main city), and three locations in Beer-Sheva (representing a peripheral city). Observations included a total of 2862 pedestrians, of whom 902 were elderly (estimated to be over 65). Be’er-Sheva observations included 1181 pedestrians of which 474 were elderly, and Tel-Aviv observations included 1681 pedestrians of which 428 were elderly. The questionnaires were completed by 143 elderly participants, 62 in Be’er-Sheva and 81 in Tel-Aviv, concerning the self assessment of road-crossing risks, perceived expectancy for adopting preventive behavior, perceived self-efficacy as well as the self-assessment of crossing related behaviors.

Observations results indicated an overall proclivity for red-light crossing in male pedestrians in both cities, as well as in younger pedestrians in Tel-Aviv. The overall safe road behavior index was higher for elderly pedestrians compared to younger pedestrians, for females compared to males, and for Tel-Aviv elderly pedestrians compared to Be’er-Sheva elderly pedestrians, indicating the Tel-Aviv elder people are more careful than their Be’er-Sheva counterparts. Overall, Tel-Aviv elderly pedestrians appeared more aware of their limitations than the Be’er-Sheva ones.

The questionnaire results also support this difference between the Tel-Aviv and Be’er-Sheva
elderly population, with Tel-Aviv respondents are more aware of their road-crossing risks and limitations, less prone to overestimation of the crossing abilities, and more willing to receive further road safety training, compared to the Be’er-Sheva respondents. These results indicate differences exist within the elderly population, requiring a different approach to elderly-oriented road-safety planned, based on local needs and norms.
Title: A WITHIN-SUBJECT DESIGN OF COMPARISON OF WAITING TIME OF PEDESTRIANS BEFORE CROSSING THREE SUCCESSIVE ROAD CROSSINGS

Presenting Author: Tova Rosenbloom

Authors: T. Rosenbloom 1; A. Peleg 1;

Affiliation
1. The Interdisciplinary Department of Social Sciences, Bar Ilan University, Ramat Gan, Israel,

Abstract:
The study was aimed to compare the waiting time of pedestrians before crossing three successive road crossings. Most of the studies related to pedestrians’ behavior are focused in between-subjects designs but not many of them are based on a deeper understanding of patterns of the same pedestrians in various situations. It is important to learn more profoundly the universal cognitive mechanisms underlining pedestrians' behavior.

One of the relatively rare examples of this trend is the work of Hamed (2001) which presents interesting findings concerning the crossing patterns of pedestrians in Jordan. Hamed found a negative correlation between waiting times of pedestrians before crossing the first part of a road divided by an island and the waiting time before crossing the second part of the same road. The more the pedestrian waited at the first crossing the less he waited at the second one, perhaps because the first trial did not leave him/her enough patience for the second trial. Theoretically, two alternative explanations are relevant to this finding: (1) The pedestrian relates to both parts of the road as to one piece of barrier and therefore the patience devoted to the crossing of the first part is on the account of the patience of the second part and (2) Each pedestrian is "equipped" with one unit of patience which decreases as the pedestrian is trying to cross both the two part of the road.

The differentiation between the two explanations of pedestrians' behavior while crossing double-crossing roads has practical value in the context of road crosses design. It is important that pedestrians when coming to cross streets will do it highly patient and alert.

The empirical determination of both the theoretical explanations has been made by testing the waiting time of pedestrians before crossing a triple-crossing. Our hypothesis was that if the first explanation was valid, then the third crossing will be perceived as a new road and therefore a new "portion" of patience will be used. If the second explanation is relevant then the pedestrian's patience will lessen and till s/he arrives at the third part the waiting time will be shorter than at the previous two crossings.

A second empirical test to determine between the two models was carried out by a comparison between the correlation of waiting times of pedestrians in two different types of double-road: (1) with a narrow or (2) with a broad island diving between the two parts of the street. Our hypothesis was that due to a broader island the double-road is perceived as two units by the pedestrian and therefore his/her patience will be refreshed at the second part.

More than 900 people (57% female) were observed by crossing a triple-crossing road in five different locations in the center of Israel. The waiting times before crossing at each part of the road were recorded by two experienced observers. The mean waiting time beyond individual differences was 5.18, 4.95 and 0.84 seconds at the first, second and third crossings in respect. Our results are not in line with those of Hamed (2001). Beyond the demographic variables of age, gender, location and other, Pearson Correlation Test reveal that there is a positive strong correlation between waiting times of the first and the third crossing \( R=0.194 \ p<0.05 \) (but not the second crossing. This finding supports the model of the renewing patience of the pedestrian.
Title: REGIONAL BICYCLE DEMAND MODELING: ESTIMATING WHAT’S NOT THERE

Presenting Author: Sherry Ryan

Authors: S. Ryan 1; A. Jovanovic 2;

Affiliation
1. School of Public Affairs, San Diego State University, San Diego, California, USA, 2. Alta Planning + Design, San Diego, California USA,

Abstract:
This paper presents an innovative tool for estimating regional bicycle demands in a manner comparable to the type of assessment carried out for regional vehicular travel modeling. Long range planning for vehicular travel is fortified by well documented and developed regional travel models. No such tools exist for bicycle planning. In the absence of sound demand analysis and forecasting techniques, cities and regions are readily able to ignore this increasingly important mode of travel, resulting in under-planning and under-funding for bicycle facilities.

This paper will present a demand analysis approach created to support the development of a proposed bicycle network as part of the City of San Diego’s long range bicycle master planning process being carried out in 2009. Given the absence of regional travel behavior data on bicycle trips -- such as number of bicycle trips per household and average bicycle trip lengths by trip purpose -- a non-empirical methodology was developed based upon demand rankings.

Bicycle demand is modeled at two scales of travel – intra-community travel consisting of relatively shorter bicycle trips that occur within a community, and inter-community travel consisting of longer bicycle trips that occur between communities.

The intra-community bicycle model relies upon raster-based spatial modeling whereby a series of population and land use variables are defined with corresponding weights and point values. The raster model allows for the identification of the convergence of multiple subpopulations and land uses expected to generate and/or attract bicycle trips.

The inter-community bicycle model employs a gravity model framework to estimate network-based bicycle demands, incorporating consideration of both the intensity of activity centers across a region and the distances between them. The gravity model posits that activity centers with higher intensity land uses will generate higher demand for travel between them than activity centers with lower intensity land uses. It also posits that activity centers in closer proximity will generate higher demand for travel between them than activity centers farther apart. Application of the gravity model in the inter-community bicycle model requires the development of activity center and network systems. The activity centers should describe the amount and intensity land uses, while the network system should characterize distances and travel paths between the activity centers. For the purposes of the San Diego bicycle planning process, the city’s long range land use plan was used to define activity centers. In terms of the network system, ArcView’s Network Analyst was employed to develop a network of shortest paths between all activity centers along the bikeable roadway network. A distance decay factor was developed to account for the fact that activity centers in closer proximity should generate more interaction; and likewise, those farther apart would experience less interaction. As with the intra-community bicycle demand model, a weight and point system was devised and applied to all network segments in the inter-community demand model.
The final assessment requires summing the demand rankings resulting from the intra and inter-community analyses to arrive at a final demand score for every bikeable roadway in the study region.

The methodology holds strong promise in that it links bicycle planning with land use planning, it is fairly easily implemented in a desktop GIS, and it can evolve into an empirical model as sufficient count data for a region becomes available. The bicycle demand model was well received by City of San Diego staff and community members, and was successfully used as an objective basis for the development of a proposed bicycle network.
Title: COUNTDOWN SIGNALS FOR PEDESTRIANS IN GERMANY

Presenting Author: Klaus Schlabbach

Authors: K. Schlabbach 1;

Affiliation
1. Civil Engineering, HafenCity University Hamburg, Germany,

Abstract:
Information in digital figures about the seconds left till the changing of the signal indication to RED is widely spread all over the world. Surprisingly their effects on the acceptance of the signal control are less researched. Many examples in China, Japan, Denmark, Ireland and Turkey have been realized without any research about their effectiveness. Furthermore there are a lot of installations especially in the United States and Canada which provide pedestrians with the remaining seconds available before the pedestrian phase ends (1); in many cases they show only the time remaining to cross (2). That is a great difference to the Hamburg experiment.

Hamburg in the north of Germany is the second biggest city (1.7 million inhabitants) of the country and is ranked eighth in the world's harbour chart (7 million TEU per year). In 2005 the local government voted for a pilot project to prove countdown signals the first time in Germany. In the first step a pedestrian crossing in the Central Business District was equipped with countdown RED signals for pedestrians.

As a simplified test of effectiveness a before-and-after-study was carried out covering the following aspects: traffic volume of cars and pedestrians, delay and acceptance of the signals. The two pillar approach consists of a traffic engineering survey and roadside interviews. This is to make sure that we have data from two levels (objective by traffic counts and subjective by the questionnaires) interpreting the results. Due to the activities in the CBD (shopping, entertainment, work places) the research intervals were fixed to 11 a.m. – 1 p.m./4-6 p.m. and 8-10 p.m. Altogether 45000 cars and 71000 pedestrians crossing the street had been recorded and 760 questionnaires had been evaluated.

Behaviour in transport is embedded in the behaviour patterns of other social sectors. If the society is marked by growing individualism, self assertion, egoism and deregulation no one can be surprised to see similar attitudes in the traffic sector. That is why red-light offences by pedestrians and cyclists are widespread in Germany. Countdown signals have a significant influence on this misbehaviour. As a whole (for both directions and all intervals) the red-light-running share dropped from 21.0% to 16.7% which means a reduction of 20%. This result is very remarkable, because we know inevitable basic values about 10% referring to unsaturated flows.

The questionnaire showed first of all an increasing threshold value of the acceptable waiting times. One quarter of the sample stated a changed behaviour by the countdown signal which corresponds to the observed reduction of the red-light running. The public opinion differs a lot depending on age and sex (women agree more with the countdown signals). At least the participants rated the countdown signal as a whole. Though 29% refused the additional help very strictly, there is a clear consent.

Due to the public opinion and the traffic engineering results, the government decided in the meantime to continue with the installation of pedestrian countdown signals.
A cost-benefit analysis has not been done because the most important parameters (f. e. delay, accidents, and journey times) keep unchanged by the countdown signals. But the results show clearly that countdown indications provide enhanced pedestrian convenience and can reduce the redlight-running of pedestrians.

REFERENCES
Title: EFFECTS OF INDIVIDUALIZED FEEDBACK ON CAR DRIVERS’ SPEED AT PEDESTRIAN CROSSINGS

Presenting Author: Bernhard Schlag

Authors: B. Schlag 1; J. Stern 1; L. Roessger 1;

Affiliation
1. Traffic Psychology, Traffic Planning and Road Traffic, Dresden, Germany,

Abstract:
The present study investigates the effects of a device (Dialogue-Display) which has been developed to mitigate risk of pedestrians during street crossing decreasing of car drivers’ speed level and facilitating their attention to vulnerable road users. The display is located at the roadside in advance of critical pedestrian crossing zones. It provides a visual message to the drivers according to his speed level: if a driver exceeds the speed limit the display will present the message “Slow down!” in red letters if the drives at or below the correct speed level a “Thank you!” in green letters will appear. These messages are combined with a situation specific and emotive representation of vulnerable road users. Hence, the Dialog-Display gives an individualized feedback to drivers. Because of its dynamical characteristic, it should attract the attention of drivers to safety adequate behavior in a higher extent than conventional static speed limit signs.

The effects of eight Dialogue-Displays on drivers’ speed have been measured at four local spots in Germany. Additionally pedestrians have been asked for their perceptions of car drivers’ behaviour and perceived safety during crossing the street.

The effects of the Dialogue-Display on relevant variables have been investigated by an A-B-A research design, i.e. baseline (without Dialogue-Display), treatment phase (with Dialogue-Display) and finally post phase (again without Dialogue-Display). During the treatment phases, significant and time stable changes of car drivers’ speed have been observed. Relevant speed parameters decreased in a range from 1.8 km/h to 6 km/h depending on the local spot. The percentage of car drivers violating the speed limit decreased markedly: speed limit violations decreased at least to a half of the baseline. The reductions in speed are particularly significant in safety relevant higher speed ranges.

At the same time, pedestrians questioned on the spot felt safer at crossing sections during the treatment phases and they felt the interactions between pedestrians and car drivers became safer with a Dialogue-Display.

