TRIPP BULLETIN

VOL 3. NO.2 MONSOON 2006

TRANSPORTATION RESEARCH & INJURY PREVENTION PROGRAMME

INDIAN INSTITUTE OF TECHNOLOGY DELHI

IIT faculty members associated with TRIPP supervise research projects at undergraduate and postgraduate levels. The current and recently completed projects are listed below:

Ph.D. Scholars

Current

Optimal pricing of urban transport - a case of Delhi
Scholar: Akshay Sen
Supervisors: Geetam Tiwari and V. Upadhyay

Study of the effect of thigh and leg muscle activation on the response of human knee to impact loading
Scholar: Anurag Soni
Supervisors: Anoop Chawla and Sudipto Mukherjee

Transportation projects and their effects on the poor: integrating a social impact assessment methodology
Scholar: Anvita Anand
Supervisor: Geetam Tiwari

Constitutive models of soft tissue for human body-vehicle impact analysis
Scholar: B. Karthikeyan
Supervisors: Sudipto Mukherjee and Anoop Chawla

In-vivo measurement of constitutive properties
Scholar: Hemant N Warhatkar
Supervisor: Anoop Chawla and Sudipto Mukherjee

Urban bus route optimization
Scholar: Mukti Advani
Supervisor: Geetam Tiwari

Institutional and regulatory structure for providing urban public transport
Scholar: O.P. Agarwal
Supervisors: Geetam Tiwari and V. Upadhyay

To study the suitability of airbags for motorcyclists
Scholar: Prashant Vidhyadhar Bhosle
Supervisors: Anoop Chawla and Sudipto Mukherjee

Biomechanics of helmet impact
Scholar: Praveen Kumar Pinnoji
Supervisor: Puneet Mahajan

B.Tech. Projects

Completed

Dynamic analysis of bicycle and pedestrian injuries for various crash situations using MADYMO
Students: Manvinder Singh and Rohit Day
Supervisors: *Dinesh Mohan and Sudipto Mukherjee*

FE simulations to study the kinematics of the knee joint after surgery
Students: Tanpreet Singh and Vijay Jain
Supervisors: *Anoop Chawla and Sudipto Mukherjee*

Design and analysis of helmet
Student: Sanyog Yadav
Supervisors: *Sanjeev Sanghi and Puneet Mahajan*

Risk analysis of traffic accidents in Delhi on GIS platform
Student: Siddharth Singh
Supervisor: *Geetam Tiwari*

Design of optimal signal plan for selected junction and developing indicator to evalluate IT
Students: Atul Magoon and Anshul Gupta
Supervisor: *Geetam Tiwari*

Demand estimation for HCBS on selected corridor & design implication
Students: Varun Sayal and Vikram Joshi
supervisor: *Geetam Tiwari*

Traffic analysis of intersections on GIS platform
Student: Mukesh Pant
Supervisor: *Geetam Tiwari*

Design of signal cycle for Chirag Delhi intersection
Students: Udit Gupta and Subhanshu Saxena
Supervisor: *Geetam Tiwari*

Evaluating equity in transport plannning case study: Delhi
Student: Arnab Roy
Supervisor: *Geetam Tiwari*

M.Tech. Projects

Completed

Study of the ISO 13232 FST Side Impact Configurations Through Computer Simulation
Student: V. Pavan Kumar
Supervisors: *Anoop Chawla and Sudipto Mukherjee*

Material Characterization of Human Bone Under Impact by Inverse Mapping in FE Simulations
Student: Adity Shekhar
Supervisors: *Anoop Chawla and Sudipto Mukherjee*

Road Safety Audit of National Highways 8 (Delhi-Jaipur section)
Student: Navdeep Asija
Supervisors: *Geetam Tiwari and Dinesh Mohan*

