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# Technical Session 1.1

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## Biomechanics: Injury Criteria and Dummy Development

Oral Presentations

Tuesday, June 5, 2001

9:00 a.m. - 12:30 p.m.

*Chairperson:* Rolf Eppinger, United States  
Auditorium

### Submission ID 492-O

#### **IHRA - International Harmonized Research Activities (IHRA) Status Report of the Biomechanics Working Group**

R. Eppinger  
National Highway Traffic Safety Administration  
United States

#### *Abstract*

A summary of the efforts of the Biomechanics Working Group to complete the task given to it by the International Harmonized Research Activities Steering Committee to determine specifications for a Universal Side Impact Anthropomorphic Test Devices is presented. Topics discussed are the nature of the world side impact problem, the anthropometric characterization of the world population at risk, dummy impact response specifications, and necessary and appropriate injury criteria and performance levels.

### Submission ID 486-O

#### **Evaluation of the ES -2 Dummy in Representative Side Impacts**

R. Radwan Samaha, M.  
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National Highway Traffic Safety Administration  
United States  
J. Bolte  
Transportation Research Center  
United States

#### *Abstract*

ES-2, the recent upgrade of Eurosid-1, was developed to address dummy response issues raised by industry and governmental bodies, in particular, the flat-top anomaly in the Eurosid-1 rib deflections. NHTSA is evaluating the ES-2 to assess its suitability for adoption in FMVSS 214 as an interim harmonized dummy. This study presents results from high mass impactor tests, and full scale side impact tests per EU 96/EC/27, FMVSS No. 214, and U.S. Side NCAP procedures. The study also presents results from biofidelity assessment tests of ES-2 relative to SID/H3, in comparison with recent cadaveric sled tests performed under similar conditions.

**Submission ID 409-O**

**Design and Evaluation of the WorldSID Prototype Dummy**

R. Scherer  
Ford Motor Company  
United States  
D. Cessari  
INRETS  
France  
T. Uchimura  
Nissan Motor Co.  
Japan

***Abstract***

This paper will provide the design requirements for the WorldSID dummy and a description of each of the critical body regions and how they fulfilled the design requirements. The biomechanical targets used for the design of the dummy will be included in this paper and a preliminary evaluation of the WorldSID's performance to these targets will be presented. An explanation of the unique instrumentation and in-dummy DAS will also be included.

**Submission ID 336-O**

**Development and Evaluation of the ES -2 Side Impact Dummy**

M. Ratingen  
EEVC WG12  
Netherlands

***Abstract***

This paper will present the design enhancements of the existing European side impact dummy which have been introduced to better assess the protection offered to car occupants and to make it acceptable for application in other standards in the world as an intermediate harmonisation solution. Results of evaluations of the new dummy are given that include an assessment of biofidelity, verification of certification specifications, a sensitivity study and the assessment of performance in European and federal full scale test conditions.

**Submission ID 264-O**

**Improved Side Impact Protection: Development of Injury Assessment Functions**

T. Gibson, E. Benetatos  
Human Impact Engineering  
Australia  
B. Fildes  
Monash University Accident Research Centre  
Australia

***Abstract***

This paper describes the development of a set of Injury Assessment Functions for lateral impact from the analysis of cadaver test data. The IAFs form the link between the performance of the vehicle safety system in a side impact and the cost of injury to the occupant. To allow design optimisation on the basis of harm.

**Submission ID 195-O**

**Upper Extremity Interaction with a Side Air Bag: The Effect of a Door Handgrip**

B. Boggess, J. Crandall  
University of Virginia  
United States  
S. Duma  
Virginia Tech  
United States

***Abstract***

The interaction of the small female upper extremity with a door handgrip during side air bag deployment was investigated by utilizing computer simulations, dummy experiments with a new enhanced upper extremity, and small female cadaver experiments. A multivariate logistic regression analysis was performed to investigate the correlation between observed injuries and measured occupant response, as well as the effects of cadaver age and bone mineral content.

**Submission ID 141-O**

**Body part study from real life accidents for a new SID (Side Impact Dummy)**

T. Kreuzinger, S. Knack  
Bundesanstalt fuer Strassenwesen (Federal Highway Research Institute)  
Germany

***Abstract***

This paper describes how a body part study of real life accidents in France, Great Britain, Sweden and Germany has been carried out within the project SID2000. During the analysis, the body parts most often injured were ascertained and the severity of the injuries was taken into account. The sensoric equipment most necessary for the planned dummy was determined in order to suit the real life requirements.

**Submission ID 474-O**

**Dynamic response analysis of the THOR-LX dummy lower extremity**

M. Ito, T. Gotor, K. Ono  
Japan Automobile Research Institute  
Japan

***Abstract***

Regarding THOR-LX for next generation dummy lower extremities, we have conducted a series of tests as follows. HYGE sled tests with simulating intrusion into the vehicle compartment around the occupant feet, dummy dropping tests with two different postures; one is the upright posture with the knees set straight and another is the posture with the knees bent, in order to apply impact loads and to measure/evaluate the impact response characteristics.

**Submission ID 456-O**

**Lower Extremity Response and Trauma Assessment using the Thor-Lx Hybrid III Retrofit and the Denton Hybrid III Leg in Frontal Offset Vehicle Crashes**

S. Kuppa, M. Haffner, R.  
Eppinger  
National Highway Traffic Safety Administration  
United States

***Abstract***

The response of the Thor-Lx Hybrid III retrofit and the Denton Hybrid III leg were compared and evaluated in frontal offset vehicle crash test environment. Injury assessments for the leg-foot/ankle complex in these tests were made using newly developed injury criteria.

**Submission ID 457-O**

**Lower Extremity Injuries and Associated Injury Criteria**

S. Kuppa, R. Eppinger, J.  
Wang  
National Highway Traffic Safety Administration  
United States

***Abstract***

Prediction of fatality risk was made using common types of high severity injuries and combination of these injuries sustained along with the age and gender of the subject. The fatality risk obtained in this manner was compared to the risk obtained using the two highest AIS level injuries.

**Submission ID 355-O**

**A Tibial Mid-Shaft Injury Mechanism in Frontal Automotive Crashes**

K. Yang  
Bioengineering Center Wayne State Univ.  
United States  
A. Tamura  
Toyota Central R&D Labs  
United States  
K. Miki  
Toyota Central R&D Labs  
Japan

***Abstract***

This study is based on a finite element model of the human lower extremity that has been previously developed and validated against published data obtained from quasi-static and dynamic tests. The predictions of this mathematical model indicate that increasing footwell intrusion and velocity change has a combined effect on the tibia, which is constrained proximally by the occupants of inertia and the instrumental panel.

**Submission ID 318-O**

**Requirements for the Evaluation of the Risk of Injury to the Ankle in Car Impact**

C. Owen, R. Lowne  
TRL Ltd  
United Kingdom  
J. McMaster  
University of Nottingham  
United Kingdom

***Abstract***

Lower leg injuries contribute significantly to the societal costs of injuries to car occupants in frontal impacts. To make sound assessment of the risk of such injuries in cars, a biofidelic dummy leg and the injury risk functions in terms of parameters measured on this leg must be available. This paper reports an overview of the biofidelity of existing dummy legs and the results of injury creation tests performed to provide better understanding of the injury mechanisms and injury risks.

**Submission ID 237-O**

**The Effect of Active Muscle Tension on the Axial Injury Tolerance of the Human Foot/Ankle Complex**

J. Funk, J. Crandall, L.  
Tourret  
University of Virginia Automobile Safety Laboratory  
United States

***Abstract***

Blunt axial impact tests were performed on 44 isolated lower limbs in order to assess the injury tolerance of the foot/ankle complex to axial loading. Muscle tension due to pre-impact bracing was simulated in half the tests by experimentally generating 1.5 kN of tension in the Achilles tendon. A closed-form survivor function was developed that relates the risk of foot/ankle fracture to axial tibia force as a function of specimen age, gender, mass, and level of Achilles tension.

**Submission ID 105-O**

**Response and Vulnerability of the Ankle Joint in Simulated Footwell Intrusion Experiments – A Study with Cadavers and Dummies**

D. Kallieris, H. Riedl, R.  
Mattern  
Institute of Legal Medicine and Traffic Medicine, University of Heidelberg  
Germany

***Abstract***

To develop methods to prevent ankle joint injuries, tests under controlled conditions are needed. Results from frontal collisions with belt restrained cadavers and dummies using instrumented lower extremities and simulated footwell intrusion are described. The most important injury mechanism is ankle dorsiflexion which results in cartilage contusion and shearing off of the talus and the tibia. Fractures of the medial and lateral malleoli were observed.

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## Technical Session 2

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### Advanced Technology Safety Systems (Active, Passive Safety/Collision Avoidance)

**Tuesday, June 5, 2001**

9:00 a.m. - 12:30 p.m.

**Chairperson:** Bernd Friedel, Germany  
Room A

**Submission ID 478-O**

**Active Night Vision - Enhancement of the Drivers View by Infrared Headlamps**

M. Burg, K. Eichhorn  
Hella KG Hueck & Co.  
Germany

**Abstract**

Near Infrared Headlamps, which use a spectral range from 780 to appr. 1200 nm wavelength, can be used to "illuminate" the road with a permanent high beam pattern. As this cannot be seen by the human eye, it won't produce any glare, but a camera is needed to detect the IR-Image of the road. Furthermore, the image has to be displayed to the driver.

**Submission ID 327-O**

**Potential effectiveness of Electronic Stability Programs (ESP) - What European field studies tell us**

R. Sferco  
Ford Motor Company  
Germany  
P. Fay  
Ford Motor Company  
United Kingdom  
Y. Page  
LAB PSA Peugeot Citroen - Renault  
France

**Abstract**

This paper describes an a priori evaluation of the potential effectiveness that could be provided by ESP if it was installed on all cars in Europe. This evaluation is based on the data from the European Accident Causation Survey (or "EACS") database which contains in-depth information about 1,674 accidents occurring in 5 European countries from 1995 to 1999.

Analysis of the detailed EACS data shows that in approximately 18% of all accidents, ESP would have a certain influence reducing the likelihood of an accident or would avoid the accident altogether.

**Submission ID 300-O**

**How soon to brake and how hard to brake: unified analysis of the envelope of opportunity for rear -end collision warnings**

B. Wilson  
Volpe National Transportation Systems Center  
United States

***Abstract***

The development, analysis, and evaluation of rear-end collision warning systems requires considering the envelope of opportunity available to a driver, once an alert issued, to avoid a collision. This paper develops methods for synthesizing this envelope from kinematic variables and indicates the advantages of plotting reaction time versus the reciprocal of the deceleration.

**Submission ID 346-O**

**Scenario Definition and Control for the NADS**

Y. Papelis, O. Ahmad, M.  
Schikore  
NADS, The University of Iowa  
United States

***Abstract***

This paper describes the architecture for the scenario definition and control software for the NADS.

**Submission ID 254-O**

**Unique Features and Capabilities of the NADS Motion System**

A. Clark, H. Sparks  
MTS Systems Corporation  
United States  
J. Carmein  
Solidica  
United States

***Abstract***

Developed by the U.S. National Highway Traffic Safety Administration, the NADS many unique capabilities, including the large excursion envelope and high performance motion system. MTS Systems Corporation was responsible for the manufacture and installation of the thirteen degree of freedom motion system driven by forty-five actuation channels. This paper discusses the real-time control and mechanical design technologies that support the high motion envelope capacity of the NADS, including representative performance data.

**Submission ID 175-O**

**Enhancing Post-Crash Vehicle Safety Through Automatic Collision Notification**

G. Preziotti  
Johns Hopkins University Applied Physics Laboratory  
United States  
J. Kianianthra, A. Carter  
National Highway Traffic Safety Administration  
United States

***Abstract***

Automatic Collision Notification (ACN) System applies advanced computer and communication technologies to notify appropriate authorities automatically when a motor vehicle crash occurs. Information regarding the type of crash, its location and other pertinent information are provided for the improvement of pre-hospital emergency care for motor vehicle crash victims. The National Highway Traffic Safety Administration (NHTSA), under the U.S. Department of Transportation's Intelligent Transportation System (ITS) research program, designed and developed an ACN system in partnership with Veridian Inc. NHTSA conducted an operational test of the system by installing it in several hundred volunteers' cars and collected data from vehicles involved in crashes. The data showed that it was technologically feasible for ACN systems to improve the timeliness and delivery of pre-hospital medical care of motor-vehicle crash victims.

**Submission ID 352-O**

**Development and Validation of the URGENCY Algorithm to Predict Compelling Injuries**

K. Digges  
The George Washington University  
United States  
S. Ogata  
University of Miami School of Medicine  
United States  
J. Augenstein  
William Lehman Injury Research Center  
United States

***Abstract***

The URGENCY algorithm uses data from on-board crash recorders to assist in identifying crashes that are most likely to have compelling injuries. This paper describes the basis for the URGENCY algorithm, and the retrospective application of the algorithm to the population of frontal crashes in the William Lehman Injury Research Center database. The ability of URGENCY to identify high-risk crashes is demonstrated. Recommendations for improvements are included.

**Submission ID 493-O**

**A Vision for an Integrated Safety Concept**

K. Baumann, J. Rainer, R.  
Schöneburg  
DaimlerChrysler AG  
Germany

***Abstract***

The early recognition of an accident will be the greatest challenge facing safety development in the years to come. Timely preparation for an imminent danger is a behavior demonstrated by nature and will lead to the introduction of new preventive-safety-systems.

**Submission ID 171-O**

**The development of a crashworthy system: Interactions between car structural integrity, restraint systems and guard-rails**

A. Ydenius, A. Kullgren  
Folksam Research  
Sweden

C. Tingvall  
Swedish National Road Administration and Monash University, Australia  
Australia

***Abstract***

In the development of a crashworthy system, the interaction between cars and guard-rails plays an important role to prevent frontal collisions with other vehicles and to avoid collisions with road side objects. This study presents results from 8 crash tests with identical vehicles into 4 types of guard-rails at 2 different test speeds, 80 and 110 km/h, and with 2 different impact angles, 45 and 20 degrees respectively. Large variations in car deformations were found. The airbags were only triggered in the rigid barrier types.

**Submission ID 94-O**

**Advanced Roof Design for Rollover Protection**

C. Nash  
George Washington University  
United States

D. Friedman  
MCR/LRI, Inc.  
United States

***Abstract***

Experimental evidence and rollover crash data show that contemporary light vehicle roof designs often contribute to severe head and neck injuries. We discuss deficiencies in contemporary roof design and in the Federal roof strength standard. Advanced technologies can provide adequate roof strength to protect occupants in most rollovers. We discuss an approach to a new dynamic roof strength test procedure that is based on the dynamics of rollovers and the latest biomechanics data on head and neck injury tolerance.

**Submission ID 71-O**

**Automated Crash Notification System via the Wireless Web: Design and Validation**

H. Gabler, J. DeFuria, J.  
Schmalzel  
Rowan University  
United States

***Abstract***

This paper discusses the design, testing, and field trials of a new approach to Automated Crash Notification which combines emerging low cost single chip / chip sets for wireless Web communication, GPS position location and crash detection for low cost Automated Crash Notification.

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# Technical Session 1.2

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## Biomechanics: Injury Criteria and Dummy Development

**Tuesday, June 5, 2001**

2:00 p.m. - 5:30 p.m.

*Chairperson:* Rolf Eppinger, United States  
Auditorium

**Submission ID 469-O**

**Hybrid III Dummy Neck Response to Air Bag Loading**

V. Agaram, J. Kang, G.  
Nusholtz  
Daimler Chrysler  
United States

***Abstract***

The paper describes the mechanics of the air bag - hybrid III neck interaction, based on experimental observations.