The results of that study emphasize that the implementation of such dynamic feedback–systems have systematic positive impacts on important criteria of traffic safety. Based on the present results and on further studies the implementation of Dialogue-Displays is discussed against the background of safety improvements at pedestrian crossings, kindergarten, schools, bus stops but also concerning noise abatement and other conflict spots, as contact between car and train traffic or between car/lorry and cyclists.
Title: WALKABILITY IN THE CZECH URBAN AREAS AND POSITION OF PEDESTRIANS

Presenting Author: Karel Schmeidler

Authors: K. Schmeidler

Affiliation
1. Urban and Transport Sociology Dept., Transport Research Centre Brno, Vinohrady 10, Czech Republic,

Abstract:
Context, aim methodology:
Right from the beginning of car transport development pedestrians have been paid little attention; with the growing number of vehicles and roads for these vehicles their position is becoming even worse. Unequal position of pedestrians is also emphasized by their significantly greater vulnerability in the road traffic as compared to other road users. These circumstances have been highlighted more frequently only in recent years, when suitable solutions have been searched on the worldwide scale particularly with regard to making especially the roads in towns safer and friendlier to pedestrians.

Project objectives are:
The objective of this study is to map legal bases for searching optimum outputs within the limits of the Czech legal order. We also consider our obligation to mitigate a special legal regime of walking away from roads, i.e. pedestrian rules for the movement in protected natural areas and in the countryside.

Results and conclusions:
Particularly recently it has become obvious in the whole society that each road user is starting to understand in a better way the importance of enhanced safety of pedestrians. This was mainly helped to by relatively new legal regulations encompassing some essential elements of pedestrian protection, such as the introduction of an absolute right of way of pedestrians, decreased speed limits of vehicles in towns, and also reduced tolerance to drinking and driving.

This work has introduced a certain legal framework, which defines a mutually relatively well-balanced system of rights and obligations of road users increasingly focused on the protection of pedestrians as relatively most vulnerable road users. Nevertheless, any legal arrangement only provides a certain degree of formal protection, and to achieve the highest possible safety of pedestrians a strong appeal to each individual is necessary.

Regulating the status of pedestrians by means of various legal acts from decrees of municipal authorities to legislation amendments will obviously create only a certain legal framework, a mere specification of basic rules which all participants in road traffic, not just pedestrians, should follow. A much more important pre-requisite for achieving the prime (as we believe) objective of reducing the number of road accidents involving pedestrians, generally speaking, increasing the safety of people most vulnerable and most easily affected by road traffic, i.e. the objective set, amongst others, by society on a supranational level, is without doubt the primary change in the way of thinking and behaving of all road traffic participants. Any changes to the legal framework would remain ineffective should there be now willingness to comply with the rules. Another significant coherent aspect is of course the practical enforceability of such provisions.

Any potential proposals for legislation amendments de lege ferenda leading to a greater safety of pedestrians must therefore be regarded from the point of view of individual categories mentioned above.
Title: DEMOGRAPHICAL CHANGES OF EUROPEAN SOCIETY AND ITS IMPACT ON WALKING AND ACCESSIBILITY OF ELDERLY

Presenting Author: Karel Schmeidler

Authors: K. Schmeidler 1;

Affiliation
1. Urban and Transport Sociology Dept., Transport Research Centre Brno, Vinohrady 10, Czech Republic,

Abstract:
Context, aim methodology:
European policy regarding the elderly aims at maintaining their mobility. This is a central element of their integration in society. Senior citizens want to stay autonomous and independent as far as possible. Without the possibility to maintain mobility, senior citizens cannot lead an independent life, with many other problems, such as isolation and health problems as a consequence.

Many older people make their journeys by walking. However, pedestrian casualty rates are much higher among people over 60 compared with younger adults, and fatalities of people aged 75 and over account for a quarter of all pedestrian fatalities. Although walking and cycling are recommended to older people as the best way to keep fit and healthy, the conditions are often difficult for older persons.

Results and conclusions:
The investigations point out the subjective view of elderly road users, focusing on the importance of social relations and social behaviour in the public areas. There are plenty of suggestions and ideas of older people concerning the improvement of public spaces, walking and cycling paths and their connections to other means of transportation.

A central goal of policies regarding the senior citizens especially elderly women is to maintain their mobility, as this is a central element of their integration in society. They want to lead an autonomous and independent life (everything from shopping to visiting friends) as much and as long as possible without the help of others (for example the family). Losing the ability to participate in outdoor activities can create a vicious circle of immobility, implying that an important stimulus for the elderly women to remain active vanishes. This regularly leads to passivity, which affects health. This, in turn may induce still greater isolation and passivity. Thus, the provision of transport and mobility for the elderly women is a central societal goal.
Title: PERSPECTIVES FOR MOTORCYCLE STABILITY CONTROL SYSTEMS

Presenting Author: Kai Schröter

Authors: K. Schröter 2; P. Seiniger 1; J. Gail 1;

Affiliation
1. Active Safety, Federal Highway Research Institute (BASt), Bergisch Gladbach, Germany, 2. Technical University Darmstadt, Darmstadt, Germany,

Abstract:
Motorcycle accident figures did not decrease significantly over the last fifteen years, but as the total number of road fatalities decreases, the share of motorcycle fatalities raises and puts motorcycle accident issues in the focus of decision makers. This paper describes the enormous potential of technical measures to help save motorcyclists' lives. It summarizes safety research carried out by the Federal Highway Research Institute (Bundesanstalt für Straßenwesen, BASt) in the last 25 years, including especially the authors' own work in the last five years, and the state of the art in motorcycle control systems. The conclusion is the encouragement of further investigation in motorcycle control systems and mandatory Anti-Lock Brake System (ABS) application on motorcycles, thus making the powered two-wheeler a safer urban transportation system.

Motorcycles are statically unstable. During riding, they are stabilized mainly by two mechanisms. Both stabilizing effects require a possible increase in side force (on the front wheel). They do not work with sliding wheels, which happens on slippery surface. In the event of a locking front wheel, the motorcycle becomes kinematically unstable. A coupled yawing and rolling motion is induced that lets the motorcycle tumble in fractions of seconds. This instability can be treated by ABS. Recent studies on the impact of ABS on motorcycle accident numbers in Germany show a possible reduction of motorcycle fatalities by at least 10%. A benefit-cost-analysis reveals a cost-benefit ratio of about 4 for the case of mandatory ABS. However today's systems are not fully qualified for cornering, because they do not take the roll angle into account. Wheel slip control while cornering induces oscillations of steering torque. The vehicle does not capsize as it would without ABS, but the course can be disturbed. One possible control strategy that avoids steering torque oscillations is to switch the brake force distribution during cornering so that the rear wheel is overbraked. Another countermeasure is the adjustment of the steering axis by means of a technical device. The actuator technologies required for these approaches are already available. Recent advances in signal processing and sensor technology have been made so evolution of these systems is expected for the next decade.

In a research project carried out for BASt, a method for the detection of motorcycle critical driving situations has been developed. This method evaluates the vehicle slip angular velocity, utilizing the fact that motorcycles do have almost no slip angle during uncritical driving situations. Roll angle stabilization of a motorcycle with sliding wheels is not possible with today's technology. But with the detection method, in the case of a motorcycle accident (or a near-accident), an automatic warning message to surrounding vehicles can be generated.

Active stabilization of Motorcycles is not possible and will very likely never be possible in the future. Therefore further development, evolution and optimization of ABS and Traction Control System (TCS) are required. Also, the general application of today's ABS systems on motorcycles should highly be encouraged.
1 INTRODUCTION

In its white paper „European Transport Policy for 2010“, the European Commission defines the goal to reduce the traffic fatalities rate in Europe by 50 % in the time period 2001 to 2010. Some (but not all) member states are on course for that goal, regarding the total traffic fatalities rate. Motorcyclist fatalities, however, do not decrease with the same reduction rate, and as a conclusion, the share of motorcyclists on all traffic fatalities increases. Thus, motorcycle accident figures will more and more get into the focus of policymakers. In this paper, the authors will show how active safety of powered two-wheelers contributes to motorcycle accident reductions and give an overview on measures, state of the art and what can be expected in the future. One key contributor to the reduction of total traffic fatalities over the last decade are vehicle stability control systems, one of the most known being the Bosch Electronic Stability Control (ESC), see [1], [2]. However, the most sophisticated system available for powered two-wheelers is an Antilock Brake System. Presently it is not designed to work during strong cornering. An Antilock Brake System that allows braking at high lateral accelerations could contribute to lowering the accident rates. The technical foundations for such a system have been laid in research projects carried out on behalf of BASt by the Technical University Darmstadt (Technische Universität Darmstadt, TU Darmstadt) [3]. In a more holistic study, driver behavior during braking [4] and the requirements for future motorcycle brake systems [5] have been investigated, and the potential for vehicle control systems beyond ABS has been assessed [6]. Concluding from this research work, an improvement of Antilock Brake Systems can be achieved and in combination with driver behavior improvements a substantial impact on accident figures can be expected. Research also shows that further control systems comparable to ESC are not feasible on motorcycles.

2 SPECIFIC MOTORCYCLE STABILITY ISSUES

The different and complex driving dynamics of motorcycles in comparison to four-wheeled vehicles are certainly the main issue in designing vehicle stability control systems for motorcycles. Motorcycles are inherently unstable vehicles, their stabilization depends on two mechanisms: if the velocity is high enough, the motorcycles' wheels act as gyroscopes, and for lower velocities, the rider stabilizes the vehicle by handle bar movement. Both mechanisms depend on sufficient friction between the tires and the road. If the friction potential is exceeded, motorcycles can become irreversibly unstable, and also instantaneous loss of gyroscopic effect due to wheel locks can lead to a fall. In contrast to four-wheeled vehicles, motorcycles can become unstable if the front wheel locks even if the gyroscopic effects would still be there. The reason for this is a kinematic instability with growing vehicle slip angles. A full description of motorcycle dynamics is given in several sources [7], [3]. At this place, only the mentioned driving stability and braking stability issues are discussed. They are important to understand the expected impact of control systems on accident figures.

2.1 Driving Stability

The most obvious difference between four- and two-wheeled vehicles is the banking while cornering. The equilibrium bank or roll angle \( \lambda \) depends mainly on the lateral acceleration. The roll angle as defined in Figure 1 is given as

\[
\lambda = \arctan \left( \frac{F_e}{G} \right) = \arctan \left( \frac{\ddot{y}}{g} \right) = \arctan \left( \frac{v^2}{R \cdot g} \right)
\]

with the centrifugal force \( F_e \), the weight force \( G \), lateral acceleration \( \ddot{y} \), gravity \( g \), cornering radius \( R \) and velocity \( v \).
The equilibrium for the roll angle is unstable. Small perturbations generate a roll momentum that would either cause a capsize motion or a flip-over of the vehicle.

The bank angular velocity can be controlled by handle bar actuation: whenever the handle bars are turned into the bend, the lateral acceleration is increased and thus the vehicle is lifted, and the other way around.

For velocities above approximately 30 km/h, the gyroscopic coupling mainly of the front wheel connects handlebar movement and bank angular movement in a stabilizing way. Below this velocity, the rider needs to turn the handle bars in order to stabilize the vehicle. Both mechanisms depend on an increase of the vehicle lateral acceleration, and that can only work if there is sufficient friction between road and tire. Stabilization is not present in any case of exceeding the possible friction, which happens e.g. on slippery roads, and also if the accelerating or braking forces are too high. The gyroscopic coupling also vanishes when the front wheel stops turning, e.g. if the brake force is too high and the wheel locks.

2.2 Braking Stability

The brake systems of four-wheeled vehicles are commonly designed to lock the front wheels first. In the case of locked front wheels, the vehicle side-slip angular motion is stabilized by the rear wheels that generate side forces that compensate the side-slip angle [5], [6].

As mentioned, the gyroscopic stabilization of a two-wheeled vehicle vanishes whenever the front wheel locks, so this mechanism cannot be used on two-wheelers. Moreover, the capsize that occurs because of a locked front wheel generates a camber side force on the rear wheel.
The sum of the side forces on the rear wheel does not stabilize (and for higher roll angles destabilizes) the side-slip angular movement. Both movements combine to a sudden fall of the motorcycle that can take as little time as 0.2 seconds from upright position and an accident is almost inevitable [5]. During cornering these times will be significantly shorter\textsuperscript{1}.

As a conclusion, motorcycles become unstable when the front wheel locks because of hard braking, and they become unstable when the road friction is exceeded (e.g. slippery roads).

3. STATE OF THE ART AND BENEFIT OF MOTORCYCLE CONTROL SYSTEMS

3.1 Accident Situation
Motorcycle accident figures (for Germany) stayed almost constant since the mid-nineties. Each year, between 800 and 1,000 fatalities and approximately 30,000 severe injuries occur.

Three facts are significant in comparison with the total accident situation:
1. Wrong brake actuation is a contributor to at least 10\% of all motorcycle accidents [8]
2. Motorcyclists brake weaker while cornering [5]
3. Driving accidents (meaning a loss of control occurred prior to the accident) account for about 60\% of motorcycle fatalities, but only for 41\% of all fatalities (see Table 1) [9]

Table 1: Share of driving accidents on all accidents, figures for Germany 2007.