Course Announcement

The Transportation Research and Injury Prevention Programme (TRIPP) at the Indian Institute of Technology, Delhi, Volvo Education and Research Foundations and the French National Institute for Transport and Safety Research (INRETS) France, are organizing a seven day "**International Course on Transportation Planning and Safety**". The course will be held in New Delhi, India, from 04-10 December 2006, and TRIPP will be the host institution. The course will have a common component for the first three days, followed by two parallel modules on Traffic Safety and Biomechanics and Crashworthiness.
Details of the course can be accessed from - www.iitd.ac.in/tripp

Visiting Faculty

Prof. A. Hassan, Professor, Birmingham Automotive Safety Centre, University of Birmingham, spent 3 weeks (April 8, 2006 to April 29, 2006) atTRIPP, IIT Delhi, working on "Crash reconstruction and analysis"

The **Transportation Research and Injury Prevention Programme (TRIPP)** at the Indian Institute of Technology Delhi, is an interdisciplinary programme focussing on the reduction of adverse health effects of road transport. TRIPP attempts to integrate all issues concerned with transportation in order to promote safety, cleaner air, and energy conservation. Faculty members are involved in planning safer urban and inter-city transportation systems, and developing designs for vehicles, safety equipment and infrastructure for the future. Activities include applied research projects, special courses and workshops, and supervision of student projects at postgraduate and undergraduate levels. Projects are done in collaboration with associated departments and centres at IIT Delhi, government departments, industry and international agencies.

TRIPP BULLETIN
TRANSPORTATION RESEARCH & INJURY PREVENTION PROGRAMME
VOL 3. NO.2 MONSOON 2006


Sanjeev Sanghi

Fluid mechanics, pollution and safety

Sanjeev Sanghi obtained his B.Tech. in Mechanical Engineering from IIT Kanpur, MS from Corenell University and Ph.D. from the Levich Institute, City University of New York. Since 1992 he is teaching in the Applied Mechanics Department at IIT Delhi and has been affiliated with TRIPP since 1997. He works on modelling of turbulent flows, computational fluid dynamics and non-linear dynamics and chaos. He is also a co-founder of Tensor Technologies Ltd., a technology incubation unit at IIT Delhi.

How did you come to problems of air flow in a motorcycle helmet?

Basically, I had specialized in fluid mechanics and was working on theories of turbulence modelling. I was on the lookout for practical and applied problems. My contact with TRIPP introduced me to the problem of air circulation and heat transfer patterns in the gap between the head and the helmet; it also opened my eyes to the study of air quality data in Indian cities, particularly Delhi; but we will get back to that later. In our country wearing a helmet becomes very uncomfortable, especially in the summer months, because of heat and excessive sweating on the head. It is observed that air velocity on the top and rear portions of the head is very low; this is also borne out by experiments in the wind tunnel. A helmet which will ensure higher air velocity all over the head will be more comfortable to wear.

To computationally model this flow, we have to first determine its nature. In a confined passage, the flow is laminar or turbulent depending on the Reynolds number which is directly related to the product of the air velocity and the gap between the head and the helmet. For standard flow configurations, critical values of Reynolds number are known. However, in a new application this has to be determined. Most turbulence models work well for the cases where it is established that the flow is turbulent.

What new angle did you bring to the work at this juncture?

I had done some work on the Spalart – Allmaras turbulence model which was designed to study flow on aircraft wings. I had shown that when this particular model is used in internal flow (like flow in a pipe) it performs very well in laminar, transition and near transition turbulent flows, whereas the other standard turbulence models perform well only in the turbulent regime. For our problem we were not sure of the critical Reynolds number and based on my earlier experience, I could sense that in this case the Spalart-Allmaras model would give better results. It turned out that solutions obtained by this model gave results which matched with the experiment carried out by us. Thus working on an application problem helped me to validate my theoretical hypothesis. We are now using CFD (Computational Fluid Dynamics) simulations with new helmet configurations. This should give us practical pointers towards constructing a more comfortable helmet without sacrificing the safety factor.