**Submission ID 242-O**

**A new test method for the assessment of neck injuries in rear -end collisions**

H. Cappon, M. Philippens  
TNO Automotive  
Netherlands  
J. Wismans  
TNO Automotive, Crash Safety Centre and Eindhoven University of Technology  
Netherlands

***Abstract***

The European Community has sponsored a 3-year research program aimed to develop e research tools and test procedures to improve the protection of car occupants in rear-end collisions. The research methodology includes: accident investigation, tests with human volunteers, crash dummy development, computer modelling and benchmarking of current seat designs.

In this presentation the most important results of this study will be summarised with special emphasis on a new crash dummy (RID2).

**Submission ID 196-O**

**Human Head-Neck Kinematic Response to Impact Acceleration: Comparison of Oblique to Combined Frontal and Lateral Response**

E. Kaminsky-Bourgeois  
Electrical Engineering Department-University of New Orleans  
United States  
S. Guccione, Jr.  
National Biodynamics Laboratory  
United States

***Abstract***

This paper relates human oblique head-neck kinematics to human frontal and lateral head-neck kinematics for seven subjects of varying anthropometry. Head-neck kinematic behavior for an oblique test is compared to the superposition of the head/neck behavior of appropriate frontal and lateral ("component") tests for the same subject. The results have important implications in terms of the complexity required in the design and validation of omni-directional biofidelic crash test manikins (e.g. THOR) and mathematical models of human head-neck response.

**Submission ID 116-O**

**A Comparison between BioRID and Hybrid III Head/Neck/Torso Response in Middle Speed Sled Rear Impact Tests**

T. Gotou, M. Ito, K. Ono  
Japan Automobile Research Institute  
Japan

***Abstract***

We compare the impact response of 2 types of dummies - BioRID P3 and Hybrid III - and human volunteers in rear impact tests ( $f\phi V=9.2\text{km/h}$ ), and BioRID and Hybrid III impact response in HYGED sled tests ( $f\phi V=15, 25\text{km/h}$ ). We deduced that the biofidelity of the BioRID P3 is higher than that of Hybrid III in rear impact tests under  $25\text{km/h}$ .

**Submission ID 459-O**

**SIMon; A Simulated Injury Monitor; Application to Head Injury Assessment**

A. Zhang, R. Tannous  
Conrad Technologies, Inc.  
United States  
F. Bandak  
National Highway Traffic Safety Administration  
United States

***Abstract***

Discussion of a fully transportable, computer based, finite element aided process that predicts injury risks by evaluating dummy responses.

**Submission ID 458-O****Foundations and Elements of the NHTSA THOR Alpha ATD Design**

N. Rangarajan  
GESAC, Inc.  
United States

M. Haffner, R. Eppinger  
National Highway Traffic Safety Administration  
United States

***Abstract***

The Thor ATD has undergone extensive test and evaluation on an international basis in cooperation with many partner institutions. This paper will summarize results from this broad test experience and will discuss current efforts toward the development of a small female version of the Thor ATD, which incorporates new performance and design features. Finally, complementary research efforts aimed at longer term Thor product improvement will be discussed, together with overall anticipated program schedule.

**Submission ID 411-O****Development of Performance Specifications for the Occupant Classification Anthropomorphic Test Device (OCATD)**

M. Reed, S. Ebert, L.  
Schneider  
The University of Michigan Transportation Research Institute (UMTRI)  
United States

***Abstract***

Seat surface pressure distributions of 68 women and children were measured to determine parameters of the pressure distributions that best predicted occupant body weight. Target values on these parameters were developed for each OCATD. The OCATDs produce pressure distributions that are in good agreement with these targets.

**Submission ID 155-O****Computer simulation of impact test and injury criteria analysis by using Sensitivity Analysis**

I. Ciglaric, I. Prebil, M.  
Ambroz  
University of Ljubljana, Faculty of mechanical engineering  
Slovenia

***Abstract***

Articulated multibody mechanical model of human body is used as a tool to investigate injury mechanism during a car crash event. Dynamic response of the proposed multibody system is calculated for two sets of human body mechanical parameters. First set of mechanical parameters is generated by GEBOD (GEnerator of BOdy Data from WPAFB), while the second one was obtained from measurements of human body parts conducted on real human corpses. Accordance of results between the two dynamic responses and some injury criteria corresponding to the two input data sets is discussed by using Sensitivity Analysis.

**Submission ID 114-O****Comparison of head and thorax cadaver and Hybrid III response to a frontal sled deceleration for the validation of a car occupant mathematical model**

P. Vezin, K. Bruyere, F.  
Bermond  
INRETS - LBMC  
France

***Abstract***

The response of cadaver and dummy were compared using frontal sled tests. Two types of force-limiting belt were used and the subject instrumentation included head and spinal accelerometers, autopsies were also performed. This research provided complementary information concerning human behavior that will be used as validation data for a numerical model of a driver. The comparison with the dummy indicates that improvements in the thoracic and head dummy response have to be made with new restraint systems.

**Submission ID 463-O****Development and Application of the New Pedestrian Dummy**

M. Shams, M. Artis, J. McDonald  
GESAC, Inc.  
United States

***Abstract***

This paper describes the design enhancements that have been made to the first version of the Polar pedestrian dummy. It also describes the results from vehicle testing with the new Polar II dummy.

**Submission ID 468-O****Extractions of Information From Noisy 3-Year -Old ATD Response Signals in Static Out-of-Position Airbag Tests**

L. Xu, G. Nusholtz, G.  
Kostyniuk  
Daimler Chrysler Corporation  
United States

***Abstract***

A comparison of the Q3 and Hybrid III 3-year old dummies is presented in this paper, based on their performance in seventy-seven static out-of-position airbag tests. Various time histories and other data pertaining to accelerations, deflections, forces, moments, as well as the repeatability of dummies responses are compared.

**Submission ID 294-O****Child Restraint System for Children in Cars - CREST Results**

X. Trosseille, F. Cassan  
LAB PSA Peugeot Citroen Renault  
France, Metropolitan  
M. Schrooten  
TNO Automotive  
Netherlands

***Abstract***

A European project, CREST, was created in 1996 to develop the knowledge on child behaviour and tolerances and to improve test procedures. The method used in this project was to collect data from accident investigations and from reconstruction crash tests in order to determine the physical parameters which correspond to the various child injury mechanisms. Main results from accident reconstructions are presented, allowing the evaluation of some injury criteria.

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## Technical Session 3

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### Worldwide NCAP Related to Existing Test Procedures

**Tuesday, June 5, 2001**

2:00 p.m. - 5:30 p.m.

*Chairperson:* Keith Rodgers, United Kingdom  
Room B

**Submission ID 390-O**

**The U.S. New Car Assessment Program (NCAP): Past, Present and Future**

L. Hershman  
National Highway Traffic Safety Administration  
United States

*Abstract*

This paper takes a strategic look at NHTSA's NCAP program, including a review of the program's history and a comparison with similar programs around the world. Pros and cons of different approaches are discussed, as well as proposed future plans for the U.S. NCAP program, including new test initiatives as well as expansion of existing tests, their relationship to safety issues in the U.S., and international harmonization efforts.

**Submission ID 485-O**

**Status Report and Future Development of the Euro NCAP Programme**

W. Klanner  
ADAC Technical Centre  
Germany

*Abstract*

Euro NCAP has prevailed as the uniform consumer protection crash test programme throughout Europe. It delivers information about occupant protection during frontal and side impact collision and about pedestrian protection. Since the start of the programme in 1996 nine test series have been conducted so far and a total of about 100 vehicle models have been analysed.

**Submission ID 215-O****JNCAP : Today and Tomorrow**

H. Ishikawa  
Japan Automobile Research Institute  
Japan  
S. Ohta  
Ministry of Land, Infrastructure and Transport  
Japan  
K. Wani  
National Organization of Automotive Safety and Victims' Aid  
Japan

***Abstract***

After five years of public release of safety information, Japanese new car assessment program entered into the next stage. Adding to the original full frontal crash, it had side crash in 1999, offset frontal crash and overall rating protocol in 2000. Child seat assessment is to be in 2001 and pedestrian safety in the near future. This is to report what JNCAP has done, what has been changed in vehicle safety in the last six years and what it is going to do in the next few years.

**Submission ID 129-O****Harmonisation of Australian NCAP with EuroNCAP - Lessons learnt**

J. Haley  
NRMA Insurance  
Australia  
M. Case  
RACV Limited  
Australia  
M. Paine  
VDR  
Australia

***Abstract***

Australian NCAP (ANCAP) began in 1992 with full frontal 56 km/h barrier tests and added the 40% offset deformable barrier test shortly afterwards. In 1999 ANCAP decided to harmonise its testing and evaluation procedures with EuroNCAP (ENCAP). This was so ANCAP could use the results of ENCAP testing on European vehicles where the vehicle specifications were essentially similar to those of the Australian model, thereby reducing the number and cost of tests required to produce consumer information.

**Submission ID 339-O****Euroncap: Views and Suggestions for Improvements**

F. Bendjellal  
Renault Safety Department  
France

***Abstract***

This paper discusses Euroncap assessment criteria in particular those related to frontal impact. There are 2 types of assessment criteria: dummy measurements and modifiers. The paper describes the problems posed by some of the modifiers and proposes ways to improve the system in terms of adults and child protection.

**Submission ID 143-O**

**Consumer Information - Worldwide Harmony?**

T. Terry  
General motors  
United States

***Abstract***

Consumers searching for information regarding particular vehicles are confronted with inconsistent and sometimes conflicting or confusing information. This paper attempts to establish common guidelines for the development of consumer information and suggests methods to coordinate this information globally.

**Submission ID 277-O**

**Comparison of Euro NCAP test results with Folksam car model safety ratings**

A. Kullgren  
Folksam Research  
Sweden  
C. Tingvall  
Swedish National Road Administration  
Sweden  
A. Lie  
Swedish National Road Administration and Karolinska Institutet  
Sweden

***Abstract***

Euro NCAP has since its start conducted around 100 tests to guide consumers and stimulate the use of best practice in car safety development. It is, however, important that the outcome of the program is evaluated by comparing the overall improvement of crash protection with real life experience. In this study, a comprehensive real life rating system was compared with EuroNCAP ratings. The overall correlation was satisfactory, but it was clear, that some common injuries were not reflected in Euro NCAP.

**Submission ID 319-O**

**Comparison of EuroNCAP Assessments with Injury Causation in Accidents**

A. Fails, R. Minton  
TRL Ltd  
United Kingdom

***Abstract***

In this analysis, body-region injury-risk ratings determined for consumers by Euro NCAP are examined from the perspective of real contemporary accidents. The aim is to compare the real-life experience of various occupants with the objective and subjective conclusions that are presented by Euro NCAP. The accident sample, of several car models, is taken from the Co-operative Crash Injury Study (CCIS), and is comprised of crashes similar to the impact tests.

**Submission ID 288-O**

**JNCAP: Developing Overall Rating Protocol**

K. Yamazaki  
Japan Automobile Research Institute  
Japan  
H. Tozawa  
Ministry of Land, Infrastructure and Transport  
Japan  
K. Ando  
Ministry of the Environment  
Japan

***Abstract***

Adding offset frontal crash in 2000, JNCAP now has full frontal, offset frontal and side crash for assessing one vehicle. Having a lot of evaluation parameters coming from these crashes required JNCAP to have a rating protocol that could figure out the easy to understand safety rate based on these three crashes. This is to report what the protocol is all about and how it works

**Submission ID 78-O**

**Influence of a passenger dummy on consumer rating in offset frontal NCAP crash**

J. Haley  
NRMA Insurance  
Australia  
J. Hurnall  
Queensland Transport  
Australia  
C. Coxon  
Transport South Australia  
Australia

***Abstract***

The offset frontal crash test used by Australia NCAP (ANCAP), Euro NCAP and Japan NCAP all have both a front seat passenger and driver dummy while the offset frontal crash test used by the IIHS has only a driver dummy.

This paper reviews the influence of the passenger dummy on the NCAP ratings given to cars that have been part of both the ANCAP/EuroNCAP and IIHS programs. This has been done through an evaluation of the passenger dummy results from the ANCAP/EuroNCAP tests and the IIHS tests and by analysing how these results influenced the evaluation procedure.

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# Technical Session 4

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## Data Collection, Event Data Recorders and Risk Assessment

**Tuesday, June 5, 2001**

2:00 p.m. - 5:30 p.m.

**Chairperson:** Fred Wegman, Netherlands

Room A

### **Submission ID 168-O**

#### **Injury risk functions for individual car models**

A. Kullgren

Folksam Research

Sweden

C. Tingvall

Monash University Accident Research Centre

Australia

A. Lie

Swedish National Road Administration

Sweden

#### **Abstract**

Injury risk functions, or the relation between impact severity and risk of injury, is complicated to derive from real life crash data. In this study,, a new method, based on matched pairs, was used to generate relative injury risk functions describing the risk of injury versus change of velocity. The method was trialed on a number of individual car models, and showed that there are major and important differences between cars of different models and size in terms of the injury risk functions.

### **Submission ID 174-O**

#### **The correlation between crash pulse characteristics and the duration of symptoms to the neck-crash recording in real life rear impacts**

M. Krafft, A. Kullgren, A.

Ydenius

Folksam Research

Sweden

#### **Abstract**

The study present the influence of change of velocity, peak and mean acceleration on whiplash injury risk. 40 real life rear impacts have been analysed were the vehicles were equipped with Crash Pulse Recorders. The crash pulse varied considerably in impacts were the occupants sustained symptoms. No injury symptoms occurred when the peak acceleration was 5g or less and a correlation was found between crash severity measures and initial whiplash symptoms.

**Submission ID 190-O****Aggressivity variables and their sensitivity in car aggressivity ratings**

M. Cameron  
Monash University Accident Research Centre  
Australia  
V. Laine, T. Ernvall  
University of Oulu, Road and Transport Laboratory  
Finland

**Abstract**

In car aggressivity ratings the weights of different explanatory variables are different compared to crashworthiness, because we are observing the crash outcomes to the opposite vehicle and its occupants. The most sensitive variables of aggressivity are age and sex of the opposite vehicle driver, speed limit at the crash site and damage severity of the opponent vehicle for injury risk. Accordingly, for injury severity the most sensitive variables are age and sex of the other vehicle driver, vehicle damage of the other vehicle, speed limit at the crash site and crash location. All these variables were also significant predictors of injury risk and injury severity.

**Submission ID 216-O****Acceleration pulses and crash severity in low velocity rear impacts - real world data and barrier tests**

A. Linder  
Chalmers University of Technology, Sweden; MUARC, Australia  
Sweden  
M. Krafft  
Folksam Research  
Sweden  
M. Avery  
Motor Insurance Repair Centre, Thatcham  
United Kingdom

**Abstract**

The dummy response in a crash test can vary depending on the acceleration pulse in the impact. How the acceleration pulse varies in cars impacted in the same way and in cars impacted in different ways is limited reported. In this study real world and crash test acceleration pulses were evaluated. The results show that a large variety of pulses could be generated. The results are an important input to the design of test methods for low velocity rear impacts.

**Submission ID 225-O****Accidents and Near-misses Analysis by using Video Drive-recorders in a Fleet Test**

Y. Arai, T. Nishimoto  
Japan Automobile Research Institute  
Japan  
Y. Ezaka  
Ministry of Land, Infrastructure and Transport  
Japan

**Abstract**

The drive-recorder was installed in 200 vehicles in Japan and accident data was collected. As a result, the drive-recorder can collect scientific data of the accident and analyze the cause of the accident.

**Submission ID 236-O**

**Dutch in-depth accident investigation: first experiences and analysis results for motorcycles and mopeds**

F. Galliano  
ACEM  
Belgium  
H. Mooi  
TNO Automotive  
Netherlands

***Abstract***

In September 1999 the Dutch Accident Research Team (DART) within TNO started with the in-depth investigation of traffic accidents. In this paper, the exact methodology, working procedures and experiences are described and explained in detail. Also, analysis results of the Dutch part of a European study into powered two-wheelers (acronym: MAIDS, partly sponsored by ACEM) are shown. These results are also compared with the results of foreign studies. At last, some validations of accident reconstruction techniques are shown.