<table>
<thead>
<tr>
<th></th>
<th>Slightly injured\textsuperscript{2}</th>
<th>Severely injured</th>
<th>Fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>All powered two-wheeler</td>
<td>36,8%</td>
<td>52,5%</td>
<td>60%</td>
</tr>
<tr>
<td>Motorcycles (&gt;125 cm\textsuperscript{3} engine displacement)</td>
<td>40,1%</td>
<td>57,7%</td>
<td>60%</td>
</tr>
<tr>
<td>All traffic participants</td>
<td>16,2%</td>
<td>31%</td>
<td>41%</td>
</tr>
</tbody>
</table>

Motorcycle operation itself seems to be a problem in some driving situations. Obviously, braking while going straight ahead (with wrong brake actuation) and while cornering (with weak braking and/or brake steer torque effect, see section 5) are fields where active safety systems can contribute in accident figure reductions. The system of choice for these situations is the Antilock Brake System.

The fact that driving accidents are significantly higher for motorcycles can not only be explained by brake accidents. To address all kinds of driving accidents, traction control, improved ABS that works during cornering and also stability control would be needed.

3.2 Motorcycle Control Systems State of the Art and Limitations
Antilock brake systems do help preventing wheel locks, but they are not yet designed to work during strong cornering. This is expected for future Antilock Brake Systems in the new decade that will make use of new sensor technologies.

Motorcycle Antilock Brake Systems are commercially available since 1988. Key milestones were ([10]):
- Pure wheel acceleration controllers, two independent channels, one for each wheel (BMW ABS1, ABS2, etc. ([11]).

\textsuperscript{1} See e.g. the explanations in 3, S. 149, Figure 106

\textsuperscript{2} Official German definition: Accident participants that had to stay in hospital at least for one night are severely injured. Those who were treated at the scene or could leave earlier are slightly injured.
Hydraulic integral ABS (Honda Single- and Dual-CBS-ABS) that controls both wheel brakes to ensure a reasonable brake force distribution. These systems have a full hydraulic connection between brake lever and wheel brake.

Electronic integral ABS (Continental MIB, Bosch ABS-M8). These systems can apply brake pressure on at least one wheel independently from driver input, but still have a hydraulic connection between brake lever and wheel brake.

Brake-by-wire-system (Honda eCBS [12]), no hydraulic connection between brake lever and wheel brake (under normal operation conditions).

None of the existing systems has a lateral acceleration or bank angle sensor, and thus no system available on the market today can adapt to cornering. No system today is suited for full cornering, because the brake force oscillation on the front wheel that is generated by ABS control induces potentially dangerous steering torque oscillations. Figure 2 shows an ABS control cycle during cornering.

The front wheel slip rises at \( t = 0 \) s, a roll angle of approximately \( \lambda = 20^\circ \) and a velocity of approximately \( v = 65 \) km/h. Note that the wheel velocity does not become zero, the ABS controller releases the brakes and allows the front wheel to accelerate again.

At the time the front wheel slip rises, friction potential is over-exceeded and the front wheel builds up a significant side-slip angle. In case of sliding wheels, the brake force is about 10% smaller than the maximum brake force, so at the time the wheel starts to lock, the brake force also decreases significantly.

The sum of all components of the steering torque is close to zero, as the braking situation is almost steady-state, but steering torque has a part that is directly connected to brake force (see also section 5). This part decreases proportionally with brake force, but the rider does not adapt his steering torque fast enough and turns the handlebars out of the bend. The same thing happens after the control cycle in the opposite direction, but obviously the rider tried to adapt his steering torque. An effect on roll and yaw rates can clearly be observed, and if this had happened in real traffic, a departure of the lane could have been the consequence.

This example shows that present ABS do not deliver optimal support for the driver while braking in bends.
Although corner braking is a challenge for vehicle and component manufacturers, the necessary scientific foundations have been laid out already in the mid-nineties by WEIDELE [3]. Their implementation and evolution requires mass production roll angle sensors to adopt to the cornering situation. These sensors are available from 2010 on e.g. in the BMW S1000RR [14]. The mentioned S1000RR control system however uses its roll angle sensors up to now only for traction control, another control system that helps preventing accidents, with the first generation being available on the 1993 Honda Pan-European and the second generation on the BMW R-Series in 2006.

3.3 Estimated Effect of Today’s ABS on Future Accident Figures
Braking poses stress on motorcyclists and leads to mental strain. In a research project carried out on behalf of BASt, the mental strain was investigated on a closed test track [15]. Test riders had to brake with different brake systems on the same motorcycle (Standard brake system = independently operated front and rear wheel brakes, Standard brake system with ABS functionality, combined brake system, combined brake system with ABS functionality, combined brake system with only the hand lever) in three different situations (going straight ahead,
braking from 90 and 60 km/h and cornering, braking from 50 km/h). The strain was measured indirectly using mainly the heart rate of the test persons. Results show that braking distances are shorter with ABS, mostly because the brake force is built up faster (straight ahead) or because the brake deceleration is higher (cornering). The rider’s strain is higher without ABS. These results clearly show the positive effect of ABS, even on a closed test track.

Other authors estimate ABS on all motorcycles could lower the motorcycle road traffic fatalities by at least 10% [8]. A cost-benefit-study of carried out on behalf of BASt reveals a benefit-cost-ratio of more than four (taking into account the system costs, the effect of ABS on accident figures and the development of accident figures over the next decade) [16]. Taking into account all these results, the mandatory application of ABS on all powered two-wheelers is strongly encouraged. From a society point of view, the benefits are not neglectable, and technical issues can definitely be solved.

4 CONCEPTS BEYOND ABS AND TCS

Another question that arises from motorcycle driving dynamic issues is whether any systems beyond ABS and TCS are feasible. These current control systems control the longitudinal forces on each wheel but have no direct effect on wheel side forces. Future systems that would resemble the ESC for passenger cars or stabilize the roll motion are not feasible for reasons that are shown in this chapter. However, future systems could act as a kind of electronic co-pilot comparable to the aviation state of the art [17].

4.1 Detection of Critical Driving Situations

Critical driving situations are defined by the fact that friction demand due to lateral acceleration is higher than the friction potential. These situations happen in real life e.g. because of wet, slippery or icy road conditions, because of bad road construction (see [18]), because of leaves on the road during autumn or because of sand on the road. In all these situations, the horizontal forces that can be generated by the tires are limited to the product of the friction coefficient and wheel load. Relevant accident situations that derive from the defined situations are mainly cornering accidents without and with braking or accelerating – the latter situations are being dealt with by ABS and TCS. Thus, focus for research are situations without braking or accelerating.

Main requirements for the feasibility of a control system that addresses cornering accidents without longitudinal acceleration are the detection of those situations and methods to stabilize the motorcycle in those situations.

In a research project carried out on behalf of BASt, these accident situations were simulated and analyzed [19]. Cornering accidents without braking are detectable using the vehicle side-slip angle. The side-slip angle of a motorcycle is close to zero in normal driving but rises with a high dynamic in critical driving situations. The side-slip angular velocity criterion developed from the analysis proved to be adequate in critical driving situations (detection of all situations) as well as in uncritical driving situations (no false detection).

Data on the said critical driving situations and also on uncritical driving situations like swerving etc. was gained with a test motorcycle equipped with outriggers and measurement devices as shown in figures Figure 4 and Figure 5.
Motorcycle tire side-slip and vehicle side-slip angles cannot be measured directly (with the exception of an optical system like the DATRON CORREVIT that still is influenced by the roll angle and needs complex correction methods). A method to determine the actual vehicle side-slip angular velocity $\dot{\beta}$ is the calculation using vehicle velocity $\dot{x}$, vehicle yaw rate $\dot{\psi}$ and vehicle lateral acceleration $a_y$. These three quantities are connected as follows with the motorcycle treated as a rigid body:

$$\dot{\beta} = \dot{\psi} - \frac{a_y}{\dot{x}}$$

The assumption of a rigid body is not true for a motorcycle. Turning the motorcycle handle bars tilts the line connecting the wheels out of the symmetry plane. This effect has to be taken into account if the measurement unit is placed in the vehicle’s symmetry plane. A correction can be done with the handle-bar angular velocity. This is explained in detail in [6].

More complexity derives from the motorcycle roll angle. The lateral acceleration has to be measured with respect to the road plane. For this correction, at least two orthogonal acceleration sensors have to be combined, the roll angle has to be measured and also an assumption of the height of the vehicle’s roll axis with respect to the road plane is needed to correctly incorporate the roll angular velocities and accelerations into the correction. For regular driving situations, the roll axis height will approximately be zero. When the friction coefficient approaches zero, the roll axis approaches the vehicle’s center of gravity, and calculating the lateral acceleration with the assumption of a roll axis in the road plane leads to an error.
A reference value for the vehicle side-slip angular velocity $\dot{\beta}$ could be given by measuring the lateral acceleration and roll movement of the vehicle, calculating a friction demand from these quantities and using the tire side-force functions to define the tire side-slip angles. However, it is not possible to robustly use this method because of two main facts: Even if the tire side-slip angles as function of the side-force demand are known, it is not possible to distinguish between the rider's intention to lower the side forces to zero (to achieve a high roll acceleration) or low road friction values. The other fact is that the calculation of the friction demand is very sensitive to axis deviations of the roll angle sensor that can easily occur because of slight pitching motions of the vehicle and other errors.

Driving experiments of critical and uncritical driving situations show a robust detection of critical driving situations using the assumption that $\dot{\beta}$ is almost zero in uncritical driving situations – of course with the exception of the so-called geometric side-slip angle (and also some noise due to sensor errors).

The reference value then is

$$\dot{\beta}_{ref} = -\delta \cdot \left[ \frac{l_r}{l} + \frac{c}{l} \right]$$

with the wheel base $l$, the distance rear wheel to center of gravity $l_r$, the front wheel caster $c$ and the steering angular velocity with respect to the road plane $\dot{\delta}$.

Figure 5 shows an example of this calculation method. Extensive testing proves the feasibility of this concept to distinguish between critical and uncritical driving situations.

Figure 5: Example of vehicle side-slip angular velocity in critical (upper) and uncritical (lower) driving situations, also showing the boundaries that are made up by reference value and error estimations. Detection occurs for the critical driving situation (upper), but not for the uncritical driving situation (lower).
4.2 Stabilization of a Motorcycle

Goal of any driving dynamics control is to prevent or at least mitigate a critical situation. The roll instability tilts the motorcycle in a very short time and thus limits the time that is available for a control cycle. Primary goal must therefore be the stabilization of the roll angle. If this goal is achieved, the secondary goal has to be the stabilization of the yaw movement of the vehicle and the prevention of the dangerous high-side type accident where the vehicle tilts over to the “high side”.

A simplified form of the roll equation for steady-state cornering is

\[ \Theta_{\text{Roll}} \cdot \ddot{\lambda} = h_{\text{CG}} \cdot m \cdot (\sin \lambda \cdot g - \cos \lambda \cdot \ddot{y}) + M_{\text{Gyro}} \]

\[ = h_{\text{CG}} \cdot m \cdot g \cdot \sin \lambda - \cos \lambda \cdot \sum F_s + M_{\text{Gyro}} \]

with the roll moment of inertia \( \Theta_{\text{Roll}} \), the height of the center of gravity \( h_{\text{CG}} \), lateral acceleration \( \ddot{y} \), tire side forces \( F_s \) and the gyroscopic moments \( M_{\text{Gyro}} \).

Roll stabilization is achieved when the sum of roll moments is positive with respect to an upright movement (in theory already a sum of 0 leads to a stabilization, but in real situations the motorcycle will still capsize because of the roll angular velocity), either because the side forces generated by the tires or gyroscopic coupling compensate the vehicle’s weight moment. Since the wheel side forces in those specific situations cannot be increased, stabilization is only possible by applying gyroscopic moments; however this method puts technical requirements on the gyroscopic devices that are not feasible today.

Another option could be the control of the normal forces of the wheels. The side forces of sliding wheels are directly connected to the wheel load via the friction coefficient:

\[ F_s = \mu \cdot F_z \]

Active suspension could admit control of the wheel load of a specific wheel by lifting the vehicle body. For the time the body is accelerated upwards, the wheel load will be increased, and the other way around. For motorcycles, this control method will also raise the friction demand, so the positive effect on side forces is over-compensated. Stabilization cannot be achieved. More details on this topic can be found in [6].

For yaw stabilization the difference of side forces between front and rear wheel needs to be controlled. The reduction of side-forces is possible e.g. by control of the wheel slip. A simplified form of the yaw equation is

\[ \Theta_{\text{Yaw}} \cdot \dot{\psi} = F_{s, \text{rear}} \cdot I_{\text{rear}} - F_{s, \text{front}} \cdot I_{\text{front}} \]

Control of the yaw movement of the motorcycle is technically feasible. This can help to prevent high-side type accidents. The effect on accident figures however is estimated relatively low.