Going back to what you said earlier, tell us something about your other area of interest: the study of air quality in Delhi and other Indian cities?

The migration to urban centres is very much a part of our lives today. The health impact of this demographic shift is complex and the cities of tomorrow must change to accomodate these changes in a healthy manner. The most common mode of public transport in our cities are buses which used to run on diesel. On a per-passenger basis, even the diesel bus was the least polluting vehicle on the road. When the Supreme Court handed down a decision that all buses plying on the road in Delhi must convert from diesel to CNG (Compressed Natural Gas), it was argued that this would make a big difference to the air quality in Delhi; it was even said that this would solve all the city's air pollution problems.

When did you decide to intervene?

We decided to wade into the problem just about this time as we felt that different players were not taking into cognizance all of the relevant factors concerned. As a direct consequence of the change over to CNG as a fuel, though visible pollution reduced on the road, the chartered bus fares went up. This had an all round adverse impact on transport and livelihood issues for all the disadvantaged in the city's informal sector. A parallel consequence was a switch over from public to private modes of transport like cars and motorized two-wheelers especially by school children. Our calculations showed that even a 10% passenger shift from buses to personal transport modes would nullify the merits of this fuel-use policy. In the total traffic on the road the modal share of buses is decreasing. For example at ITO intersection the modal share of buses has decreased from 7.5 to 4.3 % from year 2002 to 2005. Not only this, the actual number of buses on the roads have decreased in sharp contrast to personal modes of transport like cars and two-wheelers which have, in fact, increased. Another important factor is the fact that CNG as a fuel burns at a higher temperature which produces an increase in NOx (Nitrous oxide) pollution. The actual quantum of NOx in Delhi is going up. This was predicted by us in our report "Air quality impact assessment by changerover to CNG buses in Delhi.". These findings could serve as cautionary signposts to governments, policy planners and the courts when considering issues of clear air quality in the other cities in our country. However, these issues need to be studied more rigorously in the future.

What do you have lined up for the future?

I have extensively worked on proper orthogoral decomposition. This is a statistical technique to capture structure from a data based on the data itself. In other words, we do not need to carry out any physical modelling of the phenomenon to capture the structure. I propose to use this on traffic, emission and other data to help us understand the inherent structure in these problems.

TRIPP BULLETIN
TRANSPORTATION RESEARCH & INJURY PREVENTION PROGRAMME
VOL 3. NO.2 MONSOON 2006

INDICES AND TRAFFIC SAFETY

Various road safety indices are used to judge whether a society is improving its record in promoting road safety and in comparing the record of one country with another. However an article in a recent issue of Status Report states that "Numbers can, and often are, used to 'prove' just about any program or policy that anybody with an agenda wants to praise or discredit. It's an ongoing problem, and the field of highway safety is no exception… Politicians often express national goals in terms of targeted reductions in the motor vehicle death rate per mile driven. The problem is that this rate is influenced by numerous factors that have nothing at all to do with traffic safety policies ." (See Box below)

Road safety can be addressed from two perspectives: (1) from the standpoint of the individual and (2) from the standpoint of society (i.e., government). The first perspective reflects the individual's probability that he or she will be involved in a crash resulting in death or serious injury. The societal perspective reflects not merely the probability that an individual person will suffer injury or death, but also the total number of transport-related deaths or serious injuries.

According to these measures, from the viewpoint of the individual, a lower probability of injury or death are "good." From the viewpoint of government, such lower probabilities are also "good." However, if increasing volumes of personal movement overwhelms these reductions, producing an overall increase in the expected number of individuals killed or injured, and, this is "bad." We give below various indices used and what they mean.

Fatalities per hundred thousand persons: This is the most important measure for a society. This measure gives an overall assessment of road traffic injuries (RTI) as a health burden for society. The lower the index the better off the society is as far as this problem is concerned. This index helps compare the relative ranking of RTI as a health problem compared with other diseases. The lower this index, the better it is for governments and individuals.

