



Bus Rapid Transit - Delhi

The Government of Delhi plans to provide over a hundred kilometres of Bus Rapid Transit facilities to the citizens of Delhi within the next five years. The design details of the first corridor have been completed jointly by the Transportation Research and Injury Prevention Programme of the Indian Institute of Technology Delhi (TRIPP) and RITES Delhi.

In order to ensure that the designs prepared by the RITES/TRIPP team conform to international best practices, the Transport Department of the Government of Delhi sponsored a Workshop on Bus Rapid Transit – Delhi on 12-13 December 2005, with the following objectives:

- ▶The designs should be suitable for special conditions obtaining in Delhi.
- ▶The designs should have the approval in principle of all the stakeholders in Delhi.

The invitees to the workshop included the following:

- Foreign experts.
- Professionals from universities and research institutions.
- Administrators from departments dealing with transport planning and operations, infrastructure building agencies, policy planning and law enforcement agencies.
- Consulting companies.
- NGOs.
- Bus manufacturers.

Some observations of the invited experts are reproduced below:

“We in European cities, who make all efforts to improve the quality of life by supporting walking, cycling and public transport, cannot understand, why mayors in the developing countries still invest so much into car traffic, which deteriorate the quality of urban life and urban economy”

Professor Hermann Knoflacher (Technical University of Vienna)

“When land uses are not matched to transit, the result is often inconvenient for pedestrians – and transit is about pedestrians.”

“The vehicle exterior is ultimately less an issue than is: the interior design, the station experience, the right-of-way environment, and the total door-to-door trip.”

“Bus Rapid Transit projects can help reshape Delhi, creating wealth and opportunity for residents of all economic levels.”

“Bus Rapid Transit isn’t just the poor man’s rail system ... It allows you to do things you just can’t do with rail systems.”

“Station platforms and footpaths are your one opportunity to create space for people. It is more important to create adequate space for people than adequate space for automobiles.”

Alan Hoffman (Director, The Mission Group, USA)

“Use Flexibility of BRT. You do not have to use a uniform approach. Cross section can vary. Can have mixed traffic along certain sections”.

“To be a long term success, you need to attract all classes: High quality vehicles. Effective control systems. Passenger information systems.”

Mr. Lee S. Sims (Director IBI Group, Canada)

The following observations and conclusions were adopted by the participants by consensus:

OBSERVATIONS

- Global cities of the 21st century are reprogramming road space for more effective and broader purposes.
- This implies a clear priority for pedestrians, non-motorized transport and public transit.
- Road based public transport provides the most effective connectivity for a majority of city residents.
- Details matter. It is essential not to cut corners in the planning and implementation of the BRT system – institutional, technology, route planning, network planning, operations, and financial resources.
- This is the first step of a network strategy – just like in computer systems the power is in the efficiency of the network system. People throughput matters, not vehicle throughput.
- It does not matter how many vehicle lanes there are or the total road width. What matters is the effective width available for vehicles. The proposed cross section by eliminating the choke points increases the effective width available.

RECOMMENDATIONS

Cross-section design

- The cross section designs of the corridor have been worked out in great detail, with international practice adapted to local needs. Some more attention needs to be given to pedestrian approach, crossing and circulation in stations.
- Asphalt paving runs the risk of rutting with high flows of heavy buses. Surface materials should be chosen carefully.

Intersection design

- Continued planning of BRT stations and configurations should minimise difficulties of pedestrian circulation and passenger transfer. This implies that stations should be as close to intersections as possible.
- Transit stations should be located in the heart of their target service areas.

Passenger information systems

- There are plans for introducing passenger information systems. However, the present plans do not give enough importance to include ITS applications right from the beginning. This should take advantage of the excellent expertise available in India.

Corridor

- Extension of the corridor from Delhi Gate to ISBT is an opportunity to revitalise and restore this globally unique and valuable historic site as well as a transportation need.
- The BRT can be configured to complement other modes even in the same corridor.
- BRT is a very flexible technology in terms of cross section and configuration. Maximum advantage should be taken of this flexibility in future network planning. Upgrades can be phased.
- You need to develop the institutional and operational frameworks NOW, not later, to best ensure successful implementation.