To sum up, roll angle stabilization of a motorcycle with sliding wheels is not possible with today’s technology. However, with the detection method using \( \dot{\beta} \) as criterion, in the case of a motorcycle accident (or a near-accident), an automatic warning message to surrounding vehicles could be generated, or this information could be used for on-board passive safety systems like airbags etc., or could also help to improve ABS and TCS with regard to corner braking.

5 POSSIBLE EVOLUTION OF TODAYS SYSTEMS

While today’s TCS as on the BMW S1000RR already feature a roll angle sensor and are thus fully cornering-approved, this does not hold true for brake systems currently in the market. As described in section 3 and also in the following chapter, efficient corner braking is a complex and demanding task that often leads to (near-) accidents. Therefore, a fully cornering-approved brake system in combination with a behavioral change in activating the brakes in curves could change the structure of motorcycle accidents completely rather than just decrease a specific accident type. The analysis of rider behavior patterns and intuitive interaction with new safety
concepts and a safe reproduction of relevant critical situations with test persons in the loop are key issues for the testing of new systems, which is not addressed in this section.

5.1 Theoretical Potential of Ideal Corner Braking and Brake Steer Torque Problems during Real Corner Braking

In comparison to straight braking, corner braking under ideal conditions (even road, constant friction potential, ideal brake force distribution and ideal steering control through the rider) offers a great theoretical potential for shortening stopping distances, illustrated in Figure 6.

![Figure 6: Kamm Friction Circle](image)

Beginning at steady state cornering conditions with 99% of the overall friction potential used to generate the necessary side forces (high roll angle, point A), the friction potential for braking increases rapidly with decreasing velocity, side forces and roll angle (moving from point A to B on the Kamm Friction Circle). Thus the total braking distance in the above extreme example is just 60% longer than in straight braking (being in point B all the time).

A great deal of this potential can be accessed by trained riders under controlled conditions, as can be seen in Grand Prix Racing. However, the smallest irregularity can immediately lead to a crash. Unexpected hazardous situations in real traffic can cause the rider to fall in some sort of shock condition, leading to partly unreasonable reactions. Especially the coordination of conventional brakes under difficult conditions demands too much of the rider’s control capabilities (see also quotes\(^3\) from [20]).

Current Combined Brake Systems (CBS) and especially ABS could already be of great help, if the riders would brake hard enough. However, knowing the risk of falling with an over-braked

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\(^3\) 12.1 Findings (page 417): “The typical motorcycle accident allows the motorcyclist just less than two seconds to complete all collision avoidance action.” – “Motorcycle riders [...] showed significant collision avoidance problems. Most riders would over-brake and skid the rear wheel, and under-brake the front wheel greatly, reducing collision avoidance deceleration. The ability to counter-steer and swerve was essentially absent.”
front wheel, most riders do not dare to do so, as was revealed by a naturalistic driving study conducted for BASf in the 1990s ([4]).

![Image](https://example.com/image.png)

**Figure 7**: Generation of Brake Steer Torque (BST) through lateral offset between tire contact patch and steering axis in cornering conditions. [Picture: Wolfgang Stern, German Safety Tour Rider Training, ifz Motorcycle Conference, Cologne 2006].

An additional disturbing effect that makes corner braking difficult for the rider is the so called brake steer torque (BST, Figure 7). Due to the tire geometry, the tire contact patches move out of plane with the steering axis. If a brake force is applied, especially at the front wheel, the roll angle dependant contact patch offset to the steering axis generates a BST, that wants to turn the handle bars to the inside of the bend. As described in section 2, this leads to an upward roll movement of the bike, if the rider does not compensate the BST. Given a hazardous situation and high brake force gradients that can also arise from ABS activation, the BST gradient is so high, that the rider is not able to do so (see also Figure 2). Moreover, under shock, the upward roll movement of the bike might confuse the rider. The tendency of the motorcycle to leave its trajectory tangentially often leads to an even stronger application of the brakes, which in turn amplifies the negative side effect (see also quotes\(^4\) from [20]). In order to take these cornering specific challenges into account, a roll angle sensor is essential for future safety systems.

### 5.2 Approaches to Brake Steer Torque Optimized Corner Braking

The BST that needs to be compensated by the rider can be written as:

\[ BST_{\text{rider}} = (\text{Brake Force}) \times (\text{Offset between Steering Axis and Tire Contact Patch}) - \text{Steering Damper Torque} - \text{Active Counter Steer Torque} \]

This equation shows four different means to approach the BST problem:

1) Reducing the Brake Force (→ “Corner Adaptive Brake Force Distribution”)

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\(^4\) 7.18 Motorcycle Rider Loss of Control (page 150 ff.): “Also, those riders involved in “running wide on a turn loss of control” gave the same impressions of having no plan or strategy for traffic hazards. In those cases where the rider entered a curve at excess speed, the ability to brake effectively was always absent. Also it appeared that most of these riders would lean adversely (they would straighten up rather than lean into the turn) and thereby reduce ground clearance and cornering ability, and many of the collision contact conditions confirmed this impression.”
Reducing the Offset between Steering Axis and Tire Contact Patch
(→ "BST Avoidance Mechanism", BSTAM)

Adapting the Steering Damper Characteristics
(→ “Advanced (Semi-Active) Steering Damper Control”)

Providing an Active Counter Steer Torque (→ “Electronic Co-Pilot”)

Reducing the Brake Force
Given the fact, that the contribution to the BST effect is much bigger at the front wheel than at the rear, and that the friction-optimal Brake Force Distribution (BFD) becomes anyway more rear wheel oriented under large roll angles (Figure 8), an over-braking of the rear wheel will relieve the front wheel to a certain degree from brake forces and thus reduce the BST effect in partial braking conditions.

![Figure 8: Friction-optimal Brake Force Distribution (BFD) at different roll angles (Model calculation for a sports touring bike equipped with measurement devices): Under cornering conditions, the center of gravity is lower than straight. Since the wheel base remains almost constant, the BFD becomes more rear wheel oriented.](image)

\[F_h = \text{Rear Brake Force [N]}\]
\[F_v = \text{Front Brake Force [N]}\]
\[G = \text{Vehicle Weight Force [N]}\]

In order to assess the technical effectiveness of such a system, preliminary experiments have been carried out at TU Darmstadt. A series BMW F800S motorcycle (with ABS) has been equipped with measurement devices (among others: steering torque, steering angle, brake pressures, and roll angle sensors) as well as manually adjustable brake lever stops for front and rear brake (Figure 9).

![Figure 9: BMW F800S test bike equipped with measurement devices and manually adjustable brake lever stops during corner braking experiments.](image)
The maximum deceleration for rear braking has been experimentally determined to be approximately 0.4 g before the ABS of the test motorcycle is activated. Consequently, this marks the absolute maximum of brake force, that could be shifted from front to rear by means of a corner adaptive BFD. To estimate the benefit for the rider, the front brake lever stop has been adjusted to a point, that allows for the same deceleration in a predefined cornering situation ($R = 70$ m, $v_0 = 60$ km/h, max. brake pressure $\approx 8$ bar). However, in preliminary tests (with only two test riders) this seems to be the threshold value to recognize a disturbing BST effect from a subjective rider point of view. (On a scale from 0 to 10, “don’t feel anything” to “out of control” it was ranked between 1 and 2).

Moreover, there is a trade-off between the benefit in BST mitigation and rear wheel stability. On real surfaces an over-braked rear wheel has a strong tendency to wheel lock and thus ABS activation. With conventional ABS this leads to a perpetual alternation between a sliding and rolling rear wheel, causing a harmless and – under controlled boundary conditions – easy to control jerking movement of the bike, which might greatly disturb the rider in real traffic, especially in panic braking. Therefore, the overall positive impact of a Corner Adaptive BFD on the BST effect is estimated to be rather low, from today’s point of view.

However small the potential of such a solution may seem, it is easily accessible by adding a roll angle sensor to current CBS/ABS that offer the possibility to freely transfer brake load from front to rear and vice versa, especially when its ABS control is rather smooth.

**Reducing the Offset between Steering Axis and Tire Contact Patch**

The second approach allows a variety of opportunities to deal with the BST effect, ranging from mitigation to full compensation and even over-compensation. The principle of function of the so called BST Avoidance Mechanism (BSTAM) is shown in Figure 10.

![Figure 10: Principle of function of a Brake Steer Torque Avoidance Mechanism (BSTAM) [Picture: 3].](image)
For a full BST compensation the steering axis is moved sideways in such a manner, that it is always in plane with the front wheel tire contact patch by means of a double eccentric layout of the upper spherical roller bearing in the steering head.

A prototype motorcycle equipped with a BSTAM is currently being developed at TU Darmstadt in cooperation with an industry partner in order to investigate its function under various conditions with a rider in the loop.

### Adapting the Steering Damper Characteristics

Semi active steering damper control with speed and acceleration dependant damping is already available on the market (e.g. the Honda Electronic Steering Damper (HESD) system in the current CBR-Models). Based on multi sensor information (e.g. brake actuation, roll angle, and others), such systems could be upgraded to selectively react on BST relevant corner braking situations as well. However, damping forces can only be applied when the steering is turned. The function of such a system is therefore limited to BST (gradient) mitigation.

### Providing an Active Counter Steer Torque

A fourth solution features an actuator to apply an additional steering torque. Based on a multi sensor layout that – to a certain degree – allows a prediction of the expected disturbing BST, this system allows even more degrees of freedom, than the BSTAM presented before. Both systems could be the basis for further future safety systems, such as autonomous corner braking or a correction of the current trajectory before a crash, e.g. in order to prepare for airbag inflation. However, such “Co-Pilot” functions require thorough safety concepts regarding the intuitive interaction with the rider.

### 6 CONCLUSIONS AND RECOMMENDATIONS

Motorcycling is dangerous compared to driving a four-wheeled vehicle, but on the other hand, it has advantages, not only in terms of resource and energy consumption, and can be one of the future urban mobility solutions. As a consequence, it is highly needed to further improve motorcycle safety systems.

A giant leap towards safer motorcycles is the application of ABS. Even today’s systems that are still improvable would be socio-economically sensible with a benefit-cost-ratio of more than four.

The impact on accident figures is estimated to be at least a 10% reduction. Concluding from these results, all motorcycles should be equipped with ABS.

Further systems like active stabilization of Motorcycles are not possible and will very likely never be in the future. Therefore further development, evolution and optimization of ABS and TCS are required as a basis for other advanced safety systems.

It was shown that improvements especially addressing corner braking are possible and could be realized with available technology. However, research is needed to find out how the interaction between drivers and advanced safety systems can be achieved best.

### 7 REFERENCES


Title: ARE DRIVERS LESS LIKELY TO SPOT OVERTAKING MOTORCYCLES THAN CARS WHEN CHANGING LANES?

Presenting Author: Amit Shahar

Authors: A. Shahar 1; E. Van Loon 1; D. Clarke 1; D. Crundall 1;

Affiliation
1. Accident Research Unit, School of Psychology, University of Nottingham, Nottingham, UK,

Abstract:
Right of way (ROW) violation crashes are of the most common type of accident that motorcyclists face. In most of such crashes, other road users violate the motorcyclist's ROW and cause the collision. Although the majority of such ROW crashes occur at T-junctions, violations of motorcyclists ROW by other motorists commonly occur also at crossroads, roundabouts, when drivers perform u-turns and when they change lanes in front of filtering or overtaking motorcyclists. As the most common type of these ROW violation related motorcycle-car collisions occur at T-junctions, most research regarding such collisions has typically focused on those scenarios. The current study was however concerned with changing lanes scenarios, which is the second most common type of car-motorcycle accidents in the UK. Specifically, this study assessed car drivers' decisions to change lanes in scenarios which require checking whether there is traffic from behind that is about to overtake. For this purpose, we created a filmed-based hazard perception test which presents participants with a wide field of vision (from a driver’s perspective in a moving vehicle) approximating 180 degrees across multiple large screens. A central screen displays the front view from a driver’s perspective through the windscreen of a moving vehicle, while the two further screens positioned to the left and right of the central screen (at a set angle of 120 degrees), displays the side views. Mirror information is inset to allow information from behind the vehicle to be attended. Using this new methodology, three groups, 25 novice drivers, 25 experienced drivers, and 24 experienced motorcyclists, watched short video clips lasting between 10 to 30 seconds containing either a motorcycle or car (or no vehicles) about to overtake the participants’ vehicle. Overtaking vehicles were visible to the participants in the mirrors. Eye movements were monitored, using a setup which consisted of four cameras positioned in front and to the sides of the participants, above the bottom border of the screens. Participants were asked to view each clip as if they were the driver, and the task required them to press a button as quickly as possible when they thought it was safe to change lanes. Behavioural data is currently being analyzed and will be discussed in respect to differences between groups (i.e., novices, experienced, motorcyclists) and conditions (overtaking cars, motorcycles, or no vehicles) in relation to the proportions of less safe and of more safe responses (button presses before and after the overtaking vehicle had passed the driver, respectively). Eye movement data will identify differences between groups and conditions relating to time to fixate on the approaching overtaking vehicle, number of gazes, sequences of fixations and visual strategies. Finally, integrating the behavioural data with the eye tracking data will allow us to assess (as a function of drivers groups and vehicle types) the proportions of failures to (1) look in the appropriate directions, (2) perceive the approaching vehicles (i.e., Look But Fail To See errors) and (3) to correctly appraise the attendant risk (judging the time-to-contact) that the overtaking vehicles pose when pulling out in front of them. Future directions regarding research and training visual skills and strategies of drivers when attending to mirror information (particularly when judging situations involving overtaking motorcyclists) will be purposed.
Title: ACCIDENTS AND INJURIES CHARACTERISTICS AMONG DRUNK DRIVING IN ISRAEL

Presenting Author: Maya Siman-Tov

Authors: M. Siman-Tov 1; K. Peleg 1,2

Affiliation
1. Israel National Center for Trauma and Emergency Medicine, Gertner Institute for Epidemiology and Public Health Policy, Tel-HaShomer, Israel, 2. Department of Disaster Management, School of Public Health, Tel Aviv University, Tel Aviv, Israel,

Abstract:
Background: Over the past decade the consumption of alcohol in Israel has been on the rise. Monitoring blood alcohol concentrations (BAC) among drivers is not routine and the role of alcohol in driver-related injuries in Israel is unknown.