Fatalities 10,000 vehicles: This is the index used most often, but it only tells you the probability of a vehicle being involved in a crash. It is a reasonable measure to use only when comparing groups (countries) with similar vehicle use rates and traffic modal shares. Studies show that fatalities per vehicle almost always reduce as the number of vehicles per capita increases even in the absence of extra safety measures. Both, the total number of fatalities and fatalities per capita can keep increasing while fatalities per vehicle keep reducing. Low income countries can have high per vehicle rates but low per capita rates, and high income countries will always have very low per vehicle rates but some can have high per capita rates. This measure is not necessarily useful for individuals or for societies.

Fatalities per vehicle km: This gives you a measure of the probability of a vehicle being involved in an injury producing crash based on its exposure level in traffic. This is a useful measure to judge the relative risk of crash involvement among different vehicle types or to understand the effect of technology improvement in a particular vehicle in a before and after study. This measure is used by insurance companies for assessing risk for each type of vehicle and by designers to assess effectiveness of technology improvements. This measure can decrease in magnitude but overall deaths in society can increase if driven mileage or occupancy rates increase. For the same value of this measure, a road user's risk of fatality per trip can increase if the trip length increases. The measure can be good for assessing individual safety for same mileage use but not for society.

Fatalities per passenger km: This measure adds the occupancy rate to the vehicle per km measure. This would give you an idea on which modes of travel are safer on an average for an individual. So the same brand of car can have a higher rate when used for personal use, compared to use as a taxi carrying many people other things remaining the same. Can help in deciding which modes of transport to encourage. However, total number of deaths can increase in a country if people drive more while this index may remain the same.

Fatalities per trip: This is the most important rate for an individual. This is what decides the probability of an individual being killed over a lifetime. It is also an important determinant for comparing safety between different modes. Individuals seem to have a rough intuitive feel for this index. That is why walking and bicycling decrease as roads are perceived to be unsafe.

GOOD STATISTICAL ANALYSES

Point to improving vehicle designs as reasons for recent declines in death rate

It's true that US motor vehicle death rates have been trending downward for decades. Since the mid – 1980s, the rate per registered vehicle has declined 43 percent. Traffic safety policies aimed at improving drivers and roadways have influenced this trend, but it's a mistake to attribute all of the death rate reductions to such policies. More sophisticated analyses are required to get a clearer idea of what's behind the reductions, and new Institute research helps to identify the reasons.

The researchers focused on two factors that have influenced the driver death rate per registered vehicle over 20 years (1985-2004). One is how vehicle use patterns change as vehicles age. The other is vehicle design changes – the introduction over time of different types of vehicles and more crashworthy ones to replace vehicles that weren't doing as good a job of protecting their occupants.

Researchers don't know exactly why death rates go up as vehicles get older. It's probably not because of vehicle deterioration, at least during the early years of a vehicle's use. It probably has more to do with who drives older vehicles versus newer ones and how they drive them. When researchers adjusted for driver age and gender and for type of crash, the effects of vehicle age diminished or even disappeared.

Trends in the death rates have been widely used to measure highway safety progress over time and to compare relative highway safety performance among countries. Politicians often express national goals in terms of targeted reductions in the motor vehicle death rate per mile driven. The problem is that this rate is influenced by numerous factors that have nothing at all to do with traffic safety policies. An example is the presumption that a decline in deaths per mile traveled indicates that traffic safety programs are working effectively and vice versa. In fact, the relationship between miles traveled and fatality risk is more complicated. The risk per mile is much lower on congested freeways, for example, than on uncongested ones. Such differences in risk because of congestion do affect death rates, but they're unrelated to traffic safety policies.

It's the same with deaths per registered vehicle and per population. Per-vehicle rates can be useful for short-term comparisons, but over time and from jurisdiction to jurisdiction the composition of vehicle fleets changes. Per – capita rates are influenced by changing demographics including, for example, the proportions of teenage and other high – risk drivers.