Prof. H Knoflacher Mr. Lee Sims Mr. Alan Hoffman

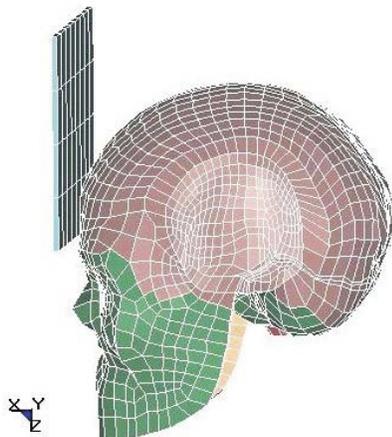
The Transportation Research and Injury Prevention Programme (TRIPP) at the Indian Institute of Technology Delhi, is an interdisciplinary programme focussing on the reduction of adverse health effects of road transport. TRIPP attempts to integrate all issues concerned with transportation in order to promote 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.



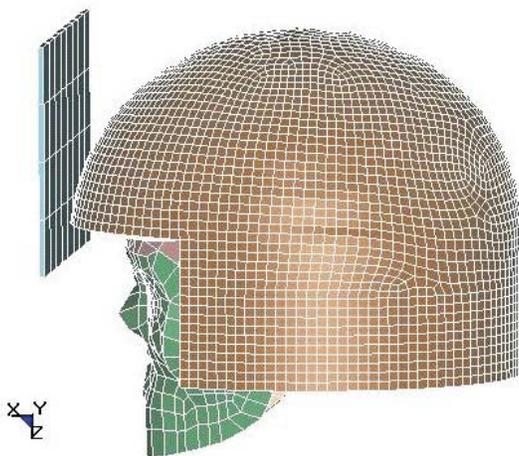
Safer Helmet Design

Puneet Mahajan

Puneet Mahajan is professor in the Department of Applied Mechanics at the Indian Institute of Technology, Delhi. His current research interests include the mechanical behavior of composites and foams, the mechanics of snow, the finite element method, helmet modelling and tractor vibrations.



Finite Element model of head impact with flat rigid surface



Finite Element model of helmeted-head impact with flat rigid surface

Why did you choose to work on helmets?

It would be incorrect to ascribe any social reasons for this. As it happened, I started work on helmets several years back. Some of my senior students chose to work in this field; and so as often happens in our discipline, the shared interests of students and supervisors map the parameters of certain research projects. Also, the subject presents an interesting area of exploration. The head is vulnerable to injury. It is particularly susceptible to acceleration/deceleration and rotational forces because it is freely mobile in three dimensions and occupies a relatively unstable position, being secured only by the neck muscles and ligaments. The protective advantages of wearing a helmet at the moment of direct impact are well documented and the risk of head and brain injury is decreased by seventy to eighty eight percent.

It has been a long slow road from the early drop tests to the numerical simulations which study how the use of the helmet attenuates the injury to the head. Then there was the use of a Finit Element techniques to simulate impact conditions during the drop test. FE is also commonly used to model the head. Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) have been used to generate geometrical data in digital format for the model of the head. This, in brief, is how research in this field has grown and contributed to safety in the manufacture of helmets.

What, in your personal opinion, is the technical/scientific excitement in this area of research?

In the course of my work over the years on composites and the impact of composites, new areas of research present themselves continuously; the very process of modeling and testing itself changes and gains in scientific accuracy as we have seen. Then again, the materials involved in the making of the helmet present one with a great challenge.

It is contra-intuitive and therefore not generally understood that the inner foam liner in the helmet is the main energy absorbing component, which decreases the severity of the injury to the head during impact by reducing its deceleration. The higher the density of the foam, the greater will be the energy absorbed; but this will be accompanied by a higher force on the head. Low density foam may reduce the force on the head initially but will crush very fast and bottom-out unless the thickness is substantial. The optimum density and thickness of the inner liner are therefore, important constituents of helmet design. For the purposes of our experiments, the liner foam is assumed to be isotropic and modeled using an associative elasto-plastic constitutive law. Personally, I find these aspects of material science of absorbing interest and so do a number of my senior students, whose research work provides further food for thought.

What technical areas does this work touch upon and what are its social applications?