Methods: A prospective study was conducted to examine the BAC of hospitalized drivers due to motor vehicle crashes. Included in the study were drivers treated in a trauma room of one of the five level-1 trauma centers in Israel. Data were collected for 22 months over a three year period (2006-2008).

Results: Approximately 15% of injured drivers had a BAC ¡Ý 0.05 g/dl ('positive BAC'). The majority of drivers were males under thirty years old. Drivers with a positive BAC had a higher prevalence of self accidents, rolling over, crashes at an intersection, and disregard of seat belt use.

Summary: This is the first study to systematically quantify BAC among drivers in Israel. We found a substantially high prevalence of positive BAC among hospitalized drivers. The study compares demographic characteristics, crash attributes and injuries of drivers with and without a positive BAC.

Impact on Industry: The current study identifies at-risk groups for alcohol-related driver crashes. This information will enable intervention programs specific to this high-risk group. We recommend that this study be used as a basis for preventive and enforcement strategies for reducing alcohol-related driver crashes.
Title: BICYCLE INJURIES: A MATTER OF MECHANISM AND AGE

Presenting Author: Maya Siman-Tov

Authors: M. Siman-Tov 1; D. H. Jaffe 1; Israel Trauma Group 2; K. Peleg 1,3;

Affiliation: 
1. Israel National Center for Trauma and Emergency Medicine, Gertner Institute for Epidemiology and Public Health Policy, Tel-Hashomer, Israel, 2. Israel Trauma Group (ITG): J. Jeroukhimov, B. Kessel, Y. Klein, M. Michaelson, Y. Mintz, A. Rivkind, D. Soffer, D. Simon, G. Shaked, M. Stein, I. Waksman, 3. Department of Disaster Management, School of Public Health, Tel Aviv University, Israel

Abstract:
Bicycle riding is a popular form of recreation with positive health and environmental effects. These road users are vulnerable to serious injuries, especially when motor vehicles are involved. The goal of this study was to characterize cyclist-related injuries according to motor vehicle involvement for adults versus children.

A retrospective study was carried out using data from 11 trauma centers in the Israeli National Trauma Registry (2001-2007). Injuries were classified according to whether a motor vehicle was involved, and differences in injury characteristics were assessed for adults (18+ years) versus children (1-17 years).

A total of 5529 patients were hospitalized for bicycle injuries, of whom 1765 were adults and 3764 were children. Thirty percent (n=1662) of all bicycle injuries involved motor vehicles, and adults were 1.3 times more likely to be involved in a motor vehicle-related bicycle crash than children (95% CI 1.16-1.49). Injury characteristics and hospital resource utilization differed substantially by age group. Cyclists struck by a motor vehicle presented with more severe injuries than those not involved with motor vehicles. The interaction effect between motor vehicle involvement and age was significant for torso injuries and need for medical imaging. We found that injury characteristics, hospital resource utilization and health-related outcomes for bicycle injuries are highly dependent on patient’s age and mechanism of injury. Effect modification of motor vehicle involvement by age may in part reflect physicians’ attitudes toward pediatric imaging.
Title: EFFECTIVENESS OF ANTILOCK BRAKING SYSTEMS IN REDUCING MOTORCYCLE CRASH RATES

Presenting Author: Eric R. Teoh

Authors: E. R. Teoh 1;

Affiliation
1. Insurance Institute for Highway Safety, Arlington, VA 22204, USA,

Abstract:
Purpose: A common pre-impact factor in motorcycle crashes is improper braking, which includes locking one or both wheels and failure to adequately apply the brakes. Antilock braking systems (ABS) prevent wheel lock and reduce stopping distances. This study examined the effectiveness of ABS in reducing motorcycle rates of fatal crashes and insurance collision claims in the United States.

Methods: The rate of drivers involved in fatal crashes per 10,000 registered vehicle years of motorcycles with optional ABS were compared against the rate for those same motorcycles without the option. Characteristics of motorcycle drivers and crash circumstances were compared for the two groups. Optional ABS effectiveness also was studied by comparing insurance collision claim frequencies and severities. Effects of individual motorcycle model, vehicle age, insured driver age/gender, and regional vehicle density on insurance claim rates were accounted for with regression models.

Results: The rate of fatal crashes per 10,000 registered vehicle years of ABS motorcycles was 37 percent lower than the rate for those same motorcycles without ABS. No substantial differences in the two groups were observed in terms of demographics, risky driving behavior, or fatal crash circumstances. Motorcycles with ABS had 22 percent fewer collision claims per insured vehicle year than those same motorcycles without ABS. Both effectiveness estimates were statistically significant at the 0.05 level. No significant difference was observed on the average cost of collision claims.

Conclusion: ABS is highly effective in reducing the rate of fatal motorcycle crashes and the frequency of collision insurance claims, which are primarily non-fatal. These results suggest that ABS is effective in preventing crashes of a variety of severities.
Title: ROLE OF MOTORCYCLE TYPE IN FATAL CRASHES

Presenting Author: Eric R. Teoh

Authors: E. R. Teoh 1; M. Campbell 2;

Affiliation
1. Insurance Institute for Highway Safety, Arlington, VA 22204, USA, 2. Highway Loss Data Institute, USA,

Abstract:
Purpose:
Motorcycles are built to a variety of design and performance specifications. This study investigated differences by motorcycle type in driver death rates and prevalence of risky behaviors such as speeding, alcohol impairment, and helmet use.

Methods:
Each motorcycle make, model, and model year were identified by decoding vehicle identification numbers and then matching these to a motorcycle classification database. The rate of motorcycle driver deaths per 10,000 registered vehicle years was computed for each type of motorcycle in the United States, including supersport, sport / unclad sport, sport touring, touring, and cruiser / standard. Data on driver demographics and contributing factors were analyzed by motorcycle type.

Results:
Supersport motorcycles had the highest driver death rate, with a death rate four times as high as that of cruiser/standard motorcycles. Fatally injured supersport drivers were most likely to be speeding, but were also most likely to have been helmeted and least likely to have been impaired by alcohol compared to drivers of other types of motorcycles. These patterns remained after accounting for effects of rider age and gender. For all types of motorcycles, universal helmet use laws were effective in reducing motorcycle driver death rates per registered vehicle year, and increased engine displacement was associated with higher driver death rates when controlling for motorcycle type.

Conclusion:
Strong effects of motorcycle type were observed on fatal crash rates and likelihood of risky behaviors such as speeding and alcohol impairment. While the current study could not completely disentangle effects of motorcycle type and rider characteristics such as age on driver death rates, the study found effects of both motorcycle type and rider age on likelihood of risky behaviors among fatally injured motorcycle drivers.
Title: GENDER DIFFERENCES IN PEDESTRIAN RULE COMPLIANCE AND VISUAL SEARCH

Presenting Author: Ariane Tom

Authors: A. Tom 1; M.-A. Granié 2;

Affiliation
1. Université Paris Est, LEPSIS, INRETS-LCPC, Paris, France, 2. MA, INRETS, Salon de Provence, France,

Abstract:
Gender remains one of the main factors of road Accidentology. Men composed seventy to eighty percent of road fatal injuries between 15 and 59 year olds (Assailly, 2001). Boys’ injuries are more frequent and more severe than females’ ones and exposition to risk seems to not be the only explicative factor (Waylen & McKenna, 2002). In particular, sex differences are observed in injury risk behaviours (Byrnes, Miller, & Schafer, 1999) and in risk assessment among children, adolescents and adults (DeJoy, 1992; Harré, Brandt, & Dawe, 2000; Peterson, Brazale, Oliver, & Bull, 1997).

Indeed, research on adults has brought out gender differences in compliance with traffic rules. Dangerous behaviours and involvement in accidents among adult drivers were shown to be more often due to rule-breaking in males than in females (Harré, Field, & Kirkwood, 1996; Simon & Corbett, 1998; Yagil, 1998). Moreover, previous studies have shown that male pedestrians violate more rules than female pedestrians do (Latrémouille et al., 2004; Moyano Diaz, 2002; Rosenbloom, Nemrodov, & Barkan, 2004; Yagil, 2000).

Research shows males anticipate less negative consequences than females when committing violation (Parker, Manstead, Stradling, & Reason, 1992). Moreover, females are more sensitive to what they risk to lose when committing traffic violation, whereas males are more sensitive to what they can gain with this violation (Castellà & Pérez, 2004).

One explanation could be that rule compliance motivation varies with gender: male drivers (Yagil, 1998) and pedestrian boys (Granié, 2007, 2009) display a lesser degree of normative motivations than female drivers or pedestrian, that is a lesser rule internalization (Tyler, 1990). For the time being, research showing gender differences in pedestrian behaviours are based on declared behaviours (Moyano Diaz, 2002; Yagil, 2000) or have only observe behavioural rule compliance (Latrémouille et al., 2004; Rosenbloom, et al., 2004): no study has observed effect of gender difference on walking and crossing behaviours.

Objective of this study is to explore effect of gender difference in pedestrian rule compliance on walking and crossing behaviour. Hypotheses are males higher violation level will be accompanied by gender differences on other pedestrian behaviours.

Participants are 60 adult pedestrians (30 females and 30 males) observed on 2 signalized crossing sites, and 1 non signalized site. Pedestrians were observed using a taxonomic observation grid which detailed 14 behavioural categories before, during and after crossing. Results show that male pedestrians commit more violations than female pedestrians. Moreover, this gender difference in rule compliance is accompanied with other differences between genders, in particular in visual search targets.

Before crossing, all pedestrians pay first attention to traffic light, but principal visual target differs between genders. Men look more at moving vehicles whereas women look more at other pedestrians.

During crossing, men and women look principally at stopped vehicles, but after men look at traffic lights whereas women remain looking at other pedestrians.

Therefore, one general pattern of visual orientation before and during crossing can be found –
first traffic light and then stopped vehicles –. Nevertheless, one second visual target differs between both genders. This second target is the same before and during crossing for women – pedestrians – but varies with crossing moment for men – first vehicles, then traffic lights –. Then, genders differ on visual target pattern and on visual targets numbers: men do not look at others pedestrian, neither before nor during crossing. These results will be discussed in terms of pedestrian general visual strategy and visual strategy differentiated with gender and compliance with legal rules and gender social role.
Title: THE PEDESTRIAN AS THE CENTER OF PLANNING: NO EVALUATION WITHOUT DATA

Presenting Author: Ariane Tom

Authors: A. Tom 1; J.-M. Auberlet 1; R. Brémond 1; L. Désiré 2; M.-A. Granié 3; M. Maestracci 4; R. Rabier 1;

Affiliation
1. Université Paris Est, LEPSIS, INRETS-LCPC, Paris, France, 2. CETE de l'Ouest, LRPC St Brieuc, St Brieuc, France, 3. MA, INRETS, Salon de Provence, France, 4. Mairie de Paris, Paris, France,

Abstract:
Nowadays, only few solutions of microscopic traffic simulation exist that allow one to a priori evaluate urban planning for which the diversity among road users (pedestrian, driver) is predominant. In particular, underlying pedestrian microscopic models lack realism to simulate these situations, which differ from the situations they have been created for. In fact, despite the existing literature on pedestrians in the domain of Human and Social Sciences, research on pedestrians is numerous in the domain of passive safety but is seldom when moving simulation is considered except works done on crowd simulation (subway platforms, concourses, malls, emergency evacuation…). Actually, the initial choices of modeling are poorly favorable to establishing links between scientific communities.