**Submission ID 303-O**

**Motorcycle Braking and its Influence on Severity of Injury**

A. Sporer, T. Kramlich  
Institute for vehicle safety - GDV  
Germany

***Abstract***

Falling when braking in extreme situations may cause fatal injuries. Reconstructed cases and a database analysis show solutions.

**Submission ID 340-O**

**Risk-Benefit Analysis Methods and Criteria for Vehicle Safety Devices**

J. Zellner  
Dynamic Research, Inc.  
United States  
K. Thompson, J. Graham  
Harvard Center for Risk Analysis  
United States

***Abstract***

Vehicle safety devices may be associated with injury risks as well as injury benefits. Analytical methods from the public health, medical and vehicle safety fields are described including: principles of risk-benefit analysis, terminology, fields of application, quantification methods, assumptions, data needs, treatment of uncertainties, and risk-benefit criteria. Example applications are presented for car safety belts, head restraints and airbags; motorcycle leg protectors and airbags; and all terrain vehicle rollover protection structures. Application and further development and standardization issues are discussed.

**Submission ID 350-O****The Methodology of On The Spot Accident Investigations in the UK**

N. Byard  
Transport Research Laboratory  
United Kingdom  
J. Hill, P. Thomas  
Vehicle Safety Research Centre, Loughborough University  
United Kingdom

***Abstract***

A new 'On The Spot' (OTS) accident research project is now underway in the UK. Five hundred crashes will be studied in-depth each year by teams working alongside the emergency services within minutes of the crash. This paper describes the methodology used for collecting and interpreting accident data about vehicles, the highway, human factors and injuries sustained. The paper concludes with an illustration of how new results are to be utilized by safety practitioners.

**Submission ID 389-O****Quality Criteria for Crashworthiness Assessment from Real world crashes**

K. Langwieder  
GDV Institute for Vehicle Safety  
Germany  
B. Fildes  
Monash University Accident Research Centre  
Australia  
T. Ernvall  
University of Oulu  
Finland

***Abstract***

The possibilities and limits of the necessary “Quality Criteria for the Safety Assessment of Cars based on Real world accidents” are analysed in an EU project in cooperation of research institutes, industry and universities. The paper summarises the results of three major objectives within this “SARAC” project.

**Submission ID 68-O****Comparative Analysis of Several Vehicle Safety Rating Systems**

M. Cameron, S. Narayan  
Monash University Accident Research Centre  
Australia  
T. Ernvall  
University of Oulu, Road and Transport Laboratory  
Finland

***Abstract***

The paper examines the application of five vehicles safety rating systems to a common crash database, for the purpose of making a comparison of the rating results produced by each system and to develop an understanding of the differences which emerge. The rating results are compared based on rank order of crashworthiness of vehicle models, correlations between each pair of the results and finally, results with their respective confidence limits will be used to classify each vehicle model as inferior, not defined or superior.

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# Technical Session 5

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## Development in Frontal Impact Protection (Legal, Technical)

**Wednesday, June 6, 2001**

9:00 a.m. - 12:30 p.m.

*Chairperson:* Claudio Lomonaco, Italy  
Auditorium

**Submission ID 491-O**

**IHRA - 5 Years Status Report of the Advanced Offset Frontal Crash Protection**

C. Lomonaco, E. Gianotti  
Ministry of Transport  
Italy

***Abstract***

This paper will provide an overview of the work progress of the advanced offset frontal crash protection group of IHRA. It resumes, including tables, the strategy of the group to cope with the assigned task. This is the commitment to achieve a harmonised frontal crash protection procedure taking into account the different worldwide views in this field.

**Submission ID 437-O**

**Review of the European Frontal and Side Impact Directives**

M. Edwards, A. Fails, H.  
Davies  
TRL Ltd  
United Kingdom

***Abstract***

Work has been undertaken to support the review of the European frontal and side impact Directives. Full scale car crash testing, accident analysis and a comprehensive analysis of the EuroNCAP crash tests results has been used to review the suitability of the current performance requirements and test configuration, focusing on the major issues identified in the Directives and accident analysis, such as the test speed.

**Submission ID 315-O**

**Progress of Passive Safety in Car to Car Frontal Collisions: Results from Real-Life Crash Analyses and from Crash Tests**

A. Berg, P. Ruecker  
DEKRA Automobile GmbH  
Germany  
E. Miltner  
Society for Real-Life Accident Crashes  
Germany

***Abstract***

Efforts of passive safety in frontal collisions of cars are shown with car to car and car on barrier crash tests using old and new car models. In-depth studies focused on real-life frontal crashes involving old and new cars are confirmed with this. The federal statistics show overall trends of passive car safety on German Roads. Compatibility aspects “new to old” caused by different front-end stiffness and mass are discussed, too.

**Submission ID 193-O**

**Airbag efficiency in frontal real world accidents**

J. Huère, J. Foret-Bruno, G.  
Faverjon  
Laboratory of Accidentology, Biomechanics and human behaviour  
France

***Abstract***

The in depth analysis of severe frontal accidents involving 300 belted drivers with airbags, compared with drivers without airbags, in the range of EuroNCAP severity crashes, has led to establish the efficiency of airbag in preventing head injuries. The combination of airbag with belt force limiters shows a good protection of head, neck and thorax.

**Submission ID 136-O**

**Steering Column Movement in Severe Frontal Crashes and Its Apparent Effect on Airbag Performance**

D. Zuby, B. O’Neill  
Insurance Institute for Highway Safety  
United States

***Abstract***

Frontal crash tests and real-world frontal crashes were examined to better understand the steering column’s role as part of the driver restraint system. Offset frontal crash tests show significant variations in steering column movement among different vehicle types. Both crash tests and real-world crashes show that large movements of the steering column can reduce airbag effectiveness. Comparing older and redesigned models indicates steering column movement is not necessarily reduced by improved occupant compartment structural integrity.

**Submission ID 421-O**

**Static Out-of-Position Test Methodologies: Identifying a Realistic Worst Case for Small Stature Female Drivers**

S. Tylko, D. Dalmotas  
Transport Canada  
Canada

***Abstract***

A modified positioning procedure which prioritizes chest placement and positions the steering wheel in a location that is compatible with the visibility and comfort requirements of a 5th percentile female driver is described. A modified chin on hub procedure is also described. Results of the modified procedures are compared to the NHTSA procedures for a number of late model vehicles. Dummy position and responses are compared to field investigation data where applicable.

**Submission ID 363-O**

**Lower Extremity Response of the Thor-Lx Compared to the Hybrid-III Lower Leg In Frontal Barrier Crash Tests**

D. Longhitano, J. Turley  
Honda R&D Americas, Inc.  
United States

***Abstract***

In this paper we review the results from a matrix of tests performed to evaluate the response of the Thor-LX in comparison to the Hybrid-III lower extremity in high-speed frontal crashes. The testing included three 40mph frontal offset deformable barrier tests and two 35mph flat rigid barrier tests. This testing was done using the following ATD combinations: Hybrid-III with the Denton enhanced lower leg, Hybrid-III with the Thor-Lx, and Thor with the Thor-Lx.

**Submission ID 101-O**

**Parameter Study on Different Factors Influencing Lower Extremity Injuries**

S. Hesse, S. Blaesser  
Adam Opel AG  
Germany  
J. Hoffmann  
Siemens Restraints Systems  
Germany

***Abstract***

A study was performed to determine which factors influence injuries of the lower extremities. The study consisted of simulations, sled tests with hydraulic foot room intrusion and full-scale crash testing. A baseline crash test was performed to determine the main factors, after which a sled test and a numerical simulation model were set up to investigate different countermeasures. These countermeasures and their combinations were investigated using a “Design of Experiments” Matrix and verified by sled and crash tests.

**Submission ID 199-O****Structural Front Unit Global Approach**

A. Diboine  
Renault S.A.  
France  
P. Delannoy  
Teuchos Group - Renault Safety Department  
France

***Abstract***

The structural design of current vehicle front units has to account for an increasing number of constraints: improvement of real life safety for occupants and others road users, perform in the various European ratings and meet future regulations. Therefore the structural car design is the result of a compromise between pedestrian protection, car to car compatibility and self-protection. This paper describes the different relevant factors for each safety and reparability requirement, propose compromise among them in terms of structural aspects. It will also show that it is often very difficult to find an answer which satisfy all these aspects.

**Submission ID 329-O****Improved design for frontal crash protection**

K. Houtzager  
Reynolds Aluminium  
Netherlands  
N. Sharpe, R. Vendrig  
TNO Automotive - Crash Safety Centre  
Netherlands

***Abstract***

Frontal impact structural performance in legislative and consumer testing has recently improved. Pressures to minimise cost and weight whilst achieving satisfactory crash performance could however lead to vehicle designs optimised for barrier crash testing. TNO in collaboration with Reynolds Aluminium have developed a vehicle design which incorporates energy absorption through controlled bending of longitudinal members. This has been developed to achieve reliable energy absorption within the front structure independently of the impact condition to which the vehicle is subjected.

**Submission ID 465-O****Advanced Driver Airbag System**

J. Moreno  
CIDAUT  
Spain  
E. Fazio, P. Barrero  
Dalphimetal Espana S.A.  
Spain

***Abstract***

New improvements in driver safety systems need to guarantee higher control on all crash parameters such us offset crashes with non-longitudinal movements and crashes with steering column movements. New shapes of bags combined with systems that fix the position of the bag can do this work.

**Submission ID 132-O**

**Improved Safety for Drivers and Couriers of Coaches**

J. Wessels  
autobusfabriek BOVA bv  
Netherlands  
P. de Coo, R. Hazelebach  
TNO Road vehicles Research Institute  
Netherlands

***Abstract***

TNO Automotive and Coach Manufacturer BOVA developed a procedure for improvement in the frontal crashworthiness of coaches. The experience gained has been used and is demonstrated in the design of a new coach.

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# Technical Session 6

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## Simulation and Computer Modeling in Vehicle Safety

**Wednesday, June 6, 2001**

9:00 a.m. - 12:30 p.m.

*Chairperson:* Jean Pierre Verriest, France  
Room A

**Submission ID 251-O**

**NHTSA's Crashworthiness Modeling Activities**

S. Summers, W. Hollowell  
National Highway Traffic Safety Administration  
United States

***Abstract***

This paper will present an overview of NHTSA's vehicle modeling research activities

**Submission ID 157-O**

**The Investigation and Modelling of Corkscrew Rollovers**

N. Harle, P. Glyn-Davies  
Millbrook Proving Ground Ltd  
United Kingdom

***Abstract***

Corkscrew rollovers with a family sized vehicle, a convertible, and a sports utility vehicle have been conducted and successfully modelled at Millbrook Proving Ground (UK). This paper describes the corkscrew rollover phenomena, and the analysis techniques used to model it. Also discussed are the methods of using the simulation to predict vehicle behaviour for test vehicles where the entire range of model input parameters cannot be determined.

**Submission ID 281-O**

**CAE methods for simulating FMVSS 201 Interior Head Impact**

R. Sturt, B. Dennis  
Ove Arup & Partners  
United Kingdom

***Abstract***

The paper describes progress on material modelling for plastic trim components under impact conditions. Practical details of modelling, such as efficient setting up of CAE models of the many impact cases, and modelling of fixings to the body, are also presented together with correlation to test.

**Submission ID 285-O**

**The influence of residual effects of stamping on crash results**

R. Sturt, T. Dutton, P.  
Richardson  
Ove Arup & Partners  
United Kingdom

***Abstract***

Thickness changes, residual stresses and, most importantly, work hardening, occur during the panel stamping process and influence the impact behaviour of the car body. This paper presents an analytical study that quantifies the effects of forming on crash results for a typical family car. The method used for importing the forming results into the crash model are described.

**Submission ID 200-O**

**Evaluating Structural Foam as an alternative to steel in a Front Offset CAEanalysis**

S. Gupta  
Honda R & D, Americas, Inc.  
United States

***Abstract***

Structural foam was found to be a viable alternative to steel while reducing weight and cost at the same time.

**Submission ID 126-O**

**Development of Detailed Finite Element Models of Child Restraint Systems for Occupant Protection Investigation**

J. Monclus-Gonzalez, A.  
Eskandarian  
FHWA/NHTSA National Crash Analysis Center  
United States  
O. Takatori  
Japan Automobile Research Institute  
Japan

***Abstract***

A previously defined methodology for the development of Finite Element (FE) detailed models for road vehicles have been utilized to create four different FE models of child safety seats (CSS). The "fleet" of CSS include two convertible toddler seats, one infant rear-facing seat and a booster seat. Model dimensions range from 5,865 nodes, 7,836 elements and 4 parts for the booster seat to 18,204 nodes, 21,345 elements and more than 20 parts for the most complex convertible one.

***Submission ID 301-O***

***Development of CAE Simulated Crash Pulses for Airbag Sensor***

**Algorithm/Calibration in Frontal Impacts**

C. Chou, J. Le, P. Chen  
Ford Motor Company  
United States

***Abstract***

This paper presents methodologies for the development of finite element sensor models to generate CAE simulated crash pulses/signals at the sensing location during frontal impacts. These signals will be used in the airbag sensor algorithm/calibration to help achieve costly prototype test reduction.

**Submission ID 282-O**

**Development and Evaluation of a Human Lower Extremity Model**

Y. Kitagawa, C. Pal  
NISSAN MOTOR CO., LTD.  
Japan

***Abstract***

A finite element model of the human lower extremity has been developed in this study. First the performance of the model was evaluated by comparing with cadaver test data. Then a study was conducted on protecting the lower leg using the validated model.

**Submission ID 297-O**

**HUMOS: HUMAN MODEL for Safety; a joint effort towards the development of refined car occupant models**

S. Robin  
LAB PSA Peugeot Citroen RENAULT  
France, Metropolitan

***Abstract***

In the course of a European Project, a joint effort was undertaken to develop new refined models of a mid-size male car occupant. Fifteen partners are involved in this project whose main outcome will be models validated with different software, and enabling injury risk prediction in different car crash situations. The main anatomical structures, i.e. skin, bones, muscles and major organs will be accounted for by these models.

**Submission ID 119-O**

**Simulation of rear end impact with a full body human model with a detailed neck: role of passive muscle properties and initial seating posture**

M. van der Horst, P.  
Bovendeerd  
Eindhoven University of Technology  
Netherlands  
R. Happee  
TNO Automotive, Crash Safety Centre and Eindhoven University of Technology  
Netherlands

***Abstract***

Initial seating posture and muscle activation are important determinants of the human head-neck response. In this study, the role of these parameters is studied with a detailed mathematical model. This model is validated with responses of volunteers and post mortem human subjects. The influence of muscle activation on the head-neck response is investigated by varying the initial muscle stress, the muscle reflex induced activation level and the muscle motor reflex delay time. A range of realistic initial postures was simulated.

**Submission ID 152-O**

**Advances in Numerical Modelling of Crash Dummies**

R. Verhoeve, R. Kant  
TNO Automotive  
Netherlands  
L. Margerie  
TNO Automotive  
France

***Abstract***

To support simulation engineers to deal with the difficulty of optimizing vehicle design for crash safety, dummy models with varying levels of complexity have been developed for virtual testing. This paper presents state-of-the-art modelling techniques applied in both multi-body and FE dummy models. Quality and limitations are evaluated by assessing the performance of two EuroSID-1 models in terms of accuracy, CPU requirements and user-friendliness.