This kind of research work and experimentation will naturally take in several areas of study. The inner liner is generally made of expanded polystyrene (EPS) although materials such as expanded polypropylene have also been suggested. The outer shell, whose main role is to prevent penetration by sharp objects, is made from polymers reinforced with fibers (glass, carbon or kevlar) or thermoplastics like ABS or polycarbonates. Even metallic foam can probably be used in the manufacture of the outershell. In the Finite Element analysis the shell is assumed to be made of glass fibre reinforced with plastic and modeled as an homogeneous, isotropic and elastic material. The human head is a layered structure that contains seven parts. Skin, face, cranium, cerebro-spinal fluid (CSF), brain, tentorium and falx. These, and several other technical/scientific aspects, like the visco-elastic properties of the brain are studied in concert with each other.

Its social applications are very wide. In sports, helmets are used in skiing, skating, cycling, cricket, baseball, ice-hockey, etc; they are also used by cyclists and motorized two-wheelers like scooters, motorcycles, etc; in construction sites and industry it is used by workers. In such a study, we need to know how many helmet users secure their straps properly? Also, how many disengage their helmet straps because the helmets are not well-ventilated. Would better ventilation of the outer shell increase helmet strapping? These and other such questions have to be answered if we are to end up with a light, small, well-strapped and well-ventilated helmet that does not sacrifice safety or comfort.

Helmet Facts

According to the World Report on Road Traffic Injury Prevention (www.who.int/violence_injury_prevention) helmets are the principal countermeasure for reducing crash-related head injuries, the leading cause of death among unhelmeted two-wheeler riders. The risk of death for motorized two-wheeler riders is reported to be 20 times that of car occupants. Motorcycles often have excessive performance capabilities, including especially rapid acceleration and high top speeds. They're less stable than cars in emergency braking and less visible. Motorcyclists are more prone to crash injuries than car drivers because motorcycles are unenclosed, leaving the rider vulnerable to contact with hard road surfaces, other vehicles and objects. This is why wearing a helmet is so important.

Effectiveness

Helmets decrease the severity of injury, the likelihood of death, and the overall cost of medical care. They're designed to cushion and protect riders' heads from the impact of a crash. Just like safety belts in cars, helmets can't provide total protection against head injury or death, but they do reduce the incidence of both. Research studies indicate that helmets reduce the risk of death in a motorcycle crash by 30-50 percent. Helmets are even more effective in preventing brain injuries, which often require extensive treatment and may result in lifelong disability. Studies show unhelmeted motorcyclists are three times more likely to suffer traumatic brain injuries in a crash than helmeted riders. A study of crash victims done by IIT Delhi and All India Institute of Medical Sciences showed that use of any helmet with padding is better than no helmet.

Neck injuries

A study reported in the *Annals of Emergency Medicine* in 1994 analyzed 1,153 motorcycle crashes in four midwestern states in USA and determined that "helmets reduce head injuries without an increased occurrence of spinal injuries in motorcycle trauma." A study by D. Mohan et al showed that use of helmets reduces the forces to the neck during an impact and so it can be concluded that helmets are beneficial, not harmful. There is no evidence from the thousands of crashes investigated around the world that straps contribute to strangulations. Dr J. Newman, an expert in helmet design, in his investigation of a large number of motorcycle crashes in Canada, did not find a single case where the helmet contributed to neck injury. Similar results have been reported from studies in USA and Delhi. In any case, helmeted riders often survive to complain of neck pains, unhelmeted riders don't.

Speed

Helmets are particularly effective at lower speeds and this is important as severe head injuries can be caused in impacts at 20-30 km/h. It is erroneously believed that helmets are not necessary at low speeds. Dr. R. G. Snyder, of the University of Michigan, USA, showed in a study of free falling humans that even speeds as low as 17 km/h can result in serious head injury and death. It is precisely at such low speeds that helmets can be most effective.

Vision

Helmets do not restrict vision any more than many eye glasses do. Studies show that full-coverage helmets provide only minor restrictions in horizontal peripheral vision -- less than 3 percent from that of an unhelmeted rider. A special study on effect of helmets on rider vision states that wearing helmets "restricts neither the ability to hear horn signals nor the likelihood of visually detecting a vehicle in an adjacent lane prior to initiating a lane change." To compensate for any restrictions in lateral vision, riders increased their head rotation prior to a lane change. Most helmets restrict peripheral vision by less than 5 per cent, much less than spectacle frames and goggles. Also, almost 75 per cent of all crash hazards have been estimated to lie within 45 degrees of either side of straight-ahead.