How data are misused to justify speeding

Organized in 1982 to oppose the 55 mph speed limit, the National Motorists Association still opposes reasonable speed limits. To make its case, this group misuses motor vehicle death rates to try to make it seem as if safety is unrelated to speed limits and travel speeds. According to a 2005 news release, "the fatality rate has continued to decline despite higher speed limits and higher driving speeds. This clearly demonstrated that the 22-year-long experiment with an arbitrary national speed limit served no positive purpose."

What's overlooked is that per – mile death rates across all kinds of US roads – rural and urban ones, interstate highways and city streets, etc. – are too broad to assess the effects of a specific policy change like raising speed limits on specific roads.

Study after study confirms the deaths on rural interstates go up when speed limits are raised (see Status Report, Nov. 22, 2003; on the web at iihs.org). The National Motorists Association furthers its agenda by ignoring these findings of scientific studies in favor of misusing the irrelevant per – mile death rate.

Status Report, Vol.41, No. 4, April 22, 2006, http://www.iihs.org/sr/pdfs/sr4104.pdf

(For a copy of "Use and misuse of motor vehicle crash death rates in assessing highway safety performance" by B. O'Neill and S. Kyrychenko write: Publications, Insurance Institute for Highway Safety, 1005 North Glebe Road, Arlington, VA 22201, or email publications@iihs.org.

TRIPP BULLETIN
TRANSPORTATION RESEARCH & INJURY PREVENTION PROGRAMME
VOL 3. NO.2 MONSOON 2006

News

Driving, Distraction and Safety

Driving and talking to passengers

UMTRI researchers have discovered that talking to passengers may be just as dangerous for drivers as talking on a cell phone. A recent study shows that drivers who have conversations with passengers exhibit similar levels of driving performance as motorists who use cell phones.

"But the results of our study show that many of the other behaviors that drivers engage in, such as eating, drinking, grooming and having conversations with passengers, are potentially just as detrimental to driving performance." While all of the non driving behaviors were associated with more erratic steering behavior, the researchers found that other measures of driving performance, such as lane position, speed fluctuation, use of the accelerator pedal and glance behavior (checking mirrors, looking out the side windows, etc.), showed mixed results.

Driving and talking on the phone

More drivers than ever are talking on cell phones. The National Highway Traffic Safety Administration (NHTSA) reports that at any time of day 6 percent of drivers on U.S. roads in 2005 were using hand held phones – double the rate that was observed 5 years ago. The highest phone use rate in 2005 (10 percent) was among drivers 16 to 24 years old.The NHTSA survey results were released last month, the same time as a new Institute review of available evidence about the safety consequences of phoning while driving. McCartt and other Institute researchers reviewed 125 studies in all.

Almost all of these studies identified effects on driver performance from the cognitive distractions associated with phone use. For example, the reaction times of drivers using phones were likely to be slower. Drivers on phones also were more likely to deviate from their lanes.

One of these so-called naturalistic studies found that drivers were more likely to take their hands off the steering wheel or their eyes off the road when they were dialing a phone or answering it. An Institute study based on the billing records of Australian drivers found a fourfold increase in the risk of an injury crash associated with phone use. This risk was consistent among male and female drivers as well as younger and older drivers (see Status report, July 16, 2005; on the web at www.iihs.org). A Canadian study found about the same increase in the risk of a property damage crash. These two studies of real-world crashes also found about the same risk associated with hands-free and hand-held phones. This is consistent with experimental studies showing that driver performance is affected by hands-free and hand-held phone use alike.