Moreover, a major difficulty when creating a pedestrian simulation model for the road domain is the validation of these models. In fact, first there are only few “subtle” data that allow an ad hoc validation, and second gathering data needs means that go far beyond a “simple” electromagnetic loop. Furthermore, the validation process for a diversity zone such as “an encounter zone” also needs to rely on the verification of the nature and of the “intensity” of the interactions between road users.

A goal of the project “Simulation of Crossroads crossing by Pedestrians” (SiCaP), a project granted by the French Road Safety Foundation, is to partially solve the problems raised above. The aim of this project stands on modeling the notion of anticipation of drivers’ behaviors by pedestrians, and then to suggest an algorithm for the crossroads crossing by pedestrians. The project is mainly composed of four parts. The first one is an experiment in situ that focused on the behaviors, the mental representations, and the strategies of pedestrians who have to achieve a street crossing activity. In order to study that, we developed two questionnaires and an observation grid. At this stage, 60 observations were made.

The second part, the object of this paper, is focused on the anticipation of pedestrians. In order to do so, we developed a panoramic video acquisition system which allowed us to display the videos on six different screens (2.2 x 2.8 m), joined to one another. By such a procedure, we obtained an apparatus that allow the pedestrian to have a sufficient visual field (180°) in such a way he is completely immerged. We chose to use real video instead of virtual 3D-animation, due to the lack of realism in the 3D pedestrian moves and interactions with car drivers, and despite the lack of interactivity in this kind of situation. Thus, we already have gathered videos from three different urban crossroads in Paris where there are many interactions between pedestrians and vehicles.

The third part focused on the modeling of road crossing by pedestrians, based on the works mentioned above, the approach described in [TAB08], and the previous theoretical frameworks
of notably [Aub07, End95, GC38].
Finally, the fourth part is focused on gathering data in an urban crossroad dealing with pedestrians and drivers in order to obtain subtle data to assess the model.

In this contribution, we intended to explain how data gathering and processing will contribute to partially model street crossing by a pedestrian. This will be based on psychological features and “validated” by a subtle data set. Particularly, we will present the results of the experimentation “in virtuo”, focused on the anticipation of the pedestrians.

References:
Title: COUNTERMEASURES FOR DANGEROUS BEHAVIORS ON THE PART OF PEDESTRIANS BELONGING TO CULTURAL MINORITIES: THE ISRAELI CASE

Presenting Author: Tamar Tomer-Fishman

Authors: T. Tomer-Fishman 1;

Affiliation
1. Israel National Road Safety Authority, Israel,

Abstract:
In heterogeneous societies around the world, state institutions have to respond to the challenges of multicultural reality. Despite of over representation of minorities in pedestrians' accident statistics, the indications that culture influences road users' behavior, and the growing discussion on multicultural public policy in variety of disciplines (e.g. education, public health and law enforcement), very little has been written on countermeasures designed to enhancing cultural minorities pedestrians' safety. The current research tries to fill this gap, explores the different possibilities for addressing cultural differences in pedestrians' behavior, and examines countermeasures that would be suitable for Israeli cultural minorities.

The road safety literature has indicated the importance of addressing cultural differences, as it shows that culture influences pedestrians' behavior. Steinbach et al. (2007), for example, argued that an explanation for ethnic differences in injury rates should relate to lifestyle or to behavioral differences, since deprivation did not account for the difference in injury rates between ethnic groups in London. Moreover, Lam's (2005) research has shown the existence of cultural differences in parental risk-perception of road environment in Australia, with Arabic and Chinese speaking parents perceiving it less dangerous than Vietnamese and English speaking parents. In Israel Ultra-Orthodox Jews pedestrians committed more road violations than secular pedestrians (Rosenbloom 2008), and it was suggested that one reason for Ultra-Orthodox Jews to ignore traffic laws is that they regarded the whole secular law as a hostile one (Taubman 2009).

Recognizing the existence of cultural differences, practitioners have developed ways for addressing road safety cultural differences. In fact, the police of Victoria states it will strive to ensure that approaches to road safety will consider the cultural and linguistic diversity of Victorian communities. There is a wide range of approaches to deal with multicultural reality in road safety, such as advertising road safety using relevant cultural values (e.g. the Jewish religious command Guard Your Souls); tailoring specific ethnic group road safety education programs (e.g., special training programs for immigrants from less-motorized countries), and recruiting the influence of religious leaders. However, the demand for cultural recognition can also lead to exemptions from laws which penalize or burden cultural practices, and thus compromise safety. For example: the laws of Britain, India and the Canadian province of British Columbia exempt Sikhs from wearing safety helmets because their culture requires them to wear turbans.

While the importance of cultural differences in road safety behavior has been recognized and some different practices have been developed to address the cultural issues, no systematic investigation of the proper ways to deal with multicultural reality is currently available. The goal of the current research is, therefore, to examine different options for addressing cultural differences in pedestrians' behavior and to assess which ones are suitable for Israel's cultural and religious minorities.

The research covers three aspects of the issue:
A. An examination of the differences in pedestrian behaviors and attitudes between the Israeli general population and its two major ethnic groups: Arabs and Ultra-Orthodox Jews.
Data on cultural differences will be presented based on field observations on pedestrian behavior, telephone interviews on pedestrians’ attitudes and beliefs, and review of the available literature on road safety of Arabs and Ultra-Orthodox Jews in Israel.

B. A review the different countermeasures for addressing cultural minorities’ pedestrian behavior.

The review will include an overview of the current policies for dealing with cultural differences that are practiced by Israel and by other multi-ethnic countries. Novel approaches will be explored based on multicultural policy in additional disciplines (e.g. public health).

C. A discussion of the different possibilities for addressing cultural differences in pedestrian behaviors of minorities, and an evaluation of the extent that they are suitable solutions for Israeli Arabs and Ultra-Orthodox pedestrians.

This research on the proper approach for addressing cultural differences is should be valuable to practitioners interested in developing road safety measures for minority populations in heterogeneous societies around the world.
Title: THE SOUND OF THE UNDERGROUND: CAN WE IMPROVE INDEPENDENT RAIL TRAVEL FOR SENSORY IMPAIRED PEOPLE?

Presenting Author: Simon Tong

Authors: S. J. Tong 1; G. R. Watts 2; R Stait 2

Affiliation
1. Safety, TRL Ltd, Crowthorne, Berkshire, United Kingdom, 2. Noise, TRL Ltd, Crowthorne, Berkshire, United Kingdom,

Abstract:
Independent rail travel for people who are blind or deaf can be a daunting prospect. One of the simplest tasks—getting on and off a train—can become much more complex without sight; finding the doors, knowing whether a button must be pressed to open them, finding that button, and knowing when to keep clear if the doors are about to close are all essential, safety-critical tasks that sighted people often take for granted. Deaf rail passengers have similar worries about being warned of when train doors can be opened or are about to close.

The UK introduced regulations to address this problem by requiring audible and visual warning devices on all passenger doorways in the sides of rail vehicles. The regulated audible signals help blind and partially sighted passengers find the train doors and any buttons or handles needed to open them, either when inside the train or on the platform. When the doors are about to close, the audible signals warn passengers to keep clear to avoid being injured or trapped. The regulated visual signals (often illuminated buttons for operating the doors) help deaf people know when the doors are ready to be opened or are about to close. The visual signals also assist partially sighted people.

The work described here provides strong guidance on what makes an effective audible and visual door signal to make it easier for vulnerable groups such as blind and deaf people to travel by rail safely and independently. This work also provides the rail industry—and other transport modes seeking to improve accessibility—with clear examples of experimental studies that were designed to enable people with disabilities to provide an informed opinion on current and future provisions.

We set out to explore whether the safety and convenience of sensory impaired people who want to travel by train independently was best provided for by: the UK’s existing door signals; a set of proposed European signals; or, something different altogether.

Test work began in the laboratory, where novel and existing door warning signals were played over background station sounds to a sample of blind and partially sighted people who were invited to rate the audibility of these test signals. The range of test signals were developed to mimic signals currently in use, signals recommended by UK and EU regulations, and new sounds which, using theory and practice elsewhere, were expected to provide additional benefits. For the sounds to be fit for purpose, it was essential that people with vision impairments helped select the most promising sounds to be used in the experimental trials that followed.

The experimental trials were held at closed platforms on a mainline railway, a tramway and the London Underground. Standard trains were taken out of service in each location and equipped with devices to play back the audible and visual signals that had been developed beforehand.

To test the range of audible signals, blind and partially sighted people were recruited to take part in a series of controlled behavioural experiments to simulate finding the train doors and then boarding and alighting from a rail vehicle. To test the range of visual signals, people who were deaf or hard of hearing were recruited to take part in a different set of controlled behavioural trials that also simulated boarding and alighting from rail vehicles. Both experiments
provided robust data to suggest which signal types, durations and characteristics provided the best solution for sensory impaired rail passengers. Specifically, the findings state:
- How loud different signals need to be for passengers to hear them above background noise levels.
- How long audible signals need to play for a blind person to follow the sound and find the train door from inside or outside a train.
- Which types of audible signal were preferred and most effective for guiding blind and partially sighted people to the train doors.
- Which types of visual signal were preferred and most effective for warning people who were deaf or hard of hearing of when train doors could be opened or were about to close.
- Whether UK and EU regulations were fit for purpose.
Title: TRANSFERABILITY OF EUROPEAN METHODOLOGIES AND TOOLS FOR VULNERABLE ROAD USER SAFETY TO EMERGING ECONOMIES

Presenting Author: Antonino Tripodi

Authors: A. Tripodi 1; L. Persia 1;

Affiliation
1. CTL Centro di ricerca per il Trasporto e la Logistica, "Sapienza" Università di Roma, Rome, Italy,

Abstract:
The strong effort that the European Commission and all the Member States are paying to the reduction of road fatalities in Europe is giving significant results. The number of fatalities has significantly decreased by more than 25% in ten years. The trends for the number of fatalities among pedestrians and cyclists in Europe show that since 1980 both numbers have decreased by about 65 and 55% respectively.

Despite this significant improvement in the European countries, the situation in the Emerging Economies is dramatically getting worse.

In India, from 1995 to 2004, the number of accidents has increased by some 22%, while the number of fatalities has increased by some 31%. In 2004 in India 92,618 people died on the road, compared to the 43,400 died on the EU-25 road network. While India has only 1% of the world’s road vehicles, 6% of the world’s road accident deaths happen there.

In Brazil in 2004 there were 185 road accident fatalities/1 millions of inhabitants and the 33% of the Brazilian road fatalities were vulnerable road users. In European, in 2005 there were 89 fatalities/1 millions of inhabitants and the 25% of road fatalities were vulnerable road users.

In order to increase the level of Safety of Vulnerable Road Users in emerging economies, thus contributing to the overall scope of reducing the number of fatalities and the severity of injuries caused by road accidents, a research project (SaferBraIn – Innovative Guidelines and Tools for Vulnerable Road Users Safety in India and Brazil) has been set up. The project started in October 2009 in the framework of the FP7 of the European Commission.

This paper focuses on part of the activities of SaferBraIn focusing on the analysis of local requirement for Safety of Vulnerable Road Users and on the conditions for transferability of European experiences in Emerging Economies.

Such objectives are achieved through a process starting from the analysis of Indian and Brazilian situations. The first step is a short analysis of the local road accident databases with particular emphasis on accidents involving cyclists and pedestrians for the identification of potentials and gaps for effective analysis of risk factors at different levels. The actual situation of road infrastructures, land-use configuration and planning and the local current road safety management procedures is analysed, in terms of relevant parties, responsibilities and decision-making processes.

Based on the identification of vulnerable users safety requirements in India and Brazil, the condition for transferability of European experiences are defined according to the following methodology:
- analysis of similarities and differences between Europe, India and Brazil in terms of conditions of vulnerable users, infrastructure design, land-use configuration and road safety management procedures;
- identification of barriers (e.g. cultural, political, institutional, legal, physical) to transferability of methodologies, measures and tools from Europe to India and Brazil;
- definition of a generalized transferability audit to check the applicability and acceptability of available Road Safety Measures, Guidelines and Tools from European countries to India and
Brazil. The methodology for defining the generalized transferability audit is based on a synopsis of already developed transferability audits in similar fields and on a synopsis of already experienced problems in Technology Transfer from Europe to Emerging Economies (desk analysis, researches on web about relevant documents and experiences and reviews of National, European and International Projects and Evaluations are realized);

- performing an in-depth evaluation of the cause-and-effect chain and determination of the underlying mechanisms. Possible negative effects of European available road safety measures for Vulnerable Road Users, not considered in the synopsis, are estimated here using expert opinion in India, Brazil and Europe;

- identification of the underlying processes influencing failure or success in applying practices and methodologies in Emerging Economies compared to their application in Advanced, e.g. European, countries. A search algorithm and methodology to find out possible problems in applying Advanced Road Safety Technology in Emerging Economies is developed;

- development of measures to counteract diminishing effects in applying Road Safety Improvements originally designed for Europe.