Hearing

Subjects in the hearing study showed no differences in hearing thresholds under three helmet conditions: no helmet, partial coverage, and full coverage. The noise generated by a motorcycle is such that any reduction in hearing capability that may result from wearing a helmet is inconsequential. Sounds loud enough to be heard above the engine can be heard within a helmet, a NHTSA study concluded. The helmet may reduce the loudness of sounds, but it reduced all ambient noise proportionately. In any case, even without the helmet, a motorcycle rider hears only those sounds which are louder than the noise of his motorcycle. So, as long as the rider can hear her motorcycle, she can hear all the sounds she would hear without the helmet.

Law

Without a helmet law less than 20% of motorcyclists wear helmets in India. Helmet use is near 90-100 percent when a law requiring all motorcyclists to wear helmets is implemented. In India, in the states that either reinstated or enacted a motorcycle helmet law in the past decade, helmet use has dramatically increased, and motorcyclist deaths and injuries have decreased. Similar experiences have been documented abroad. California's helmet use law covering all riders took effect January 1, 1992 and helmet use jumped to 99 percent from about 50 percent prior to the law. During the same period, the number of motorcycle fatalities decreased 38 percent. Nebraska reinstated a helmet law January 1, 1989 after repealing an earlier law in 1977. As a result, the state saw a 20 percent reduction in motorcyclist head injuries. A study done at National Institute of Mental Health and Neurosciences (NIMHANS) Bangalore showed that deaths and injuries were significantly less when Bangalore had a compulsory helmet law than when it did not. Courts have repeatedly upheld motorcycle helmet use laws around the world. In 1972 a federal court in Massachusetts told a cyclist who objected to the law: "The public has an interest in minimizing the resources directly involved. From the moment of injury, society picks the person up off the highway; delivers him to a municipal hospital and municipal doctors; provides him with unemployment compensation if, after recovery, he cannot replace his lost job; and, if the injury causes permanent disability, may assume responsibility for his and his family's subsistence. We do not understand a state of mind that permits plaintiff to think that only he himself is concerned." This decision was affirmed by the US Supreme Court. The Andhra Pradesh High Court in *T. Jagdish vs Union Of India* (1988) 2TAC (350) ruled that the law requiring the use of helmets does not violate any constitutional provisions.

The following statement in support of motorcycle helmet laws was developed by the Sub-committee on Injury Prevention and Control of the Committee on Trauma of the American College of Surgeons:

Total care of the trauma patient includes endorsement of measures designed to prevent injuries. Regarding the use of motorcycle helmets, the American College of Surgeons recognizes that:

- Helmeted motorcycle riders have up to an 85 percent reduced incidence of severe, serious, and critical brain injuries compared with unhelmeted riders.
- Unhelmeted motorcyclists are over three times as likely to suffer a brain injury when compared with helmeted motorcyclists.
- The average inpatient care costs for motorcyclists who sustain a brain injury are more than twice the costs incurred by hospitalized motorcyclists without brain injury.
- A large portion of the economic burden of motorcycle crashes is borne by the public.
- In states with universal helmet use laws, helmet use is close to 100 percent.
- When universal helmet use laws are enacted, helmet use increases and fatalities and serious injuries decrease.
- When universal helmet use laws are repealed, helmet use decreases and injuries and associate costs increase. Therefore, the American College of Surgeons supports efforts to enact and sustain universal helmet laws for motorcycle riders.

Mid Term Review

The shared vision of researchers at the Transportation Research and Injury Prevention Programme (TRIPP) at the Indian Institute of Technology Delhi is to produce knowledge on future urban transport systems that addresses the unique issues of less motorised countries in general and India in particular. Sustainable growth of urban areas requires an integrated interdisciplinary approach which incorporates their special needs. The professionals at TRIPP are involved in a system of research that responds dynamically to include a heterogeneous set of practitioners collaborating on problems defined in localised contexts but integrating international concerns in a consistent format. Systems have been set up for local knowledge producing mechanisms that aid researchers in responding to the demands of society.