Status Report, Insurance Institute for Highway Safety, Vol. 41, No. 6, July 16, 2005

Sports Utility Vehicles and Older Pedestrians: A Damaging Collision

Among road users, pedestrians are already a group at high risk, and elderly pedestrians are particularly at risk. People over 60 are more than four times as likely to die if injured by a car than younger people: in a pattern repeated around the developed world, older people in Ireland account for 30% of pedestrian deaths but only 11% of the population. The World Health Organization has recognized protection of older pedestrians as a key safety measure for this age group. Pedestrian protection is an even more pressing problem in the developing world. Pedestrian injuries and deaths from collisions with vehicles represent about 20% of automotive casualties in the European Union, but they rise to nearly 50% of casualties in developing countries, which have poorer roads and more travel by foot.

Pedestrian protection is achieved in several ways including improved vehicle design to reduce injuries to pedestrians. The proliferation of sport utility vehicles represents a backwards step in safer vehicle design.

In Europe sales of SUVs have increased by 15% in the past year, while sales of standard cars have dropped by 4%. Glaber and Lefler have used the US fatal accident reporting system database (FARS) to analyse the relative dangers posed to pedestrians by these high fronted vehicles. Their results show that, for the same collision speed, the likelihood of a pedestrian fatality is nearly doubled in the event of a collision with a large SUV compared with a passenger car. Other studies have consistently shown higher rates (up to four times greater) of severe injury and death for pedestrians in collisions with SUVs.

The increased mortality and morbidity rom SUVs arises primarily from the geometry of the front end structure. In a typical collision between a car and an adult, the bumper strikes the lower legs and the leading edge of the bonnet strikes the femur/pelvis, causing the pedestrian to rotate towards the bonnet. This results in the bonnet or windscreen hitting the shoulder or head.

SUV bonnets are higher than those of cars and this results in a more severe primary impact on the critical central body regions of the upper leg and pelvis. Also, there is less rotation as the impact is closer to the body centre of mass, resulting in a more efficient transfer of energy. For example, raising the bonnet leading edge height from 600 mm to 850 mm increases the impulse by a factor of about two. This results in a doubling of injuries to vulnerable regions such as the head, thorax, and abdomen.

Addressing this threat requires an integrated approach from public health and transportation and road safety agencies (including vehicle designers). One measure should include changing crash investigation processes to identify SUVs in vehicle-pedestrian impact statistics.

In the meantime, informing consumers of the increased risk to pedestrians form SUVs may represent a useful first step in raising public awareness. Addressing the hazards posed by SUVs to pedestrians is an emerging and real traffic safety challenge in the developed world.

Injury Prevention, Vol. No. 12, Issue No. 1, February 2006

Road Traffic Casualties: Understanding The Night Time Death Toll

A disproportionate number of fatal injuries occur after dark. The paper presents some statistics of road traffic injuries in a novel way which suggests that low luminance plays a major role in this effect. A sound physiological explanation for this is advanced based on the poor temporal characteristics of rod photoreceptors. It is argued that processing information based on low luminance, low contrast targets is much slower than that for high contrast bright targets. To test the idea, simple visual reaction times were measured under typical low visibility conditions encountered on non-lit roads and were found to be substantially longer than under optimal conditions. It is shown that longer reaction times translate into significantly increased stopping distances. This important point has received insufficient attention in the road safety literature, by the Highways Agency, the police, injury prevention officials, and the UK highway Code.

S Plainis, I J Murray, I G Pallikaris, Injury Prevention 2006; 12:125-128.

Establishment funds have been received from
Ministry of Industry, Government of India
Asian Institute of Transport Development
Tata Motors
Volvo Research and Education Foundations

Endowments for perpetual Chair
CONFER, India: TRIPP Chair for Transportation Planning

Transportation Research and Injury Prevention Programme
Room MS 808 (Main Building)
Indian Institute of Technology
Hauz Khas, New Delhi 110016, India
Phone: 91-11-26596361, 26858703
Fax: 91-11-26858703, 26851169
Email: mahesh@cbme.iitd.ernet.in
www.iitd.ac.in/tripp