**Submission ID 307-O**

**A Stochastic Approach for the Simulation of an Integrated Vehicle and Occupant**

C. Lin, Z. Gao, Y. Cheng  
General Motors  
United States

***Abstract***

Typical injury criteria (HIC, chest G, chest deflection, neck loads, and femur loads) and structural performance (effective acceleration, efficiency, and intrusions of toe pan, steering column, and A-pillar) are extracted. These values are then used to determine the effect of the structural and the restraint system variations on the occupant and vehicle crash performances. The cross relationship between the structural crash behavior and occupant injury numbers can also be investigated.

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# Technical Session 7

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## Compatibility in Frontal and Side Collisions (Car/Car, Car/Vehicle)

**Wednesday, June 6, 2001**

2:00 p.m. - 5:30 p.m.

*Chairperson:* Richard Lowne, United Kingdom  
Auditorium

**Submission ID 337-O**

**IHRA – Status Report of IHRA Compatibility Working Group**

P. O'Reilly  
DETR  
United Kingdom

*Abstract*

The IHRA Compatibility Group report overviews the thrust of work to date including the current position on candidate approaches for frontal tests.

**Submission ID 249-O**

**NHTSA's Research Program for Vehicle Aggressivity and Fleet Compatibility**

S. Summers, A. Prasad, W.  
Hollowell  
National Highway Traffic Safety Administration  
United States

*Abstract*

This paper will present an overview of NHTSA's vehicle aggressivity and fleet compatibility research activities.

**Submission ID 444-O**

**EEVC Research in the Field of Improvement of Crash Compatibility Between Passenger Cars**

E. Faerber  
BASt (Federal Highway Research Institute)  
Germany

*Abstract*

Accident and crash test data as well as mathematical models were analysed to investigate compatibility between passenger cars. Structural incompatibilities were frequently found but were not easy to quantify. In a next phase research work will concentrate on the development of methods to assess compatibility of passenger cars.

**Submission ID 140-O****Development of Criteria and Standards for Vehicle Compatibility**

R. Zobel, T. Schwarz  
Volkswagen AG  
Germany

***Abstract***

Paper summarizes the results of a project on vehicle crash compatibility, run by European automotive industry together with some research institutes. The project was funded by the European commission as BE97-4049.

**Submission ID 127-O****Test Procedures to Evaluate Vehicle Compatibility**

K. Tateishi  
Japan Automobile Research Institute  
Japan  
Y. Ezaka  
Ministry of Land, Infrastructure and Transport  
Japan  
K. Mizuno  
Traffic Safety and Nuisance Research Institute  
Japan

***Abstract***

Test procedures to evaluate compatibility were examined based on accident analyses and crash tests. This paper summarizes the research, which Japan reported to the IHRA compatibility working group. To improve compatibility, after maintaining structural interaction between cars, it is necessary to absorb impact energy, while preserving the structural integrity of the passenger compartment. Thus, three tests will be effective: 1) a full frontal rigid barrier test with load cell measurement, 2) an ODB test, and 3) an overload test.

**Submission ID 239-O****Current Front Stiffness of European Vehicles with regard to Compatibility**

J. Huibers, E. de Beer  
TNO Automotive  
Netherlands

***Abstract***

Loadcell barrier test results of ENCAP test at TNO and TRL of a number of different vehicle categories are analysed and presented in the paper. It shows that small good performing cars show nearly the same frontal stiffness as large saloon cars. This means small cars can survive when hit at the front by large cars, meaning they are more compatible. Heavy MPV's with relative little crushable space show high front stiffness, which makes them aggressive for other vehicles.

**Submission ID 349-O****Measurements of Stiffness and Geometric Compatibility in Front to Side Crashes**

K. Digges, A. Eigen  
The George Washington University  
United States

***Abstract***

This study examines the load cell barrier data collected during recent years of NCAP testing to assess the magnitude and geometric distribution of the crash forces that act during a front to side crash. The location of the force center of the loading from the individual load cells is proposed as a metric for quantitatively describing the geometric properties of the crash forces. This paper shows the range of the proposed geometric compatibility parameter measured on cars, pickups, vans, and multi-purpose vehicles, and how this data is applicable to front-to-side compatibility.

**Submission ID 158-O****The Essential Requirements for Compatible cars in Frontal Collisions**

M. Edwards, J.  
Happian-smith, H. Davies  
TRL Ltd  
United Kingdom

***Abstract***

Further understanding of compatibility within frontal car-to-car collisions is established alongside the development of crash evaluation procedures. An essential pre-requisite for compatibility between cars of structural interaction is demonstrated and current research using high resolution load cell wall results is described.

**Submission ID 91-O****Effects of Geometry and Stiffness on the Frontal Compatibility of Utility Vehicles**

S. Meyerson, J. Nolan  
Insurance Institute for Highway Safety  
United States

***Abstract***

To examine the effects of front-end stiffness and geometry on vehicle deformation patterns and occupant injury measures, two utility vehicle models with different front-end stiffnesses were tested against a common crash partner, a Ford Taurus. Each utility vehicle model was tested with a low and high ride height. Results indicated that the frontal geometry (ride height) of a utility vehicle is much more important than stiffness in the vehicle's compatibility with passenger cars.

**Submission ID 428-O****Evaluation of Vehicle Compatibility in Various Frontal Impact Configurations**

S. Barbat, P. Prasad, X. Li  
Ford Motor Company/Safety R & D  
United States

***Abstract***

This paper describes apart of ongoing research at Ford Motor Company to further investigate the problem of compatibility in multi-vehicle crashes. It examines test results of vehicle-to-vehicle crashes in various frontal impact configurations to develop meaningful test procedures and requirements that are capable of assessing vehicle compatibility. Three vehicle-to-vehicle frontal impact configurations, full overlap collinear impact, 50% offset collinear impact, and 30 degrees oblique impact have been explored and presented in this study. Test results in terms of structural and occupant performances to quantify the effect of mass, stiffness and geometry is presented and discussed. Preliminary results indicated that the geometric incompatibility is the dominating factor of the vehicle design characteristics that causes extensive intrusion due to override.

**Submission ID 133-O****Empirical Comparison of Vehicle Aggressivity Rating Systems**

M. Cameron, M. Les  
Monash University Accident Research Centre  
Australia  
T. Ernvall  
University of Oulu, Road and Transport Laboratory  
Finland

***Abstract***

This study represents the first attempt to empirically compare existing vehicle aggressivity rating methods in order to identify the most satisfactory vehicle aggressivity 'rating' model. Vehicles were distinguished by make and model, and the aggressivity of each model was estimated from data on real two-vehicle crashes. For comparison purposes, two common crash databases were used for estimation of ratings by each method: police-reported tow-away crash data from three US states, and motor liability insurance claims from Finland. New methods of vehicle aggressivity rating were also proposed and tested.

**Submission ID 172-O****Mass Data Evaluation of the Importance of Structural and Mass Related Aggressivity**

A. Kullgren  
Folksam Research  
Sweden  
A. Lie  
Swedish National Road Administration and Karolinska Institute  
Sweden  
C. Tingvall  
Swedish National Road Administration, Sweden, and Monash University, Australia  
Sweden

***Abstract***

This study presents the influence of car mass and structural aggressivity on driver relative injury risk. Police reported two-car collisions in Sweden have been analysed with the paired comparison technique. Influence of mass and structure has been separated with a new developed technique. Influence of mass was found to vary within  $\pm 35\%$ , while influence of structure was found to vary within  $\pm 10\%$ .

**Submission ID 354-O****A Systems Modeling Methodology For Estimation Of Harm In The Automotive Crash Environment**

A. Kuchar  
Volpe National Transportation Systems Center, USDOT  
United States

***Abstract***

A systems modeling approach is presented for assessment of harm in the automotive crash environment. The methodology consists of parametric simulation of several controlled accident variables, with case results weighted by the relative frequency of each specific event. The model is validated against injury field data, and is found to accurately reflect trends in distribution of injury severity.

**Submission ID 343-O**

**PSA's views on compatibility : a potential two-step approach to improve compatibility among the vehicle fleet**

S. Monnet  
PSA Peugeot Citroën  
France, Metropolitan

***Abstract***

PSA's views on compatibility

PSA's proposal is to make a first step toward compatibility by improving structural interaction with a specific test - because compatibility is a specific performance. In the same time, we propose to reinforce the compartments in order to have a self-protection margin in case of incompatibility.

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## Technical Session 8

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### Improved Safety for Vulnerable Road Users (Bicyclists, Pedestrians, Children)

Wednesday, June 6, 2001

2:00 p.m. - 5:30 p.m.

*Chairperson:* Yoshiyuki Mizuno, Japan  
Room A

**Submission ID 280-O**

**IHRA - Summary of IHRA Pedestrian Safety WG Activities - Proposed Test Methods to Evaluate Pedestrian Protection Afforded by Passenger Cars -**

H. Ishikawa  
Japan Automobile Research Institute  
Japan  
Y. Mizuno  
Japan Automobile Standards Internatization Center  
Japan

***Abstract***

The pedestrian test procedures tried to be harmonized by the experts of IHRA member countries are proposed in high priority identified in the analysis of pedestrian accidents. These are adult headform, child headform and legform impact tests. This paper summarizes the IHRA Pedestrian Safety WG Activities from 1996, focusing on the test procedures, test tools, injury criteria and its threshold. Future activities of the IHRA Pedestrian Safety WG are also presented with scopes and time schedule.

**Submission ID 263-O**

**Reconsideration of Injury Criteria for Pedestrian Subsystem Legform Test - Problems of RIGID legform Impactor -**

M. Tanahashi  
Japan Automobile Manufacturers Association  
Japan  
A. Konosu, H. Ishikawa  
Japan Automobile Research Institute  
Japan

***Abstract***

The legform impactor proposed by EEVC/WG17 is too rigid to assess lower limb injuries in car-pedestrian accident. The flexibility of leg or bending motion of femur and tibia should be incorporated in designing the legform impactor as long as we use the current injury criteria obtained from the biomechanical experiments.

**Submission ID 212-O**

**The Emerging Threat of Light Truck Impacts with Pedestrians**

D. Lefler, H. Gabler  
Rowan University  
United States

***Abstract***

This paper investigates the effect of striking vehicle type on pedestrian fatalities and injuries. The paper presents and compares pedestrian impact risk factors for sport utility vehicles, pickup trucks, vans, and cars as developed from analyses of U.S. accident statistics and computational models.

**Submission ID 475-O**

**The development of a new class of two wheeler vehicles**

H. Osendorfer, S. Rauscher  
BMW Group  
Germany

***Abstract***

With the C1 BMW developed a new class of motorized two wheeler vehicles for safe and comfortable travelling in heavy traffic. It is equipped with safety belts and special damping devices in order to assure good protection even if driven without a helmet. Details about developments of this recently launched vehicle and achievements thereof will be presented.

**Submission ID 423-O**

**New headlamp concepts as key to optimisation of vehicle front ends in consideration of pedestrian protection**

R. Lachmayer  
Hella KG Hueck & Co.  
Germany  
F. Friesen  
Institut für Kraftfahrwesen Aachen (ika), RWTH Aachen  
Germany

***Abstract***

In nearly 70 % of all accidents with pedestrians, the initial contact zone is the corner of the vehicle front-end. With this in mind Hella is working in cooperation with the Institute for Motor Vehicles on optimising headlamps design in terms of energy absorption and deformation characteristics in crash situations. Different solution concepts are presented and evaluated.

**Submission ID 183-O**

**Pedestrian and cyclist protection on road vehicles with high or fl at fronts**

I. Neilson  
PACTS (Parliamentary Advisory Council for Transport Safety)  
United Kingdom

***Abstract***

Many Pedestrians and cyclists are killed or injured by being struck by the fronts of large vehicles. The EU countries are preparing to require the design of car fronts to offer protection to pedestrians struck by them. This paper suggests how such protection can be introduced into the design of all vehicles larger than cars. It discusses the design problems to be solved and the way in which the existing test procedures might be used.

**Submission ID 202-O****Pedestrian Safety Upper Legform Bumper Impact Simulation**

S. Mark  
Honda R&D, Americas  
United States

***Abstract***

An upper legform to bumper impact simulation was performed using Madymo software. This simulation aided in the development of a pedestrian friendly bumper system.

**Submission ID 283-O****Improvements to Pedestrian Protection as Exemplified on a Standard-Sized Car**

I. Kalliske  
Federal Highway Research Institute (BASt)  
Germany  
F. Friesen  
Institut für Kraftfahrwesen Aachen (ika), RWTH Aachen  
Germany

***Abstract***

In spite of the steady reduction in the number of pedestrians killed or injured over the recent years the pedestrian protection is of high importance in the European Union as well as in Germany. Using the test method according to EEVC WG 17 for pedestrian protection a series vehicle was tested as production version and modified. The results show that considered measures for pedestrian protection in many areas of the vehicle front structure can lead to a significant reduction of the loads of pedestrians.

**Submission ID 131-O****Evaluation of a new pedestrian head injury protection system with a sensor in the bumper and lifting of the bonnet's rear part**

R. Fredriksson, Y. Håland  
Autoliv Research  
Sweden  
J. Yang  
Chalmers University of Technology  
Sweden

***Abstract***

A protection system has been developed to decrease the risk of head injury in car-pedestrian impacts. The system is activated at the impact by a sensor located in the bumper and lifts the rear part of the bonnet to better absorb the impact energy. It has been tested by a headform impacting the bonnet at various locations and speeds (20-50 km/h), as well as by a pedestrian dummy impacted by a complete car front. The test results showed a reduction of HIC values to acceptable levels (<1000).

**Submission ID 322-O****Closure and trim design for Pedestrian impact**

W. Souren  
Centre of Lightweight Structures TUD-TNO  
Netherlands  
H. Gaalman  
DSM Design & Application Development Centre  
Netherlands  
F. Bosma  
TNO Automotive - Crash Safety Centre  
Netherlands

***Abstract***

To provide protection to pedestrians, the design and construction of a vehicle's bumper, hood and fender panels will need to be addressed. TNO and DSM have undertaken a research project to investigate how this may be done. Vehicle styling, packaging and an analysis led design process for the front of the vehicle and in particular the hood and bumper will be shown with the recommendations of EEVC working group 17 used as a measure of the design proposal's suitability.

**Submission ID 330-O****Pedestrian Protection - An Evaluation of an Airbag System Through Modelling and Testing**

P. Holding, B. Chinn, J.  
Happian-Smith  
TRL Ltd  
United Kingdom

***Abstract***

Pedestrian protection systems, consisting of sensors which would identify a pedestrian at risk, and airbags fitted to the bumper and bonnet of two different vehicle types to protect the pedestrian in impacts of 25mile/h and 30mile/h, have been studied. The research comprised modelling in MADYMO to evaluate the potential for injury reduction, followed by vehicle-to-dummy impact testing. The sensor systems were investigated in parallel. Correlated results from the modelling and testing showed that the potential injury reductions were substantial.

**Submission ID 375-O****Improvement of visibility for vulnerable parties in traffic accidents**

A. Takahashi, N. Asanuma  
HONDA R&D CO.,LTD.  
Japan

***Abstract***

We fabricated Honda ASV-2 (Advanced Safety Vehicle 2) which installed the following three functions improved the visibility drastically for the purpose of reducing accidents toward the vulnerable parties in traffic society. (Honda night vision system, Active headlight system, Inter-Vehicle Motorcycle-Automobile communication system).

**Submission ID 454-O**

**Development of a dynamic testing procedure to assess crashworthiness of the rear patient compartment of ambulance vehicles**

J. Yannaccone

ARCCA Inc.

N. Levick, G. Li

Johns Hopkins University

United States

***Abstract***

Ambulances have different performance needs and structural design to standard passenger vehicles. There is also no dynamic safety standard for testing the ambulance patient compartment occupant or equipment restraint systems. This study describes an accelerator sled test conducted of an ambulance rear cabin environment which demonstrates some optimal restraint practices for pediatric patients and also the interaction between the different occupants and the need for effective restraint systems.

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# Technical Session 9

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## Developments in Restraint Systems (Airbags, Safety Belts)

**Thursday, June 7, 2001**

9:00 a.m. - 12:30 p.m.

