Improving Vehicle Crashworthiness - The Need for Real World Accident Data

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In recent times, the European Union has re-focussed it's research efforts and funding toward active safety, as a means to address the road traffic injury problem. But the truth is that there is still considerable scope to improve passive safety or vehicle crashworthiness. Although the prevention of crashes holds great potential for traffic safety, in reality, the value of active safety technology in reducing the number of accidents is yet to be substantiated. For example, the effectiveness of ESC varies widely from study to study, while studies of the efficacy of ABS are still inconclusive. Even though many active safety features can be realised with current technology, important factors needing further research concern limitations of human adaptation to new systems and the acceptability of the driver to relinquish control over the vehicle. Therefore, there remain large benefits to be gained from improving vehicle crashworthiness that may not be obtainable from active safety systems in the same timescale. In highly motorised societies, car occupants are still the most commonly injured road users. In the EU, for example, 56% of fatalities are car occupants, with corresponding values of 48% for the U.S and 27% for Japan. Importantly, for less motorised societies, there is good reason to expect that the contribution of car occupants to the injury toll will only increase as motorisation advances.

Regulation crash testing was first introduced in the U.S. in the late 1960's to ensure manufacturer's compliance to a minimum standard of crashworthiness. The rest of the motorised world quickly followed and there have been various new test configurations added in the past 30 years. There is little doubt that vehicles have become safer with each successive generation of tests and the introduction of consumer crash testing, like NCAP, has also driven up levels of safety. The fact of the matter is, however, that people are still injured in car crashes, often at crash severities well below the levels at which vehicles are tested and approved. This is because crashworthiness systems engineered to protect humans in specific crash test conditions do not always adequately cover the wider range of conditions surrounding real crashes.

Real-world crashes show considerable variability in terms of the casualties involved, the characteristics of the vehicles and the crash configuration and there are many questions still to be addressed if we are to make vehicles safer. Real occupants do not, for example sit in the same posture as dummies, they are also of varying weight and height and these factors pose special challenges for single point restraint systems. The injury assessment criteria for crash tests are generally single point such as a HIC of 1000 or a maximum chest acceleration of 60g, whereas real occupants have a wider variation in injury tolerance. Children's tolerance to injury for example is still not well understood because of their different physiology to adults and in older humans, injury tolerance drops away rapidly so that the load deemed acceptable by regulation may well cause serious injury to an older person. This situation is compounded by the fact that people are now living and driving longer.

Car occupants also often sit in positions where standard restraints are less effective so for example the safety of non-struck side occupants as well as rear seat occupants still needs to be addressed. The need for a thorough understanding of the non-struck side occupant situation is paramount if we are to adequately protect them and the limits of protection for rear seat occupants remain to be explored. Indeed, there is some evidence to suggest that the injury risk for rear seat occupants has increased in recent years commensurate with the increase in vehicle front end stiffness.

In terms of crash configuration there are a number of factors which still need to be understood and addressed. The effects of structural geometry, stiffness and mass differences between collision partners is important to consider for both structural and restraint design. These so-called compatibility issues can have a significant effect on the safety of vehicles which are essentially optimised to pass crash tests that mimic impact to a vehicle of similar mass. Occupant protection in rollover crashes still needs further attention and side impact protection, though improved, is still a major challenge for engineering safety design. Side impact is currently on a par with frontal crashes in contributing to fatal occupant injury.

Virtual testing, in addition to crash tests, will soon offer the possibility to extend occupant protection assessments to a wider range of crash conditions and provide a better prediction of injury outcome to that which can be made with dummies alone. Currently, there are limitations concerning how well dummies can predict certain injury types. Brain injuries, whiplash injuries and injuries to vascular organs (such as the liver, spleen and aorta) are but some examples. It is anticipated that humanoid models will be used to improve the protection offered to real people, bypassing the approximations imposed by the use of crash test dummies and considerable benefit is expected once specific real-world collisions can be simulated. This will allow the precise loading conditions on the body to be estimated and the derivation of real-world injury risk curves for a wider cross section of the population. Before this can be done however, there is a need for improved information concerning the specific mechanisms of injury in car crashes and for more specific engineering information concerning the related loads imposed on the human frame. Soon, Event Data Recorder technologies ("black boxes") should routinely provide that improved engineering information about the crash phase (e.g., crash pulse, airbag deployment, seat belt use, pre-crash conditions).

A prerequisite to engineering design for real crashes is rigorously collected and detailed real-world crash injury data that can be used to specify performance requirements of future safety systems and to provide feedback for those already in use. In-depth crash injury studies can help to assess second generation safety systems by giving a measure of their effectiveness and by pinpointing areas where the system may be limited or actually cause injury. Such studies can also be used to update crash testing programs. For example, many new cars gain 5 stars in the EuroNCAP rating and there will eventually be a need to modify the program to ensure continued improved safety. Real world data will provide an important input to this procedure. One of the recent developments in passive safety concerns the engineering of SMART restraint systems that can cope with some of the real world variability that has already been discussed. In order to be effective, SMART systems need to know how and when to deploy. That in turn relies on a knowledge of the crash conditions and occupant variables related to injury risk in a modern car. Such information can only be gleaned from a study of real world crashes.