By applying this procedure two main results are expected: i) a specific database for the Transferability Audit (making use of checklists and other automated tools) and ii) a dedicated Curriculum for Transferability Audit from Europe to India and Brazil.
Title: USING COGNITIVE WORK ANALYSIS TO ELICIT EXPERT KNOWLEDGE FROM MOTORCYCLE AND SCOOTER RIDERS

Presenting Author: Christine Turetschek

Authors: C. Turetschek 4; M. A. Regan 1; G. Lintern 2; R. Hutchinson 3;

Affiliation
1. French National Institute for Transport and Safety Research (INRETS), Lyon, France, 2. Cognitive Systems Design, Melbourne, Australia, 3. Monash University Accident Research Centre (MUARC), Melbourne, Australia, 4. Chaloupka & Risser OHG (FACTUM), Vienna, Austria,

Abstract:
To design, or re-design, anything from a human factors and ergonomic perspective, it is critical to talk to the users for whom the product or system is being designed. Doing so maximizes the likelihood that the product will meet its design goals and will be “acceptable” to end users (ie useful, effective, satisfying, socially acceptable and useable). Re-designing the road traffic system to make it safer for motorcycle riders is no different. Motorcycle riders with many years of accumulated riding experience are experts, just like pilots, air traffic controllers and other operators with complex jobs in complex systems. They have valuable and vital knowledge, skills and experience that can be drawn on to inform the design of countermeasures to prevent accidents and injury, to themselves and to others.

Knowing how to elicit expert knowledge from system users is a science in itself, and several techniques have been developed for this purpose. One of them, Cognitive Work Analysis (CWA), has been used in the aviation, military and process control domains, but has never been used to elicit from motorcycle riders, knowledge and insights that can be used to improve their safety and that of others with whom they interact. This report describes how CWA was used to illicit from motorcycle riders’ expert knowledge, and how that knowledge was used to derive some options for injury prevention countermeasures for enhancing the safety of motorcycle and scooter riders.

A series of structured interviews with motorcycle and scooter riders was undertaken, using the framework of CWA, to elicit rider knowledge. An interview guide was developed to structure the interviews. Using the interview guide, 31 riders were interviewed, alone or in pairs, in a series of videotaped interviews conducted in 3 countries – France (Paris), Austria (Vienna) and Australia (Melbourne). The interviews were conducted in English, and each videotaped interview was transcribed, fully or almost fully, in English. Information extracted from the transcripts provided the raw data for the CWA.

This paper introduces and describes CWA, describes the methods and procedures involved in planning and conducting the rider interviews, describes the CWA data analysis process, and presents analyzed data for the riders interviewed. The report concludes with a discussion of major themes and options for countermeasures for enhancing rider safety that emerge from the analysis of the data.

The work described was undertaken in Work Package 5.5 (“Cognitive Work Analysis of Motorcycle Riding”) of the European Commission DG-RTD Transport – funded 2-Wheeler Behaviour and Safety (“2-BE-SAFE”) project. The overall aim of the 2-BE-SAFE project is to understand the behavioural and ergonomic factors that contribute to crashes and incidents.
involving motorcycle and scooter riders and, using this information, to formulate options for countermeasures to improve rider safety.
Title: WALKING – THE WORRIES OF PEDESTRIANS

Presenting Author: Christine Turetschek

Authors: C. Turetschek; K. Ausserer; I. Braguti; E. Füssl; G. Höfferer; A. Risser; R. Risser

Affiliation
1. FACTUM OHG, Vienna, Austria, 2. Free practicing lawyer, Vienna, Austria

Abstract:
Walking is a crucial element of our everyday mobility. It is the glue of the transport system. It connects the different traffic modes and keeps the traffic system together. Walking, however, is often taken for granted. This has the effect, that the needs of pedestrians are considered of minor importance.

Speeding of car drivers, narrow pavements, the missing of crossing facilities, etc. are aspects which make walking unattractive and even dangerous. Pedestrians are the group of road users with one of the highest accident risks. If you want to make people walk more often an increase of the objective safety and of the security of pedestrians are important.

The project “Bef(w)usst unterwegs” (Consciously underway {on your feet}) was co-financed by the Austrian Ministry of Transport, Innovation and Technology. The aim of the project was to determine those factors, which make walking a pleasant, safe and attractive transport mode. In addition, the interrelation between traffic safety, individual and social conditions, and traffic planning aspects were discussed.

Several empirical methods were used in combination, in order to get more information about those issues, which are relevant to make walking safe and attractive. It is important to know the current traffic safety situation, if you want to implement effective traffic safety measures. Thus, in a first step pedestrian accidents in Vienna from 2000-2005 were analyzed. A lawyer considered the juridical aspects of walking as a transport mode. With the help of focus group interviews attractors and barriers were identified. In order to be able to make statistically valid conclusions concerning the results of the focus group interviews a survey was carried out. In the survey people were asked to tell their opinion about pedestrian related issues at six different crossings in Vienna. In addition to the survey a behaviour observation took place to get an impression about conflict situations with pedestrians in traffic. In a workshop with experts of several disciplines the results of the empirical studies were discussed and proposals for solutions were developed.

The results of the accident analysis showed that in absolute numbers three times more pedestrians than car drivers were involved in an accident in Vienna in the time from 2000-2005. In addition, 15 times more pedestrians than car drivers were seriously injured or killed when involved in a traffic accident. Vulnerable road users are mainly endangered by car drivers.

At the same time, from a juridical point of view a single person has hardly any possibility to call for pedestrians’ rights and interests and to see to it that public institutions take their responsibility.

In the survey it turned out that walking is considered as safe despite the high accident rates. In the survey and in the observation the following aspects among others were regarded as inconvenient and dangerous while walking.

• Unattractive surroundings (“ugly environment”)
• The missing of safe crossing facilities next to public transport stops
• Speeding by car drivers, viz. inappropriate speeds
• Red light running by car drivers
In an interaction analysis several aspects were identified which influence the crossing situation for pedestrians positively; e.g. low speeds, eye contact between road users, a self-confident behaviour. Negative influence comes from high speeds, refusing to communicate, pressing one's way ahead by car drivers in spite of not having the right of way, etc. Smooth crossing of a road is reflected by getting in contact with others and interact with them.

In an expert workshop problems and solutions were discussed which are related to pedestrian traffic. Various problems (missing of information campaigns, a lack of pedestrian friendly traffic culture, etc.) and proposals of solutions (road traffic training for specific road user groups, increased enforcement and consequent punishment, etc.) were mentioned.

The study gives some hints, how you can improve the situation for pedestrians. For the future it is important to provide money for pedestrian infrastructure to appoint competent persons, who are responsible for pedestrian issues and to evaluate measures for pedestrians in a before and after study.
Title: HIGH-RESOLUTION MODELING OF VEHICLE-PEDESTRIAN INTERACTIONS FOR ESTIMATING PEDESTRIAN RISK AT THE BLACK SPOTS

Presenting Author: Gennady Waizman

Authors: G. Waizman 1; I. Benenson 1;

Affiliation
1. Department of Geography and Human Environment, Tel Aviv University, Israel,

Abstract:
The geo-referenced police data on the number of traffic accidents clearly point to “Black Spots”, where the accident rate remains high in months and years. Road safety research, however, is still far from understanding why a certain place on a road is risky. Moreover, the very question of what constitutes a safe or unsafe road facility is yet under discussion (Gettman, Head, 2006). The reason for a lack of consensus regarding road safety is the deficit of knowledge of how pedestrians and drivers interact when facing a potentially dangerous traffic situation (Zegeer, Sandt, 2006). In the same time, various aspects of pedestrian and driver behavior are investigated in laboratory experiments and field studies (Endsley, 1995; Klauer et al., 2006; Rensink et al., 1997; Schiff, Detwiler, 1979; Seward, 2007; Tresilian, 1995). The time came to combine this multi-facet knowledge within the spatially explicit agent-based model of the on-road vehicle-pedestrian interaction. Such a model enables estimating the influence of environmental and human factors and their interaction and provides the tool for assessment of safety measures, including changes in the Black-Spot geometry and architecture. The paper presents the SAFEPED - microscopic 3D simulation of the Black Spot dynamics. The SAFEPAD simulator is build using Microsoft DirectX Technology (Figure 1) and its agents can behave autonomously, according to a predetermined set of rules or be guided by one or more human users. We consider SAFEPAD as a test platform for evaluating experimentally estimated drivers' and pedestrians' behavioral rules and employ it for estimating accident risks in different traffic scenarios.

SAFEPAD builds on externally constructed 3D environments (all industrial CAD formats are accepted). The user interface enables establishing agents' behavioral rules, interactive management of the model runs and scheduling agents' appearance and motion. When applied at an early stage of the planning and development process, SAFEPAD can reveal a disadvantageous design of the Black Spot and serve for assessing alternative architectural solutions (Archer, 2005).

The set of the behavioral rules of the SAFEPED agents – drivers and pedestrians – consist of two subsets. The subset describes the rules of agents' movement. The second subset describes the rules of agents' cognition and perception. The parameters of the cognition rules are established on the base of accident-related experimental data, including Time-To-Contact judgment, reaction time, driver inattention and pedestrian caution (Seward, 2007; Bonsalla et al., 2005; Bungum et al., 2005; Klauer et al., 2006). The parameters of motion rules include acceleration and deceleration rates, dependency of driving speed on curves on lateral acceleration, performance limitations for vehicles, estimated range of velocities, and acceleration and deceleration rates for different pedestrian modes - walking, jogging, and running (Bonsalla et al., 2005; TranSafety, 1998; Daniel, Fittanto, 2004). Importantly, SAFEPED records all crash and near-crash episodes as well as the entire life-history of every agent during the simulation run thus enabling re-run of the simulation starting from any moment of time. In this way, the user can observe accidents from various viewpoints (including the viewpoints of the crash participants) and estimate accidents' characteristics. The replay mode enables intervening into the crash or near-crash dynamics by taking the full control.
over one or more agents. The paper presents the implementations of the SAFEPED for verification and calibration of pedestrians’ and drivers' behavioral models, and for estimating pedestrian risks at two Black Spot.
Title: HOW TO MAKE MORE CYCLING GOOD FOR ROAD SAFETY?

Presenting Author: Fred Wegman

Authors: F. Wegman 1

Affiliation
1. SWOV Institute for Road Safety Research/Delft University of Technology, The Netherlands,

Abstract:
If we compare bicycle use between different countries, there are enormous differences. These differences can be seen in the bicycle culture, bicycle use, the position of the cyclist in traffic, and the measures that have been taken to make cycling safer. There are countries, for example, where there is hardly any cycling, if any at all. This is often partly determined by a country’s geography (hills and mountains) and its climate (high temperatures). There are countries where cycling is practiced as a kind of recreation. And, finally, there are countries in which cycling is a substantial part of the modal split. Although cycling activities also take place in rural areas, the majority of the bicycle kilometers are travelled in towns and cities, and over relatively short distances.

Many different reasons can be given to promote cycling. An important distinction that must be made is whether cycling is recreational, or whether it is a means of transport to travel from A to B.

Arguments that are heard, for example, are: cycling is healthy (e.g. helps to prevent obesity), cycling is good for the environment if it takes the place of motorized journeys, cycling is making a contribution to the prevention of congestion because cyclists take up less space than (parked) cars, cycling is cheaper than travel by passenger car or public transport. Compared to walking, cycling increases the distances that can be covered and in developing countries it can make a contribution to the economic development and be an aid in the fight against poverty. There is also a social dimension: certain social classes or women for instance, are not supposed to be seen on a bicycle.

One important objection can be made against promoting cycling: it is rather dangerous. As a direct consequence of the laws of (bio)mechanics and the vulnerability of the human body cyclists are vulnerable in traffic. Cyclists fall easily and can sustain serious injury. Brain damage is a serious and frequent injury. A cyclist can be injured in a crash with a motorized vehicle travelling a high speed and kinetic energy in a crash must be processed. In crashes, other than sometimes by a bicycle helmet, a cyclist is unprotected. Furthermore, a cyclist can lose control of the bicycle, have a fall, and be injured, especially if a cyclist is inexperienced or when obstacles play a role. Frequently, cyclists fail to follow the traffic rules and show unexpected behaviour in the eye of other road users. The consequences are that cyclists have a relatively high crash rate compared to that of pedestrians and particularly that of drivers. Children, and in some countries also the elderly, are noted for their extremely high crash rate. Here, there are clear indications that the under-registration of crashes involving cyclists is higher than for other modes of transport.