*Chairperson:* Jac Wismans, Netherlands  
Auditorium

**Submission ID 149-O**

**Evaluation of Lower Limb Injury Mitigation from Inflatable Carpet in Sled Tests with Intrusion using the Thor Lx**

E. Hjerpe  
Autoliv Research  
Sweden  
R. Rudd, J. Crandall  
University of Virginia  
United States

***Abstract***

Sled tests with intrusion were performed to determine the effectiveness of Inflatable Carpet in reducing lower limb injury risk. Results indicate that a properly tuned Inflatable Carpet can reduce loads imparted to the lower extremities.

**Submission ID 167-O**

**The Effectiveness of Airbags in Australia as Determined by In-Depth Crash Injury Research**

A. Morris, J. Barnes, B.  
Fildes  
Monash University Accident Research Centre  
Australia

***Abstract***

The effectiveness of airbags as a Supplementary Restraint System (SRS) has been ascertained using an in-depth case-control study of frontal crashes involving Australian vehicles. Results show a clear reduction in head, neck and chest injury in frontal impacts and a corresponding reduction in cost to society as measured by Harm. This study also has implications for changes in airbag design in the United States where there is a move towards depowering airbags.

**Submission ID 177-O****Rollover: A Methodology for Restraint System Development**

P. Altamore  
TNO-MADYMO North America  
United States  
S. Ridella, A. Nayef  
TRW Occupant Safety Systems  
United States

***Abstract***

Restraint systems for rollover protection will become more common in future vehicles. This paper summarizes a methodology that combines field accident data analysis, computer simulation, testing, and hardware development techniques. This combined approach is required for a complete rollover restraint system.

**Submission ID 207-O****Factors and Status of Motorcycle Airbag Feasibility Research**

J. Zellner  
Dynamic Research, Inc.  
United States  
N. Rogers  
International Motorcycle Manufacturers Association  
Switzerland

***Abstract***

A review, analysis and enumeration is presented of factors relevant to motorcycle airbag feasibility research. This includes: status of related research in the motorcycle field; relevant experience from the car airbag field; additional unique factors for motorcycles; the need to address motorcyclist out-of-position riding; other sized riders; motorcycle seating layout variations; unintended deployment resistance and consequences; neck injury criteria and dummy neck biofidelity; injury risk-benefit considerations; feasibility definition and factors; and the relationship to the existing International Standard ISO 13232.

**Submission ID 231-O****Enhancement of Seat Performance in Low Speed Rear Impact**

H. Zellmer, A.  
Seidenschwang  
Autoliv GmbH  
Germany  
A. Brunner  
Winterhur Insurance Corp., Dep. Of Accident Research  
Switzerland

***Abstract***

An Anti Whiplash System (AWS) for the aftermarket fitting for existing seat designs was developed. Seats equipped with such device show neck loadings reduced to the half. MADYMO-Simulations with real crash pulses have been performed, and with these results the potential benefit of AWS is estimated.

**Submission ID 234-O****Performance Evaluation of Dual Stage Passenger Air Bag Systems**

W. Hollowell, L. Summers,  
A. Prasad  
National Highway Traffic Safety Administration  
United States

***Abstract***

A research program was initiated to evaluate the performance of dual stage passenger air bags in terms of both restraint performance and aggressivity for different size occupants. Variations in inflator partitioning, vent sizes, and deployment timing were examined. High speed unbelted sled tests were conducted with both 50th percentile male and 5th percentile female Hybrid III adult dummies at 48 kmph. Low risk deployment tests with child dummies were conducted to evaluate air bag aggressivity.

**Submission ID 240-O****Exploratory Study of an Airbag Concept for a Large Touring Motorcycle: Further Research**

T. Yamazaki, S. Iijima, T.  
Yamamoto  
Honda R&D Co., Ltd  
Japan

***Abstract***

Exploratory research into an airbag concept for a large touring motorcycle previously researched by Honda had found that there were cases in which the airbag changed dummy motion, resulting in increased injury in some impact configurations. Honda further investigated this subject, and was able to eliminate these phenomena, by a wider and larger airbag with more powerful inflator. Other factors have yet to be considered.

**Submission ID 328-O****An Evaluation of the Benefits of Active Restraint Systems in Frontal Impacts Through Computer Modelling and Dynamic Testing**

P. Holding, B. Chinn, J.  
Happian-Smith  
TRL Ltd  
United Kingdom

***Abstract***

Frontal impact protection systems, which adapt automatically to the characteristics and seating position of occupants, were researched to demonstrate the potential benefits of active adaptive airbag and seat belt systems above standard systems. MADYMO modeling was employed to investigate the injury potential based on three dummy sizes at two impact severities, and the best performing systems chosen for dynamic impact tests. Results were similar to the predictions and showed that substantial reductions in injury potential were possible.

**Submission ID 334-O****Study of improved safety for minibuses by better seat and occupant retention**

G. Lawrence  
TRL Ltd  
United Kingdom

***Abstract***

This paper describes an evaluation of samples of seats, seatbelt systems and minibuses, the potential for improving their performance and the appropriateness of current regulations. The selection of a suitable crash pulse for testing seatbelt systems which represents the real life accident situation is described along with the results of tests to standard and modified minibuses. Test methods to require improved protection are also described.

**Submission ID 370-O**

**Development of Whiplash Injury Reducing Seat System using Bio-RID II Dummy**

K. Sano, Y. Dokko  
Honda R&D Co.,Ltd.  
Japan  
H. Negishi  
TS-TECH Co.,Ltd.  
Japan

***Abstract***

The developing process of the seat system which enables to reduce so called 'whiplash injury' in low speed rear impact is presented. Bio-RID II dummy was adopted to evaluate the performance of seat systems mainly by means of the criterion NIC. Modifications considered through parametric studies with computer simulation were made to the standard seat system, which resulted in lower values of criteria.

**Submission ID 420-O**

**Side Airbags: Evaluating the Benefits and Risks for Restrained Children**

S. Tylko, D. Dalmotas  
Transport Canada  
Canada

***Abstract***

Child dummies were seated in size appropriate child restraints and exposed to in-vehicle, static, side mounted airbag deployments as well as full scale side impact crash tests. Interactions between the child restraint, the child dummy occupant and the deploying airbag were recorded and analyzed for all test configurations. Opportunities for improvements to child seat designs, consumer education and future regulatory measures are discussed.

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# Technical Session 10

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## Developments in Side Impact Protection (Legal, Technical)

**Thursday, June 7, 2001**

9:00 a.m. - 12:30 p.m.

*Chairperson:* Keith Seyer, Australia  
Room A

**Submission ID 151-O**

**IHRA - IHRA Side Impact Working Group Status Report**

K. Seyer  
Department of Transport & Regional Services  
Australia

***Abstract***

This paper reports on the status of work of the International Harmonised Research Activities (IHRA) Side Impact Working Group (SIWG). The IHRA SIWG's task was to coordinate research to develop a harmonised side impact test procedure. It held its first meeting in September 1998 and the paper outlines proposals made and the reasons for them as well as identifying outstanding issues that require resolution.

**Submission ID 482-O**

**Performance of the Prototype WorldSID Dummy in Side Impact**

E. Hautmann  
BMW  
Germany  
M. Page, D. Cesari  
Centre Européen d'Etudes de Sécurité et d'Analyse des Risques  
France

***Abstract***

A new, highly biofidelic, advanced side impact crash test dummy has been designed within the international WorldSID project. This world-wide project was initiated with the aim of developing a new mid-size male dummy which, it is hoped, by responding to the needs of potential users around the globe, could be adopted universally for side impact crash testing and in particular for future harmonised regulatory test procedures as defined by IHRA (International Harmonized Research Activities).

**Submission ID 442-O**

**Field and Crash Performance of Side-Mounted Airbag Systems**

D. Dalmotas, S. Tylko, A.  
German  
Transport Canada  
Canada

***Abstract***

Drawing on recent Canadian field collision investigations and crash testing, the field experience and crash performance of side-mounted airbag systems are reviewed. The limitations of current regulated testing practices are discussed, both in the context of the results obtained in the staged vehicle-to-vehicle impacts as well as in the context of vehicle damage patterns and occupant injury patterns observed in the field. Possible improvements to the design of inflatable head protection devices to increase their overall effectiveness are also discussed.

**Submission ID 399-O**

**The Dependence of Side Impact Injury Risk on MDB Configuration**

M. Terrell, C. Newland, K.  
Seyer  
Department of Transport & Regional Services  
Australia

***Abstract***

The paper reports on the analysis of a parametric study of mobile deformable barrier to car side impact crash tests. Injury risk measures are considered for front and rear struck side occupants with variations in striking barrier mass, stiffness, geometry and speed.

**Submission ID 356-O**

**Vehicle Deformation in Real-World Side Impact Crashes and Regulatory Crash Tests**

S. Ferguson  
Insurance Institute for Highway Safety  
United States  
S. Rattenbury, P. Gloyns  
Vehicle Safety Consultants Ltd  
United Kingdom

***Abstract***

Crash investigations of a sample of serious and fatal side impacts from the National Automotive Sampling System/Crashworthiness Data System (1992-98) were examined to compare real-world crash damage with the damage patterns that occur in government crash tests. Bridging between A- and C-pillars occurs frequently in FMVSS 214 compliance tests but was infrequent in the sample. Analysis of injury patterns shows a large over-representation of females among seriously injured occupants, due to a higher incidence of pelvic fracture.

**Submission ID 351-O**

**Injuries to Restrained Occupants in Far Side Crashes**

K. Digges  
The George Washington University  
United States  
D. Dalmotas  
Transport Canada  
Canada

***Abstract***

This study uses the NASS/CDS 1988-98 to determine distributions of AIS 3+ injuries among occupants exposed to far-side crashes and the sources of the injuries. To further understand the injury mechanisms in far-side crashes, Three vehicle-to-vehicle crash tests were conducted using a Hybrid III dummy restrained by a 3-point belt. The lateral crash severity of the test was approximately 25 mph. Three different belt designs were tested. The testing confirmed that the head excursion permitted by the belts tested was sufficient to permit contact with the opposite side interior. This paper documents the test results and show how they are representative of the principal mechanisms of injuries in the real world.

**Submission ID 331-O**

**Evaluation of Injury Risk from Side Impact Air Bags**

A. Prasad, R. Samaha  
National Highway Traffic Safety Administration  
United States  
A. Louden  
Transportation Research Center, Inc.  
United States

***Abstract***

Several thoracic and head protection side impact air bag systems are emerging in the US market and are projected to become prevalent in the fleet. This paper describes the tests and presents the results of a critical evaluation of any possible harmful effects for in position and out-of-position occupants from deploying side air bag systems for twelve current vehicle models equipped with side impact inflatable countermeasure systems.

**Submission ID 289-O**

**Study on Car to Car Side Impact**

S. Yamazaki, T. Sugimoto  
HONDA R&D Co., Ltd.  
Japan

***Abstract***

Recently the SUV category vehicle has been getting popular in the U.S. and it is projected that there will be a corresponding increase in occupant injury when these SUV vehicles are involved in collisions with passenger cars.

This paper presents a comparison of test result from the NHTSA SINCAP program (which is currently conducted under laboratory conditions and procedures) with real-world side collision data of several vehicles from NASS.

**Submission ID 267-O**

**Japanese Research Activity on Future Side Impact Test Procedures**

T. Harigae  
Japan Automobile Research Institute  
Japan  
Y. Ezaka  
Ministry of Land, Infrastructure and Transport  
Japan  
H. Yonezawa  
Traffic Safety and Nuisance Research Institute  
Japan

***Abstract***

This paper summarizes a future side impact test procedure based on the Japanese presentation at the recent IHRA Side Impact WG meeting.

Current Japanese regulations were determined based on a market study more than ten years ago. Thus, they may not reflect current accident situation.

Based on accident studies, a vehicle characteristic investigation and results of full-scale test, we present the Japanese view regarding future side impact test procedures.

**Submission ID 265-O**

**Improved Side Impact Protection (ISIP) in Australia - Overview of a Collaborative Approach**

L. Sparke  
Advanced Engineering, Holden Ltd  
Australia  
K. Seyer  
Department of Transport & Regional Services  
Australia  
B. Fildes  
Monash University Accident Research Centre  
Australia

***Abstract***

This paper presents an overview of a collaborative study of Improved Side Impact Protection (ISIP) that commenced in 1997. The research programme involved a partnership of industry, government and research agencies and the overall aim was the development of a new approach to vehicle design for optimised safety of occupants in side impacts.

**Submission ID 221-O**

**A Consideration on Barrier Face Specifications of Side Impact MDB**

T. Uchimura  
Japan Automobile Manufacturers Association, Nissan Motor Co., LTD  
Japan  
N. Fukushima  
Japan Automobile Manufacturers Association, Toyota Motor Co.  
Japan  
K. Hisajima  
Japan Automobile Manufacturers Association, Nissan Motor Co., LTD  
Japan

***Abstract***

This paper describes results of our investigation and examination concerning the MDB specification, which reflected the latest Japanese market. 1) Investigation on dimension and stiffness of passenger cars in Japanese market to determine the average of car front-end dimension and deformation characteristics.2) Analysis of force distribution on rigid barrier in a frontal barrier impact test of typical Japanese passenger car models by using FEM.3) Comparison of test results between a car-to-car test using the passenger car with average front-end characteristic as a striking car and a MDB-to-car test under ECE R95 test condition.

**Submission ID 47-O**

**Research Progress on Improved Side Impact Protection - EEVC WG13 Progress**

R. Lowne  
EEVC WG13  
United Kingdom

***Abstract***

EEVC Working Group 13 has been coordinating research on the development of an interior headform impact test procedure, an improved specification for the EEVC Side Impact Mobile Deformable Barrier face, used in the ECE Regulation 95 and equivalent EC Directive, and for the European contributions to the IHRA activities on the development of the next generation side impact test procedures. This report describes progress on these three topics and presents the revised specification for the MDB.

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# Technical Session 11

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## Safety of Heavy Trucks and Buses (Lanekeeping, Stability, Tire/Road)

**Thursday, June 7, 2001**

2:00 p.m. - 4:15 p.m.

*Chairperson:* Cezary Szczepaniak, Poland  
Auditorium

**Submission ID 316-O**

**Accidents with Vans and Box-Type Trucks: Results from Official Statistics and Real-Life Crash Analyses**

A. Berg, W. Niewoehner, M.  
Froncz  
DEKRA Automobil GmbH  
Germany

***Abstract***

The paper gives an overview of crashes involving vans and box-type trucks on German roads. This includes details of pre-crash phase, crash and post-crash phase. An overview based on figures in the German federal statistics about road crashes involving vans and box-type trucks supplements results of 90 in-depth studies.

**Submission ID 287-O**

**Research on Bus Passenger Safety in Frontal Impact**

H. Mitsuishi, Y. Sukegawa, F.  
Matsukawa  
Japan Automobile Research Institute  
Japan

***Abstract***

We began the work turned from bus crew to a further damage reduction as the second step of the research. The following have been understood by the sled test. 1. There is scope of the improvement in current two points seat belt. 2. It is one of an effective means to the damage reduction of the passenger to optimize at seat intervals.

**Submission ID 230-O**

**Evaluation of New Technologies to Improve Truck Safety Performance (High Safety Vehicle Project)**

H. Desfontaine, B. Favre, P.  
Ravoux  
RENAULT V.I.  
France

***Abstract***

This paper presents a demonstrator vehicle called HSV (High Safety concept Vehicle). It has been built to integrate and valid systems which improve actual and perceived safety (passive or active) and service to the customer. These systems are experimented to determine their performance in actual operating conditions and then evaluate their potential gains from the standpoint of road accidentology.