In recognition of this work, the Volvo Research and Educational Foundations (VREF) Sweden awarded TRIPP their first International Centre of Excellence grant in 2003 for work on complexity of urban transport problems with special reference to Sustainable Urban Transport in Less Motorised Countries for a period of 5 years. A mid-term review of this work was held at TRIPP on 7-8 November 2005. Dr. Arne Wittlov, Chairman of the Board (VREF) and Professor Bengt Kasemo (Chalmers University of Technology, Gothenburg) Chairman of the Scientific Council conducted the review. Members of the Scientific Advisory Committee of TRIPP, Professor Roddam Narasimhan (Chairman of the Engineering Mechanics Unit, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore), Dr. V. Sumantran (Former Executive Director Tata Motors) and Professor S. N. Maheshwari (IIT Delhi) also attended the proceedings.

Professor Surendra Prasad, Director IIT Delhi, opened the proceedings with a welcome address and then the visitors had discussions with all the faculty members, administrators, students and

The discussions included the following presentations:

Sustainable Transport Planning	-	Geetam Tiwari
Traffic and Delhi Air Quality	-	Sanjeev Sanghi
Air Flow in Buses	-	Sunil Kale
Stakeholder Participation in Urban Planning	-	Dunu Roy
Future of Non-motorised Transport	-	Rajendra Ravi
Three-wheeler Safety and Human Tissue Properties	-	Sudipto Mukherjee
Crash Modelling and Motorcycle Safety	-	Anoop Chawla
Optimising Helmets	-	Puneet Mahajan
Pre-hospital Care	-	Mathew Varghese
Safety and Sustainable Transport	-	Dinesh Mohan



News

Inaccuracy in traffic forecasts

A recent study shows that despite the enormous sums of money being spent on transportation infrastructure, surprisingly little systematic knowledge exists about the costs, benefits and risks involved. This study examined the largest sample of its kind, covering 210 projects in 14 nations worth US\$58 billion. The study shows with very high statistical significance that forecasters generally do a poor job of estimating the demand for transportation infrastructure projects. The result is substantial downside financial and economic risk. Forecasts have not become more accurate over the 30-year period studied. If techniques and skills for arriving at accurate demand forecasts have improved over time, as often claimed by forecasters, this does not show in the data. For nine out of ten rail projects, passenger forecasts are overestimated; average overestimation is 106%. For 72% of rail projects, forecasts are overestimated by more than two-thirds. For 50% of road projects, the difference between actual and forecasted traffic is more than $\pm 20\%$; for 25% of road projects, the difference is larger than $\pm 40\%$. Forecasts for roads are more accurate and more balanced than for rail, with no significant difference between the frequency of inflated versus deflated forecasts. But for both rail and road projects, the risk is substantial that demand forecasts are incorrect by a large margin. The causes of inaccuracy in forecasts are different for rail and road projects, with political causes playing a larger role for rail than for road. The cure is more accountability and reference class forecasting. Highly inaccurate traffic forecasts combined with large standard deviations translate into large financial and economic risks. But such risks are typically ignored or downplayed by planners and decision-makers, to the detriment of social and economic welfare. The paper presents the data and approach with which planners may begin valid and reliable risk assessment.

Inaccuracy in traffic forecasts. Bent Flyvbjerg, Mette K. Skamris Holm and Soren L. Buhl, Transport Reviews, Vol. 26, No. 1, 1-24, January 2006.

International Course

The Transportation Research and Injury Prevention Programme (TRIPP) at the Indian Institute of Technology, Delhi organized a seven day International Course on Transportation Planning and Safety from 05-11 December 2005 at the Indian Institute of Technology Delhi. The course was co-sponsored by the Volvo Research and Education Foundations, World Health Organisation, Shell India Ltd. and the Ministry of Road Transport and Highways. The course (an annual feature for the last 15 years), was attended by 47 participants from 10 countries. The faculty members included Anoop Chawla (IIT Delhi), Dinesh Mohan (IIT Delhi), Geetam Tiwari (IIT Delhi), G. Gururaj (NIMHANS, India) Hermann Knoflacher (Technical University of Vienna), Janusz Kajzer (Chalmers University, Sweden), Martin van Maarseveen (University of Twente, The Netherlands), Mathew Varghese (St. Stephen's Hospital, Delhi), Nicole Muhrad (INRETS, France), Shrikant Bangdiwala (University of North Carolina, USA), Sudipto Mukherjee (IIT Delhi) and Sylvain Lassarre (INRETS, France).



International Course on Transportation Planning and Safety
05-11 December 2005

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CONFER, India: TRIPP Chair for Transportation Planning

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