In essence there are two ways to increase cyclist safety, ways which fit into the Safe System Approach: one is to prevent the possibility of encounters between cyclists and motorized traffic by giving each group its own network. The second way, if these unequal transport modes can meet and a crash can indeed happen, is to reduce the speed of motorized traffic and introduce vehicle facilities which can reduce the risk of crashes and their severity. This way the exposure
to risk, the crash rates, the injury rates should be minimized. Measures to accomplish this mainly involve the area of planning and design of traffic facilities. Safe vehicle design can also make a contribution. Of course there is also a role for education and enforcement.

In comparison with other road users, relatively little research has been done into cyclist safety. And, in addition, knowledge from research cannot easily be generalized. The latter is not so much the case for research into injury severity in relation with a crash; the laws of (bio)mechanics apply everywhere. But hardly any research has been done into the safety consequences of policy aimed at promoting bicycle use and it is difficult to use the results generally. This is as much the case for research aimed at determining the effectiveness and efficiency of interventions in the area of planning and design of traffic facilities. Not to mention the issue of to which extent the research results that are available will influence decisions to make traffic safer for cyclists. This contribution will present a structured survey of the available knowledge from research trying the give an answer to the question how to make more cycling good for safety.
**Title:** MEASURING CHILD PEDESTRIAN EXPOSURE: A TOOL FOR CHILDREN TO BE COUNTED TOO!

**Presenting Author:** David Zaidel

**Authors:** D. Zaidel 1; S. Levi 2; L. Endy-Findling 2;

**Affiliation**
1. 4sight, Ergonomics & Safety, Israel, 2. Beterem – Safe-Kids Israel: National Center For Children’s Safety And Health, Israel,

**Abstract:**
Walking and cycling are increasingly recognized as important, rightful, sustainable and healthy modes of transport. Pedestrians are being seen as the major users of all urban public spaces which, therefore, must be easily and safely accessible to them.

These welcome developments require tools to assess not only the quality of urban space and interconnections (streets, paths) for pedestrians or cyclists, but also the number of pedestrians using the connections (in fact or potentially), the intensity of use and other attributes.

With respect to motorized traffic there are several tools for measuring vehicles' travel intensity and patterns, and data are routinely collected by urban and transport planners, traffic engineers and road safety analysts.

In comparison, few tools and little quantitative data are available about the presence of pedestrians, especially children, on the urban (or rural) road network. This is particularly lacking in the area of locally-linked pedestrian safety analysis, where correct ‘exposure’ data are required for valid assessment of accident risks.

The work reported here is part of a larger effort by BETEREM to develop ‘Child Road Safety Indicators for Urban Communities’. The pilot project is conducted in four municipalities in Israel, with the aim of developing a general assessment method to be used by municipalities to diagnose and correct road safety issues impacting children.

The indicators are based on injury data analysis, behaviour observations, trip surveys, municipal safety management analysis, measurement of neighbourhood Walkability (the extent that the road network provides safety, comfort and connectivity for children’s walking trips), and counts of child pedestrians and bicycle riders.

The method for counting child pedestrians and bicyclists had to satisfy three criteria:
- it has to provide a measure of pedestrian presence that is representative of an entire road network of a neighbourhood / community;
- it has to be conceptually related to vehicular traffic counts and to road safety;
- it has to be very easy to implement.

The first criterion was met by a process of systematic sampling of neighbourhoods in a community, with the help of GIS database, taking in account census track information, land-use, residential building density and roadway network attributes. Within each neighbourhood, child-relevant walking / riding destinations are identified and marked on a map.

The second criterion was addressed by the following reasoning: The cumulative road risk for children lies in the chance of encountering vehicles while they are on the street. The more children on the street the higher the chance. This is actually what is meant by “exposure”. The equivalent of this risk is the chance that a vehicle (or a vehicle stream) will encounter children while travelling on a street. This mirror conceptualization lets us measure the ‘chance’ by a standard unit such as ‘number of child pedestrians encountered per hour of travel’, which is similar to how vehicles are counted in a network-number of vehicles per hour.

The procedure for counting requires first planning a representative driving circuit in a previously sampled neighborhood. The driving circuit is planned with the help of GIS, such that it goes in
typical sub-areas of the neighborhood, on a variety of street types, and passes by many destinations children in the neighborhood are likely to visit. Practical considerations of traffic controls and specific local conditions help fine-tune the driving circuits for all sampled areas. The field work of counting is accomplished by a pair of field observers, one driver and one recorder. The team records the number and various characteristics of child pedestrians and bicycle riders they notice along the streets. They drive at a normal traffic speed, or a little slower when needed. Counts may be supplemented with still or video photography. Driving cycles are repeated in order to cover different time periods and increase the sample size. With good advance planning it is possible to count pedestrians and bicyclists in several neighborhoods within one day. The basic unit of analysis is number of recorded pedestrians (or bicyclists) of a specified characteristic, per unit of time. Results of the representative exposure measures of child pedestrians and child bicycle riders in the four cities are presented according to various classifications and in comparison to GIS-based demographic data for the neighbourhoods.
Title: MOTORCYCLE RIDING RISKS ON INTERURBAN ROADS

Presenting Author: David Zaidel

Authors: D. M. Zaidel 1; R. Ben-Zino 2; R. Zilberstein 2

Affiliation
1. 4Sight Ergonomics & Safety, Israel, 2. Amy-Metom Engineers & Consultants Ltd, Israel,

Abstract:
Background and objective
The approximately 100,000 PTW in Israel represent 4% of all registered vehicles, but are involved in nearly 11% (2008 figure) of all reported road crashes. The likelihood of PTW riders in Israel to be seriously injured or killed in the event of a crash is about three times higher than for a car driver involved in a crash. In Israel, the majority of PTW vehicles are Scooters and low-powered motorcycles. They are mostly seen in urban areas, and crash statistics reflect these facts. 85% of PTW crashes took place on urban roads. However, the severity of PTW crashes on interurban roads is three times as high as that of PTW crashes on urban roads. Over half of PTW fatal crashes take place on interurban roads.

Research program
The series of studies reported here focused on engineering analysis of roadway characteristics that might contribute to occurrence of PTW crashes on interurban roads. It included exposure surveys for the distribution of PTW on the interurban road network, and on the distribution of road hazards over the same network.

Method and main outcomes
Review of official roadway design guidelines, in Israel and other countries, for specific guidelines about how to accommodate the unique needs of PTW. Currently, there are few specific considerations of PTW in most official design guidelines. Literature review revealed a growing awareness of several issues in geometric design, road surface features, roadside hazards, guardrails, intersection design, operation and maintenance, which impact the safety of PTW riders. Suggested guidelines by advocacy groups or researchers typically address improved geometry, hazard free road surface, improved guardrails, and ‘forgiving road’ treatments to minimize crash consequences.

Statistical analysis of 5 years of interurban PTW crashes (1633 cases) in comparison to car crashes. The analysis included creation of GIS database of PTW crash locations on the road network. PTW involved in crashes on interurban roads were divided equally between the low-powered machines (up to 250 cc engine), and the larger machines, but crashes of larger machines were more severe and more likely to have taken place on road sections as opposed to junctions. About 90% percent of the crashes involved experienced riders aged 25-55.

Differences in crash patterns between PTW and cars included: higher percent of single-vehicle crashes by PTW, a lower percentage of night time crashes in the PTW group, and only 5% PTW crashes reported (by police) to have had infrastructure related causal factor, compared to 11% of the car crashes. Focus groups with PTW riders added the views and experiences of motorcycle riders in the Israeli context. Overall, the views were similar to those reported by European riders. Exposure survey of PTW on the interurban road network was conducted on a quasi-representative sample of routes, based on previous accident analysis and information on PTW ‘touring routes’. Manual traffic counts where conducted at 45 junctions along the routes, at three different periods. PTW were classified by type and power class. Traffic counts revealed that the share of PTW in traffic varied from 0.12 % to 4.3% with a mean of 1.3 %. The counts were made during mild spring weather. A planned PTW user survey will provide more detailed exposure information.
Speed measurements of PTW and of cars were conducted along 30 road sections from the same sample of routes. The measures confirmed the common impression that PTW move fast. PTW mean speeds were generally 10 km/h higher than the values for cars, measured at the same locations and times. Road survey on the distribution of PTW-relevant road hazards was carried out on 15 routes from the above mentioned sample. Two Experienced motorcyclists documented road hazards along each route in real time, with the aid of small Audio and video recording device, built-in the helmet. The riders identified 101 hazards that were later classified into three categories- geometry and visibility, surface hazards, and operational / traffic management problems. Surface hazards were the most common on all routes. Geometry problems were noted mostly on routes over hilly topography. Together, the studies help interpreting the accident data and point to potential improvements in roadway and traffic management.
Title: PEDESTRIAN CRASHES AND TREATMENTS FROM AROUND THE WORLD

Presenting Author: Charles V. Zegeer

Authors: C.V. Zegeer 1;

Affiliation
1. UNC Highway Safety Research Center, USA,

Abstract:
Pedestrian crashes and related deaths and injuries continue to be a serious problem in industrialized and developing countries throughout the world. In some nations, up to half of all traffic fatalities involve pedestrians. A wide range of activities have been implemented in the past few decades in many countries to better understand the causes and potential solutions for these pedestrian crash problems. Agencies which have been most successful in pedestrian safety efforts are those that have developed and implemented comprehensive pedestrian safety plans, consisting of engineering, education, and enforcement activities targeted toward specific pedestrian crash problems. In addition to crash reduction, more emphasis is now being placed on encouraging more people to walk, to promote healthy lifestyles, reduce obesity and other health problems, and improve auto-emissions and vehicle congestion, among other benefits.

Examples of programs that help to promote more and safer walking include “Safe Routes to School” (SRTS) efforts, which started in Europe and has spread to the U.S. and more than 50 nations to date. The use of pedestrian-friendly street networks has been an on-going practice in many countries, such as Switzerland, Sweden, Denmark, Australia, New Zealand, the Netherlands, Germany, Japan and more recently in the U.S. A well-planned network of sidewalks and walkways and special crossing provisions at transit stops and along arterial corridors are essential ingredients in the creation of a safer pedestrian environment. Other measures include calming measures to slow vehicle speeds, restriction of motor-vehicle traffic movements, appropriate use of certain warning devices and pavement markings, well-marked crossings equipped with raised islands and/or advanced pedestrian signalization can also benefit pedestrians. Special provisions for older pedestrians and those with visual or mobility limitations are also important.

Pedestrian safety education programs, such as those used in Great Britain, Switzerland, Australia, and the U.S. have been used to supplement engineering measures, particularly messages and programs directed at child pedestrians, the general public, and those safety campaigns directed at drivers. Police enforcement programs must also be an integral part of any pedestrian safety effort, and some countries, such as in the U.K., Australia, and Switzerland are using automated speed and red light enforcement to supplement police officer efforts. Countries and cities which have particularly successful safety records for pedestrians include those that have policies directed at prioritizing walking and bicycling as transportation modes, creating livable neighborhoods, and creating a system of parks, trails and open space. Other helpful measures include connected pedestrian networks citywide, high-density development, appropriate zoning and land use, and pedestrian accommodations in suburban and rural areas.

A recent study conducted in Miami-Dade County in the U.S. has found that a comprehensive pedestrian safety program can result in significant reductions in pedestrian crashes. This eight-year demonstration study involved the implementation of 16 different types of education, engineering, and enforcement strategies targeted at specific ages of pedestrians, problem locations and ethnic groups in the county. Pedestrian crashes dropped significantly
after the program was implemented, by approximately 10%, or a total of about 180 fewer pedestrian crashes per year in the two-year after period, after accounting for different control groups. Corridors and zones where the countermeasures were targeted resulted in the greatest reductions in pedestrian crashes, particularly involving school-age children and adult pedestrians in the targeted zones.

Formal procedures for conducting an agency’s pedestrian safety action plan (PSAP) have been developed in the U.S. and several European countries to improve pedestrian safety, mobility and access. Steps required in any successful PSAP include identifying problem locations and neighborhoods, conducting pedestrian safety audits, selecting cost-effective safety treatments, obtaining funding and implementing treatments, and conducting follow-up evaluations. A wealth of technical information and resources currently exists to address pedestrian safety concerns, such as from the U.S. DOT-sponsored Pedestrian and Bicycle Information Center (PBIC), as can be found at the following web site: www.pedbikeinfo.org.