**Submission ID 224-O**

**Experimental Research on Truck Driver's Safety in Frontal Collision**

N. Masuda  
Japan Automobile Manufacturers Association  
Japan  
Y. Sukegawa, F. Matsukawa  
Japan Automobile Research Institute  
Japan

***Abstract***

The Guideline for Frontal Crash Test of Heavy-duty Truck was formulated in Japan. For the next step, It is important to evaluate injuries peculiar to the truck occupants. The rear-end collision of the heavy-duty truck is enumerated as one of the important forms which truck occupants were injured or death. Therefore, the experiments by which the rear-end collision of the heavy-duty truck were done. This paper describes the current status of truck accidents in Japan, and the results of frontal collision tests.

**Submission ID 218-O**

**Performance criteria, design and crash testing of effective rear underride guards**

C. Powell  
Department of Civil Engineering, Monash University  
Australia  
K. Seyer  
Department of Transport & Regional Services  
Australia  
G. Rechnitzer  
Monash University Accident Research Centre  
Australia

***Abstract***

During the 1990s a series of projects carried out at Monash University have led to the development of design and performance criteria for rear underrun barriers for heavy vehicles over 3.5 tonne. This work focused on the development and crash testing of high capacity, yet practical, rigid and energy absorbing systems catering for both centred and offset impacts. This paper summarises the findings from this development and crash testing work, and includes a review of design principles, and current international regulations and their limitations.

**Submission ID 153-O****The analysis of Dutch national data on Heavy Truck Accidents: the necessary extension of traditional frequency counts with logistic regression analysis.**

Y. Vries, H. Mooi  
TNO Automotive  
Netherlands

**Abstract**

For the 1993-1997 Dutch national accident data, logistic regression analysis was used to find the most important factors, that influenced the outcome of an accident with a truck involved. Frequency counts were used to identify factors that occurred most frequently. The combination of these two methods led to the factors, included in the database, that have a high potential to reduce the number and the severity of truck accidents.

**Submission ID 115-O****The Potential Gain to be achieved by the Generalization of Seatbelts and Airbags in Trucks**

M. Simon  
Centre Européen d'Etudes de Sécurité et d'Analyse des Risques  
France  
Y. Page  
LAB PSA Peugeot Citroen - Renault  
France  
F. Paulhet  
RENAULT VI  
France

**Abstract**

This paper aims to evaluate the potential reduction in the number of victims with the installation of a seatbelt-only restraint system, and then with a combined seatbelt and airbag system.

**Submission ID 425-O****Development of new underride guards for enhancement of compatibility between trucks and cars**

J. Mariolani, C. Arruda, L.  
Schmutzler  
State University of Campinas  
Brazil

**Abstract**

Rear underride crashes kill thousands of people worldwide. Aiming to overcome this calamity, two new underride guards were designed and tested. Crash tests were carried out with the new guards and with another one constructed according to ECE R58. In opposition to the ECE R58 guard, both new guards avoided underride at speed collisions of 50 km/h and 64 km/h. Based on these results, the Brazilian Association of Technical Standards elaborated a new standard about the matter.

**Submission ID 470-O****Fuzzy Logic Control of Intelligent Vehicle Systems**

C. Szczepaniak, A. Szosland  
Vehicle Research Institute, Technical University of Lodz  
Poland

**Abstract**

Fuzzy logic control of devices, which are the part of intelligent vehicle presented. The results of computer simulation of vehicle motion are compared with the results of road experiments.

**Submission ID 244-O**

**Heavy Truck Passive Safety: overview, evaluations and simulations of accidents**

S. Vincze-Pap  
AUTOKUT  
Hungary  
G. Köfalvi  
IbB-Hungary  
Hungary

***Abstract***

This paper provides an overview of passive safety situation of utility vehicles and presents the standpoints and proposals of IRU (International Road Transport Union) on road safety of heavy vehicles in Europe.

**Submission ID 222-O**

**Assessment of the use of seat belts in buses based on recent road traffic accidents in Spain**

J. de Miguel  
CENTRO ZARAGOZA  
Spain  
I. Ferrer  
IDIADA AUTOMOTIVE TECHNOLOGY SA  
Spain

***Abstract***

Would the compulsory use of safety belts in buses save lives in traffic accidents?

We analysed two recent traffic accidents involving buses whose occupants died or were seriously injured. We used accident reconstruction and computer simulation techniques to make our conclusions.

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# Technical Session 12

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## Intelligent Transportation Systems (ITS) Collision Avoidance

**Thursday, June 7, 2001**

2:00 p.m. - 4:15 p.m.

*Chairperson:* Ian Noy, Canada  
Room A

**Submission ID 445-O**

**IHRA - Report of IHRA Working Group on Intelligent Transport Systems**

I. Noy  
Transport Canada  
Canada

***Abstract***

This report presents a summary of the activities of the IHRA Working Group on ITS. The report highlights the accomplishments of the group, current status of collaborative research and recommendations for future work.

**Submission ID 382-O**

**Development of The Nissan ASV-2**

S. Matsumoto, T. Yasuda, T.  
Kimura  
Nissan Motor Co.,Ltd  
Japan

***Abstract***

This paper describes Nissan's ASV-2, an experimental advanced safety vehicle. The Nissan ASV-2 has been developed in the course of the second phase (FY1996-2000) of Advanced Safety Vehicle (ASV) program promoted by the Ministry of Transport. The Nissan ASV-2 incorporates newly developed technologies aimed specifically at reducing the number of traffic accidents overall. An overview is given of the individual systems, and several technologies that are distinctive features of the ASV-2 are discussed in detail.

**Submission ID 427-O**

**Active safety experiments with common drivers for the specification of active safety systems**

M. Kassaagi  
Ecole Centrale Paris  
France  
T. Perron, G. Brissart  
LAB PSA Peugeot Citroën - RENAULT  
France

***Abstract***

In order to provide data for the specification of active safety systems, like emergency braking boosters, the LAB PSA Peugeot Citroën - RENAULT has been conducting experiments for the analysis of driver behavior in emergency situations. Two experiments concern front-to-end accident situations, involving each one more than 100 representative common drivers. The first was carried out on driving simulator and the second on test tracks. The paper demonstrates the benefit of such experiments conducted with non-professional drivers.

**Submission ID 233-O**

**NHTSA Driver Distraction Research: Past, Present and Future**

W. Garrott, M. Goodman  
National Highway Traffic Safety Administration  
United States  
T. Ranney  
Transportation Research Center Inc.  
United States

***Abstract***

Driver distraction has been identified as a high-priority topic by NHTSA, reflecting concerns about the compatibility of certain in-vehicle technologies with the driving task, whether drivers are making potentially dangerous decisions about when to interact with in-vehicle technologies while driving, and that these trends may accelerate as new technologies continue to become available. This paper summarizes significant findings from past NHTSA research in the area of driver distraction and workload, provides an overview of current ongoing research, and describes upcoming research that will be conducted using the National Advanced Driving Simulator (NADS).

**Submission ID 185-O**

**Collision Avoidance Capability of Older Driver and Improvement by Warning Presentation**

H. Uno, K. Hiramatsu  
Japan Automobile Research Institute  
Japan

***Abstract***

Avoidance behavior of older drivers was compared with younger drivers in a situation where an obstacle vehicle runs out at blind intersections set in a driving simulator. The older drivers needed larger time margin than the younger drivers to successfully complete the avoidances. Though their avoidance performances were remarkably improved by presenting the advanced warnings.

**Submission ID 324-O****Intelligent speed adaptation: the best collision avoidance system?**

O. Carsten, F. Tate  
Institute for Transport Studies, University of Leeds  
United Kingdom

***Abstract***

Intelligent Speed Adaptation (ISA) uses modern technology to transmit the speed limit into the vehicle. That information can then be used to provide information, warnings, or haptic feedback to the driver or even to prevent the vehicle from exceeding the speed limit. This paper summarises some of the results of the UK's three-year national research project on ISA, with particular emphasis on the predictions of accident savings and on the proposed implementation path.

**Submission ID 378-O****Analysis of Crossing Path Crash Countermeasure Systems**

D. Smith  
National Highway Traffic Safety Administration  
United States  
W. Najm, J. Koopmann  
US DOT Volpe Center  
United States

***Abstract***

A study of countermeasure systems was conducted to set research priorities in the area of crossing path crash avoidance under the Intelligent Vehicle Initiative (IVI). Crossing path crashes involve one moving vehicle cutting across the path of another. The IVI is concerned with facilitating the deployment of near-term advanced-technology driver assistance systems to promote safety. The safety benefits and deployment potential were projected for twelve promising countermeasure systems that could be implemented by infrastructure-based, vehicle-based, and cooperative infrastructure/vehicle system technologies.

**Submission ID 201-O****Distance Behaviour on Motorways with Regard to Active Safety - A Comparison between Adaptive-Cruise-Control (ACC) and Driver**

B. Filzek, B. Breuer  
Darmstadt University of Technology  
Germany

***Abstract***

The Department of Automotive Engineering of Darmstadt University of Technology examines by order of BMW AG the distance behaviour with and without using an Adaptive-Cruise-Control (ACC). 50 driving tests were conducted in real world traffic. On this basis, distance behaviour could be analysed objectively with regard to active safety.

**Submission ID 401-O**

**Research on a Brake Assist System with a Preview Function**

M. Tamura, H. Inoue, N.  
Maruko  
Nissan Motor Co., Ltd.  
Japan

***Abstract***

The number of accidents caused by a slight error, such as operating mistakes, careless driving and distraction, has been increasing year by year. This paper presents an analysis of driver behavior characteristics in emergency situations that lead to an accident, focusing in particular on operation of the brake pedal. Based on the insights gained so far, we have developed a Brake Assist System with a Preview Function (BAP) designed to prevent accidents by helping drivers with braking actions.

**Submission ID 483-O**

**Effects of speech versus tactile driver support messages on driving behaviour and workload**

M. Martens, W. Winsum  
TNO Human Factors  
Netherlands

***Abstract***

In a driving simulator experiment, effects were tested of an integrated support system on driving behaviour and workload, using an alternative workload measure. Two modes of support (tactile and speech messages) were compared to a control condition without support. Subjects were confronted with critical incidents dealing with lateral and longitudinal control on rural roads and motorways. Clear effects were found in terms of driving behaviour and workload, with the Peripheral Detection Task being sensitive to short lasting peaks in workload.

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# Technical Session 1.1

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## Biomechanics: Injury Criteria and Dummy Development

### POSTER PRESENTATIONS

Upper Lounge Auditorium

Tuesday, June 5, 2001

3:30 p.m. - 4:30 p.m.

#### Submission ID 160-P

##### Human injury modelling – capabilities and limitations

C. Oakley  
Transport Research Laboratory  
United Kingdom

##### *Abstract*

The results of numerical simulations of human injury are inherently limited in their accuracy due to the uncertainty of input parameters such as material and human response data. Guidance is provided on how to interpret such models taking into account this uncertainty, and examples of successful implementation of these principles are presented. Suggestions are then made as to where future research should be directed in order to increase the reliability of this potentially very powerful tool.

#### Submission ID 226-P

##### Child Injury Tolerance Through Case Reconstruction

A. Hagedorn, D. Rhule  
National Highway Traffic Safety Administration  
United States

##### *Abstract*

A basis for verification of child dummy injury assessment reference values, IARVs, is needed. Presently, the IARVs used for child dummies are derived from the Hybrid III adult dummies using scale factors for size and strength considerations. This study presents an effort to verify the IARVs through reconstructions of real world incidents which have resulted in child injuries.

**Submission ID 274-P**

**Pressure and shear responses in brain injury models**

D. Bradshaw, C. Morfey  
ISVR, University of Southampton  
United Kingdom

***Abstract***

Brain tissue injury correlates well with strain and poorly with pressure; it is the shear response of brain injury models that must be biofidelic. However, we show that brain injury models may be validated for pressure but give an almost arbitrary shear response. We present both a three-layer analytical model and a finite element model of the coronal plane of the human head. In each case, the pressure and shear response are decoupled when human brain material properties are used.

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## Technical Session 2

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### Advanced Technology Safety Systems (Active, Passive Safety/Collision Avoidance)

Tuesday, June 5, 2001

3:30 p.m. - 4:30 p.m.

**Submission ID 164-P**

**The contributive benefits that state-of-the-art sound generation technology provides for Advanced Technology Safety Systems in the NADS program**

C. Patterson, R. Welles  
G.E. Capital I-sim  
United States

***Abstract***

This paper addresses the auditory system criteria, its state-of-art design, philosophy, functional issues, and contributive benefits from the sound subsystem which is incorporated in the NADS program. Additionally, the symphony of properly correlated driving cues are reviewed in relationship with the role of the sound system. Special emphasis is provided on the human factors aspects which define proper auditory immersion and its expected effect on driver behavior.

**Submission ID 186-P**

**Traffic Accidents in Rural Areas and Assist System for Traffic Safety**

T. Katayama, H. Hashimoto, Z. Yang  
Japan Automobile Research Institute  
Japan

***Abstract***

An investigation was made into the causative factor of traffic accidents arose at a clear intersection in the rural area. Two systems, by image processing technique and using DGPS, are introduced in order to assist drivers of visual search ability.

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# Technical Session 4

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## Data Collection, Event Data Recorders and Risk Assessment

**Tuesday, June 5, 2001**

10:30 a.m. - 11:30 a.m.

**Submission ID 146-P**

**Real-World Perceptions of Emerging EDR Technologies**

T. Kowalick  
Click, Inc--Transportation Safety Technologies  
United States

***Abstract***

Research focuses on what college-age motorists perceive to be the positive and negative aspects of implementing on-board Event Data Recorders (EDR's) in the highway mode of transport. The achievements and findings offer safety researchers insight as to which societal issues need to be addressed and overcome to assure successful implementation. A number of key issues ranging from perceived safety benefits versus fear of privacy invasion are included. Research was conducted by a professor/member of the USDOT/NHTSA "EDR Working Group" at a North Carolina Community College

**Submission ID 209-P**

**Large Truck Crash Data-New Developments**

J. Carra, S. Stern  
National Highway Traffic Safety Administration  
United States

***Abstract***

Two large data collection efforts are being undertaken in the U.S. to better understand and characterize crashes involving large trucks, which account for over 5000 U.S. highway deaths per year. This work will result in one of the most extensive and in-depth databases ever assembled on these crashes.

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## Technical Session 6

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### Simulation and Computer Modeling in Vehicle Safety

Wednesday, June 6, 2001

3:30 p.m. - 4:30 p.m.

**Submission ID 313-P**

**Simulations of Large School Bus Safety Restraints - NHTSA**

A. Barsan-Anelli  
Information Systems & Services Incorporated  
United States  
L. McCray  
National Highway Traffic Safety Administration  
United States

***Abstract***

This paper describes crash simulations performed by the National Highways Traffic Safety Administration's (NHTSA) under the current research and testing activities on large school bus safety restraints. The simulations of a frontal rigid barrier test and comparative sled testing for compartmentalization, lap belt, and lap/shoulder belt restraint strategies in a frontal crash are presented.

**Submission ID 364-P**

**NADS System Architecture**

P. Whalen, A. Schafer  
TRWS & ITG  
United States

***Abstract***

This paper provides a top-level description of the NADS system, focusing on its major components, its top-level design, and most importantly, the NADS operational capabilities.

**Submission ID 438-P**

**The electronic belt-fit test device (eBTD): A method for certifying safe seat belt fit**

C. Pruett  
TecMath of North America  
United States  
C. Brown, I. Noy  
Transport Canada  
Canada

***Abstract***

An electronic version of Transport Canada's belt-fit test device (eBTD) has been created by TecMath, developers of the RAMSIS 3D human modeling system. The history of its development and a description of its capabilities as a method for certifying safe seat belt fit in automobiles will be presented.

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## Technical Session 7

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### Compatibility in Frontal and Side Collisions (Car/Car, Car/Vehicle)

Wednesday, June 6, 2001

10:30 a.m. - 11:30 a.m.

**Submission ID 243-P**

**Geometric compatibility in near side impact crashes**

R. Grzebieta  
Department of Civil Engineering, Monash University  
Australia  
C. Tingvall, G. Rechnitzer  
Monash University Accident Research Centre  
Australia

***Abstract***

This paper investigates the issue of geometric incompatibility between vehicles involved in T-bone side impact crashes that lead to severe head injuries. If the incoming bullet vehicle has an elevated bonnet or face region, and the target vehicle is a sedan shape and has no side airbag, the struck vehicle's near side occupant will strike their head against the bonnet or flat face of the incoming bullet vehicle. The severity of this head strike can be fatal at low impact speeds.

**Submission ID 308-P**

**Effects of Angles and Offsets in Crash Simulations of Automobiles with Light Trucks**

J. Brewer  
Volpe National Transportation Systems Center/DTS-74  
United States

***Abstract***

Two sets of vehicle-to-vehicle simulations (fully-engaged angled impact and offset) are done using LS-DYNA models of the C-1500 and the Crown Victoria. Assessments of deformation, energy absorption, and injury will be made as a function of initial crash parameters.

**Submission ID 433-P**

**Influence of body intrusion and deceleration on occupant injuries in frontal collisions between passenger cars**

Y. Kadotani  
American Honda Motor Co., Inc.  
United States  
H. Suzuki  
Honda R&D Co., Ltd.  
Japan  
T. Sugimoto  
HONDA R&D Co., Ltd.  
Japan

***Abstract***

In this paper, we review the results from a matrix of tests performed to evaluate the response of the occupant injuries in collision between passenger cars at 55kph. Various crash tests were conducted with different vehicle weights and stiffness to investigate the affect of body intrusion and vehicle deceleration on occupant injuries.

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## Technical Session 8

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### Improved Safety for Vulnerable Road Users (Bicyclists, Pedestrians, Children)

Wednesday, June 6, 2001

10:30 a.m. - 11:30 a.m.

Submission ID 278-P

**Pedestrian Headform Impact Tests for Various Vehicle Locations**

J. Kajzer

Kabimec Consulting

Sweden

K. Mizuno, H. Yonezawa

Traffic Safety and Nuisance Research Institute

Japan

***Abstract***

The head injury risks were examined from accident analyses and headform impact tests. From accident analyses and headform impact tests, the head injury risk rises from contact with the cowl, lower windscreen frame or A pillar, and it lessens with increasing distance from these structural elements. The headform impact tests also shows that for the current cars the HICs in the bonnet top area tend to be lower than old cars, whereas on the A pillar they are higher.

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# Technical Session 9

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## Developments in Restraint Systems (Airbags, Safety Belts)

Thursday, June 7, 2001

3:15 p.m. - 4:15 p.m.

**Submission ID 238-P**

**Protection of the lower extremities in two and three wheelers with safety cell**

C. Gehre, D. Vetter, H. Appel  
Technical University Berlin  
Germany

***Abstract***

The lower extremities of drivers of two- or three wheelers with safety cell could be protected by knee airbags and specially designed knee bolsters.

**Submission ID 347-P**

**The CREST project (Child Restraint System for Children in Cars) Accident data base**

T. Hummel  
German Insurance Association GDV, Institute for Vehicle Safety  
Germany  
P. Lesire  
LAB PSA Peugeot Citroen - Renault  
France  
R. Grant  
Vehicle Safety Research Centre, Loughborough University  
United Kingdom

***Abstract***

Description of the activity of the Workpackage 1 of the CREST project. Presentation of the methodology. General description of the database of 405 accident involving restrained children collected by 5 European teams.

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# Technical Session 10

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## Developments in Side Impact Protection (Legal, Technical)

Thursday, June 7, 2001

3:15 p.m. - 4:15 p.m.

**Submission ID 479-P**

**Modular Door System for Side Impact Safety of Motor Vehicles**

J. Townsend, M. Kaczmar  
Joalto Design Inc.  
United States

M. El-Sayed  
Kettering University  
United States

***Abstract***

This paper will discuss and summarize the attributes of our overall Modular Door System for Side Impact Safety of Motor Vehicles. This side impact door system introduces the door for the first time as a totally structural entity.

**Submission ID 484-P**

**Design Engineering with Foams and Plastics to Enhance Vehicle Safety**

H. Koelman, R. Heim, P. Naughton  
Dow Automotive Germany  
Germany

***Abstract***

Structural foam becomes even more important in Automotive Industries. Both customer and government require higher standards regarding safety, comfort and lower fuel-consumption. Structural foams could be used for better crash resistance, overall stiffness, Durability and NVH. And adding only a very low amount of weight. In order to achieve the same requirements as achieved with steel you will now be able to take out parts, adding 1 Part structural foam and reduce the overall weight of the car.

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# Technical Session 1.1

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## Biomechanics: Injury Criteria and Dummy Development

### WRITTEN PAPERS

#### Submission ID 124-W

#### **A new neck injury criterion candidate for rear-end collisions taking into account shear forces and bending moments**

K. Schmitt, P. Niederer  
Institute of Biomedical Engineering, ETH Zurich  
Switzerland  
M. Muser  
Working group on Accident Mechanics, Uni Zurich  
Switzerland

#### *Abstract*

A new neck injury predictor called Nkm was developed to assess the risk of sustaining soft tissue neck injuries from low speed rear-end collisions. The criterion takes into account the shear forces and bending moments acting on the neck and thus allows to quantify the occupant forward motion. The influence of the seat design on its protective potential could be related to the Nkm values.

#### Submission ID 144-W

#### **Parametric Study of Side Impact Thoracic Injury Criteria Using the MADYMO Human Body Model**

R. Kent, E. Sieveka, J. Crandall  
University of Virginia  
United States

#### *Abstract*

A parametric study is presented using the MADYMO human body model under side impact loading. Door velocity-time profile, padding modulus, and initial door-to-occupant offset are varied to identify critical sets of these parameters that result in contradictory injury criteria trends. This analytical study is used to develop a test matrix for future cadaver experiments.

**Submission ID 365-W**

**Characterization of CIREN**

L. Brown, Jr., C. McCullough  
National Highway Traffic Safety Administration  
United States

***Abstract***

This paper will focus on the overall structure of the Crash Injury Research and Engineering Network (CIREN), how data is collected and what makes it unique. It will also discuss how it can be used to expand and enhance the information in other Agency databases. CIREN is a collaborative effort to conduct research on crashes and injuries at nine Level 1 Trauma Centers which are linked by a computer network. CIREN data is being used in outreach and education programs on motor vehicle safety. Researchers can review data and share expertise, which could lead to a better understanding of crash injury mechanisms and the design of safer vehicles. CIREN outreach and education has already been credited with lifesaving information dissemination.

**Submission ID 373-W**

**Biofidelity of test devices and validity of injury criteria for evaluating knee injuries to pedestrians**

Y. Takahashi, Y. Kikuchi  
Honda R&D Co., Ltd.  
Japan

***Abstract***

The relationship between the bumper height and the shear displacement / bending angle of the knee joint in car-pedestrian impact simulation has been investigated using finite element models for legform impactor, pedestrian dummy and a human lower limb. The result showed that both the flexibility of bony structure and the anatomic structure of the knee joint have significant effect on the improvement in biofidelity for the dynamic knee joint response.

**Submission ID 436-W**

**Improved Thorax Behaviour of the EUROSID and Effects on Thorax Injury Assessment on the Basis of Pendulum Impacts**

M. Beusenbergh, M. Keown  
Biokinetics and Associates Ltd.  
Canada

N. Yoganandan  
Medical College of Wisconsin  
United States

***Abstract***

Presented are the results of lateral and oblique pendulum tests, conducted on the EUROSID-1 and ES-2, to study the effects of the modified torso back plate as well as to study the responses of three proposed rib module designs for ES -2.

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## Technical Session 2

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### Advanced Technology Safety Systems (Active, Passive Safety/Collision Avoidance)

#### Submission ID 86-W

##### Tendencies Recognition and Analysis of Critical Situations by the Active Safety Systems

V. Ivanov  
Belarusian State Polytechnical Academy, Dept. of Automobiles  
Belarus

V. Boutylin, J. Lepeshko  
Scientific Centre for Machine Mechanic Problems  
Belarus

#### *Abstract*

Critical situations, which can arise at car's motion and should be prevented by its safety systems, are subdivided into two levels. The micro-level is connected directly to wheel-road-interaction, and the macro-level with the car's behavior. For authentic recognition of critical situations the active safety system should be constructed on intelligent principles with parallel information channels and with possibility of self-configuration.

#### Submission ID 122-W

##### Difficulties in Determining the Cause of Real-World Crash Injuries: A Case Study of a NASS Investigation

R. Arbelaez, B. O'Neill  
Insurance Institute for Highway Safety  
United States

#### *Abstract*

A NASS case with implications for airbag performance was recreated in the laboratory to obtain more information on the possible fatal injury mechanisms. The case involved a parked 1958 Chevrolet Bel Air that was rear-ended by a 1991 Dodge Grand Caravan whose unbelted driver sustained fatal chest injuries that may have been related to the airbag performance. The crash test results indicate that steering column movement, rather than airbag performance was the most likely cause of the driver's fatal injuries.

**Submission ID 228-W**

**TOR (Total Occupant Recognition) system**

G. Becker, T. Mousel, P. Schockmel  
International Electronics & Engineering  
Luxembourg

***Abstract***

TOR (Total Occupant Recognition) system, a system to fulfil the NHTSA regulation for a automatic suppression system.

The TOR system is a combination of sensors based on different physical properties: A force sensitive Sensor mat and a electrical field detection.

**Submission ID 258-W**

**The Influence of a Rear Tire Tread Separation on a Vehicle's Stability and Control**

S. Arndt  
Safety Engineering & Forensic Analysis, Inc.  
United States  
M. Arndt  
Transportation Safety Technologies, Inc.  
United States

***Abstract***

Three vehicles, including a passenger car and two SUV's, were tested to evaluate the effect of a tread separation event on their handling characteristics. All three vehicles exhibited similar responses before and after the tread came off of a rear wheel position. The vehicle responded by pulling laterally as the tread was coming off and transitioned from understeer to oversteer when the tread separated tire was on the outside of a cornering maneuver.

**Submission ID 314-W**

**The effect of occupant characteristics on injury risk and the development of active -adaptive restraint systems**

M. McCarthy, B. Chinn  
TRL Ltd  
United Kingdom

J. Hill  
VSRC, Loughborough University  
United Kingdom

***Abstract***

Intelligent restraint systems adapt to specific occupant characteristics in order to maximize secondary safety. The analysis of occupant characteristics with respect to their effect on injury severity is a necessary step to design and optimise active-adaptive restraint systems. This paper describes the analysis procedure and identifies casualty groups who are at above average risk in frontal and side impacts. The effect of each occupant characteristic on injury severity is discussed in terms of the implications for active-adaptive restraint systems.

**Submission ID 320-W**

**The Necessity of an Adaptive Vehicle Structure to Optimize Deceleration Pulses for Different Crash Velocities**

W. Witteman, R. Kriens  
Technische Universiteit Eindhoven  
Netherlands

***Abstract***

To minimize injury to the occupants, the frontal vehicle structure must absorb much more energy in the first deformation phase in case of a high-speed collision. Depending on the crash situation an intelligent system must regulate the structure stiffness yielding additional energy absorption by means of friction. Concept ideas are mentioned to achieve different crash pulses at different crash velocities within the available deformation length.

**Submission ID 325-W**

**Development of an Occupant Position Sensor System to Improve Frontal Crash Protection**

J. Carlson  
Autoliv  
United States  
D. Breed  
Automotive Technologies International  
United States

L. Summers  
National Highway Traffic Safety Administration  
United States

***Abstract***

Considerable research has been initiated to develop new or enhanced injury countermeasures to mitigate injuries to persons, particularly children, who are out-of-position at the time of air bag deployment. This paper reports on the development of an occupant position sensor that can be used with multi-stage inflation technologies for modulating air bag deployment. The occupant position sensor system uses ultrasonic transducers in conjunction with artificial neural networks for the discrimination of out-of-position occupants.

**Submission ID 476-W**

**Improved driver assistance and collision avoidance with adaptive lighting**

B. Wordenweber  
HELLA KG Hueck & Co.  
Germany

***Abstract***

Headlamps are the primary active safety device for over 25% of the vehicle operating time. During twilight and night the driver relies on the headlamp for safe guidance, that is for both visual tracking and obstacle detection. The dynamic nature of driving requires adaptive lighting. Technology can supply practical solutions now. The paper describes both the new qualities and the underlying technologies of adaptive headlamps.

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## Technical Session 3

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### Worldwide NCAP Related to Existing Test Procedures

#### Submission ID 64-W

##### Injury and deformation trends with offset crash tests

M. Griffiths  
Road Safety Solutions  
Australia

M. Paine  
VDR  
Australia

##### *Abstract*

Injury and deformation data from more than 200 offset crash tests carried out since 1995 by EuroNCAP, the Insurance Institute for Highway Safety and Australasian NCAP are analyzed. Trends for head protection, leg protection and structural performance are discussed.

#### Submission ID 128-W

##### Review of Australian NCAP since ESV 1998

J. Haley  
NRMA Insurance  
Australia  
M. Case  
RACV Limited  
Australia

##### *Abstract*

The Australian New Car Assessment Program (ANCAP) last reported on progress at ESV 1998 in Canada. This is an update of results since then. In 1999 ANCAP decided to harmonise its testing and evaluation procedures with EuroNCAP (ENCAP). This was so ANCAP could use the results of ENCAP testing on European vehicles where the vehicle specifications were essentially similar to those of the Australian model, thereby reducing the number and cost of tests required to produce consumer information.

**Submission ID 211-W**

**NCAP - Field Relevance of the Metrics**

J. Lavelle  
General Motors Corporation  
United States

***Abstract***

A simple, high level parsing of towaway crashes from the NASS-CDS files shows that only a small fraction of occupants (but a somewhat larger portion of their injury as measured by ISS) find themselves in crash circumstances remotely similar to NCAP crash conditions. Given the limited scope of frontal NCAP it should not be surprising that it has limited usefulness in discriminating among various vehicles' overall performance in the field.

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# Technical Session 4

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## Data Collection, Event Data Recorders and Risk Assessment

### Submission ID 246-W

#### Air Bag Crash Investigations

A. Chidester, T. Roston  
National Highway Traffic Safety Administration  
United States

#### *Abstract*

This paper presents information from NHTSA's SCI and NASS CDS programs concerning crash investigations on air bag equipped vehicles. The paper's focus is providing information on data collection and findings in the NHTSA sponsored air bag crash investigations. Topics include: air bag related injuries, side air bags redesigned air bags and advanced air bags.

### Submission ID 247-W

#### Real World Experience with Event Data Recorders

J. Hinch  
National Highway Traffic Safety Administration  
United States

A. Chidester, T. Roston  
National Highway Traffic Safety Administration  
United States

#### *Abstract*

This paper will present information from NHTSA's data collection programs concerning crash investigations of vehicles equipped with event data recorders. The focus of the paper will be to provide information on specific findings from the event data recorder compared to the physical evidence and computer reconstruction models.

### Submission ID 248-W

#### Final Report on the Pedestrian Crash Data Study

A. Chidester, R. Isenberg  
National Highway Traffic Safety Administration  
United States

#### *Abstract*

This paper will examine the results of 521 pedestrian crashes collected from 1994 through 1998 through on-scene crash investigations involving late model year passenger cars, vans, and light trucks at six selected urban CDS sites. Additional analyses of the vehicle to pedestrian interaction, including detailed injury documentation, physical characteristics and avoidance actions, will also be examined.

**Submission ID 259-W**  
**Safety Benefits of Improvements in Vehicle Design since the Introduction of the ANCAP Crash Test Program**

J. Haley  
NRMA Insurance  
Australia  
D. Hendry, G. Lyle  
University of Western Australia  
Australia

***Abstract***

Costs and benefits of injuries calculated from ANCAP crash tests - This paper quantifies the value of reducing injuries by improving vehicle safety design derived from data from Australian NCAP tests. An injury cost database was developed under contract by the University of Western Australia from data supplied by the Government Department responsible for personal injury claims in New South Wales. The analysis shows substantial savings from the introduction of better safety in vehicles.

**Submission ID 357-W**  
**Crash Visualization using Real-World Acceleration Data**

R. Galganski, B. Donnelly  
Center for Transportation Injury Research  
United States  
  
L. Lombardo  
National Highway Traffic Safety Administration  
United States

***Abstract***

Real-world crash acceleration data from the Automated Crash Notification Field Operational Test can be used to simulate the occupant response within minutes of the crash using the Articulated Total Body model. This simulation can be used by emergency medical personnel to improve trauma care.

**Submission ID 412-W**  
**The Role of Innovation and Statistical Methodology in Safety Assessment Projects**

G. Stewart  
National Highway Traffic Safety Administration  
United States

***Abstract***

This paper discusses safety assessment projects which are characterized by availability of advanced vehicle information technologies. Past, present, and future event recording situations are discussed to illustrate the use of innovation and statistically designed experiments to provide adequate data for safety evaluations. New and emerging information technologies are providing more opportunities for linkage of different safety data sources; however the role of innovation and statistical considerations are still important for improvement of data quality and ease of use in safety assessments.

**Submission ID 426-W**

**Driver Characteristics using Driving Monitoring Recorder**

M. Ueyama  
National Research Institute of Police Science  
Japan

***Abstract***

A field trial has been carried out using a set of automatic recording system; DMR (Driving Monitoring Recorder) and EEC (Event Eye Camera) installed on 105 vehicles in 3 fleets of taxi and truck in Tokyo area for 4 years, in order to assess the implications in driving characteristic and traffic conditions. DMR can record the data such as running speed vs. time continually, and frequencies of emergency behavior are counted and recorded on drive whenever emergency braking, rapid starting and sharp acceleration. Also, EEC can be imaged the driver views in pre- and post scene during 10 seconds emergency behavior occurred. In conclusion, a set of the automatic recording systems can be offer useful data to study driver characteristics. In addition, the important aspect of this study is persuasively, most drivers tend to accept these data without complaining for improve their safety drive because of digital data and image data.

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# Technical Session 5

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## Development in Frontal Impact Protection (Legal, Technical)

### Submission ID 147-W

#### Old car crash test program

J. Haley  
NRMA Insurance  
Australia  
V. Bonney  
University of New South Wales  
Australia

#### *Abstract*

This paper presents some observations about the structural and safety performance of older vehicles in the frontal offset crash test conducted by the Australian New Car Assessment Program (ANCAP), the Insurance Institute for Highway Safety (IIHS) and EuroNCAP for consumer information.

### Submission ID 385-W

#### Evaluation of Frontal Offset/Oblique Crash Test Conditions

D. Elliott  
Abacus  
United States  
O. Fessahaie  
Information Systems and Services, Incorporated  
United States  
C. Ragland  
National Highway Traffic Safety Administration  
United States

#### *Abstract*

In order to establish a more effective frontal crash test procedure, the NASS CDS crash data were analyzed to determine crash conditions which caused the largest number of moderate and severe injuries. Crash conditions were defined by PDOF, orientation angle, overlap, and delta V for vehicle frontal collisions. The significance of these parameters were examined to determine their contribution to injury causation and the ability of existing dummies to measure this injury potential in crash testing.

### Submission ID 392-W

#### Evaluation of the Effect of Air Bags in Multi-Year NCAP Tests

A. Berkowitz  
National Highway Traffic Safety Administration  
United States

#### *Abstract*

The New Car Assessment Program (NCAP) has conducted tests on the crashworthiness of vehicles since 1979. This paper presents analysis of data on frontal tests for passenger car models that have maintained a consistent body platform and have been tested multiple times since 1979. The effect on test results following the introduction of air bags is evaluated. Data from the 2000 model year tests is included.

**Submission ID 487-W**

**Frontal Offset Deformable Barrier Crash Testing and its Effect on Vehicle Stiffness**

J. Nolan, A. Lund  
Insurance Institute for Highway Safety  
United States

***Abstract***

The Insurance Institute for Highway Safety has evaluated more than 100 new vehicles in 64 km/h (40 mi/h) frontal offset deformable barrier crash tests. Critics have claimed that such tests could push vehicle designs to be stiffer and therefore less compatible. A study of models whose offset test performance has improved indicates that most models have improved while maintaining similar front-end stiffness; however, an increase in overall stiffness may be needed to improve vehicles whose structures fail catastrophically.

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# Technical Session 6

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## Simulation and Computer Modeling in Vehicle Safety

### Submission ID 96-W

#### The virtual prototype of an off-road vehicle

C. Alexandru, P. Alexandru  
University Transilvania of Brasov  
Romania

#### *Abstract*

The paper presents the virtual prototype of the rolling - guiding - suspension system of an off-road vehicle, which is made with the MBS software ADAMS. The dynamic model takes into consideration the geometric restrictions as well as the nonlinear characteristics of the elastic and damping elements. A lot of measurements have been made having in view to optimize the dynamic behavior of the vehicle.

### Submission ID 99-W

#### Proposed four ¼ turn metric to simulate rollover crashes

S. Richardson, R. Grzebieta  
Monash University  
Australia  
P. Bellion  
Victorian Police  
Australia

#### *Abstract*

Rollovers are very injurious, causing a disproportionate amount of harm. Current rollover metrics, Critical Sliding Velocity, Tilt Table Ratio, etc are based on turning a vehicle on to its side (a ¼ turn). ¼ turn rollovers account for 6.9% of AIS 3 to 6 injuries, whereas four ¼ turn rollovers (one full revolution) account for 69.5% of AIS 3 to 6 injuries. This paper proposes a four ¼ turn rollover metric based on vehicle geometry and mass.

### Submission ID 125-W

#### Finite Element Simulation of Drive Shaft in Truck/SUV Frontal Crash

X. Chen, D. Wagner  
Ford Motor Company  
United States

J. Poisac  
Radioss Consulting Corporation  
United States

#### *Abstract*

A finite element modeling method of drive shaft has been developed in this study considering both joints mechanism and material failure during frontal crash. A light truck FEA model is built using this technique and the simulation result is compared with crash test data. Correlations on rocker @ B-pillar pulse, engine velocity and crush distance has been obtained.

**Submission ID 142-W**

**Presenting the results of vehicle dynamics simulation in virtual 3D environment**

M. Ambroz, I. Prebil  
University of Ljubljana, Faculty of mechanical engineering  
Slovenia

***Abstract***

Presenting the results of vehicle dynamics simulation in virtual 3D environment.

Results of simulations computed by mathematical models of vehicle dynamics are presented with animation of 3D vehicle models in a virtual environment. A procedure has been developed that enables quick generation of large quantities of such models from photographs involving use of readily available software for photomodelling. A programme interface has been written to enable composition and display of animations using 3D vehicle models and output data from mathematical model.

**Submission ID 145-W**

**Development of a Sport Utility Front Bumper System for Pedestrian Safety and 5 MPH Impact Performance**

D. Detwiler, R. Miller, S. Malcolm  
Honda R&D, Americas  
United States

***Abstract***

A front bumper system for use on a Sport Utility Vehicle was designed using computer simulation which meets conflicting requirements for both pedestrian safety and 5 mph impact performance.

**Submission ID 159-W**

**A new approach to modelling vehicle interactions with Roadside Restraint Systems**

C. Oakley  
Transport Research Laboratory  
United Kingdom

***Abstract***

A novel methodology based on the finite element method has been developed for the analysis of vehicle interactions with roadside restraint systems (RRS). The approach makes possible the efficient prediction of the outcomes of such events that would otherwise demand very large computing resources. The approach has been validated against test results with different RRS types and avoids the use of detailed vehicle models, which makes it an effective tool for establishing legislative test conditions and for researching and predicting RRS performance.

**Submission ID 191-W**

**Application of the driver model in computer simulation of the car motion**

A. Renski  
Warsaw University of Technology  
Poland

***Abstract***

The paper presents the driver model, which can be used in computer simulation of the curved ride of the car. Examples of application of the model in computer simulations of such test procedure as: the double lane change manoeuvre and the wind gust manoeuvre are presented in the paper. It is shown also that use of the driver model allows to adapt better the car construction and its dynamic properties to psychophysical characteristics of the driver.

**Submission ID 223-W**

### **Virtual testing driven development process for side impact safety**

C. Amann  
BMW AG  
Germany

S. Mundal, D. Schaub  
TRW ORS GmbH & Co.  
Germany

#### ***Abstract***

A new simulation tool was established and approved by TRW as part of the continuous improvement of the development process. This tool allows the OEM and the system integrator to keep high quality even with further reduced development cycle times. The introduction of the tool in a side air bag development program makes it possible to ensure high development confidence with a reduced number of vehicle crashes and late availability of interior component parts.

### **Submission ID 232-W**

#### **Speed limit in city area and improvement of vehicle front design for pedestrian impact protection - A computer simulation study**

J. Yang, X. Liu, P. Lövsund  
Crash Safety Division, Chalmers University of Technology  
Sweden

#### ***Abstract***

A validated pedestrian mathematical model was used to simulate vehicle-pedestrian crashes and evaluate the effect of impact speed and vehicle front structures on the risk of pedestrian injuries. A parameter study was carried out at speeds 20 - 50 km/h and with various sizes of cars, mini vans, and light trucks. This choice represents the frequency of involvement in real world accidents. Results show possible benefits from speed control in urban area and a potential reduction of injury risks by improving vehicle front designs.

### **Submission ID 250-W**

#### **Effects of Seat Back Force-Deflection Properties on Injuries for Both Front and Rear Seat Occupants in Rear Impacts**

J. Saunders III, L. Molino, E. Sun  
National Highway Traffic Safety Administration  
United States

#### ***Abstract***

Numerous publications have discussed the relative merits of lower versus higher seat back stiffness. Mathematical modeling was used to study the relative effects of seat back strength on injury for a single seat and tandem seat arrangement at two impact velocities.

**Submission ID 257-W**

**Simulation of a Vehicle Crash into a Truck Underrun Barrier**

R. Zou, R. Grzebieta  
Department of Civil Engineering, Monash University  
Australia

G. Rechner  
Monash University Accident Research Centre  
Australia

***Abstract***

This paper describes the development of a three-dimensional MADYMO model simulating a car crashing into the rear of a truck with an energy-absorbing rear underrun barrier attached. The underrun barrier was designed to absorb part of the impact energy of the car and hence reduce the injuries of the car occupants. The collision was simulated in order to aid the design and analysis of such energy-absorbing truck underrun barrier systems.

**Submission ID 305-W**

**Analytical Evaluation of an Advanced Integrated Safety Seat Design in Frontal, Rear, Side, and Rollover Crashes**

M. Rashidy, G. T.J  
EASi Engineering  
United States

L. Summers  
National Highway Traffic Safety Administration  
United States

***Abstract***

Analytical computer simulations were used to optimize and fabricate an Advanced Integrated Safety Seat (AISS) for frontal, rear, side, and rollover crash protection. The evaluation and optimization of the AISS design was achieved through analytical simulations using MADYMO multi-body analysis software, LS-DYNA3D finite element software, and LS-DYNA3D/MADYMO coupling. Frontal and rear impact sled tests were also conducted with physical AISS prototypes and baseline integrated seats to verify performance.

**Submission ID 344-W**

**Methodology to design restraint systems with simulations : case of the seat**

M. Pajon  
Faurecia  
France

L. Bouchard, I. Pimort  
Renault Safety Department  
France

***Abstract***

This paper deals with 4 different items in order to improve occupant safety, to help discussions between a car company and the suppliers, to accelerate and control safety components development as far as the seat is concerned. In particular are developed the following subjects.

**Submission ID 419-W**

**Simplified Models for Passive Safety Engineering**

G. Boichot, B. Hazet, L. Di Valentin  
PSA Peugeot Citroën  
France

***Abstract***

In order to improve delays of development, PSA has adopted a new strategy. For crash simulations, one aspect of this strategy consists in using simplified numerical models at the very beginning of a project in order to evaluate and classify a lot of architectural solutions in very short delays. By using this method, specifications needed for drawing pieces are obtained faster, thanks to important saving of time at each step of simulation and computer modeling.

**Submission ID 477-W**

**Virtual Night Drive**

T. Weber, C. Plattfaut  
HELLA KG Hueck & Co.  
Germany

***Abstract***

Of all fatal driving accidents 55% occur at night time, although just 25% percent of the averaged traffic happens at night or dawn. Investigations in this field and the development of specific lighting devices for these situations are very important. We developed a night time driving simulator, which allows to simulate night time scenery with the computer and with virtual reality technologies. Highly accurate light distributions are used to illuminate the scene and it is possible to perform an interactive virtual night drive even with low cost hardware. This technology allows to recognize critical situations and helps to develop dynamic lighting devices for different night time driving situations.

**Submission ID 494-W**

**Development of a Finite Element Model of the Total Human Model for Safety (THUMS) and Application to Car-Pedestrian Impacts**

J. Hasegawa  
Toyota Motor Corporation  
Japan  
  
T. Maeno  
Toyota System Research Inc.  
Japan

***Abstract***

The Total HUMAN Finite Element Model for Safety, called "THUMS" with the good bio-fidelities, has been developed to clarify a variety of injury occurrence mechanisms in place of the crash dummies. This paper focuses on the pedestrian lower extremity injury, but also presents the global responses including the head and upper bodies. It is validated with the results in the frontal car impact to the pedestrian simulated by a cadaver, and it is found out that this model has good correlations with their results.

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# Technical Session 7

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## Compatibility in Frontal and Side Collisions (Car/Car, Car/Vehicle)

### Submission ID 156-W

#### Vehicle Compatibility in Car-to-Car Frontal Offset Crash

H. Bae, K. Park, J. Lim  
Hyundai Motor Co.  
Republic of Korea

#### *Abstract*

A series of car-to-car frontal offset crash tests within passenger car category - midsize vs midsize, midsize vs mini with 50kph each, and MPV vs small with 60kph each - were conducted to research the current incompatible situations using Hyundai Autonomous Crash Vehicle System. Injury levels and structural deformations are compared and a few design recommendations are also suggested. Simulation results of car-to-car frontal offset and side crashes are included for better understanding.

### Submission ID 430-W

#### A Comparative Analysis of Vehicle-to-Rigid Wall and Vehicle-to-Vehicle Frontal Impacts

S. Barbat, P. Prasad, X. Li  
Ford Motor Company/Safety R & D  
United States

#### *Abstract*

In this paper, the vehicle-to-vehicle test results obtained in frontal impact at various configurations are compared to those obtained from vehicle-to-rigid wall frontal impacts in similar test configurations. Acceleration pulses at the B-pillar/rocker, dash and cabin intrusions and toe-board intrusions in vehicle-to-vehicle crash tests are compared to those of different single vehicle crash tests. Energy distributions are also compared for the vehicle-to-vehicle and single vehicle-to-barrier crash tests. It is concluded from the analysis that vehicle weight and stiffness of the front-end are not always the overriding factors dictating aggressivity. In the present work it is shown that good geometrical interaction in vehicle-to-vehicle impact is fundamental to compatibility. The effect of geometry can mask the effect of mass and stiffness and dominate the outcome.

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## Technical Session 8

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### Improved Safety for Vulnerable Road Users (Bicyclists, Pedestrians, Children)

#### Submission ID 184-W

##### A new legform impactor for evaluation of car aggressiveness in car -pedestrian

A. Wittek, A. Konosu, Y. Matsui  
Japan Automobile Research Institute  
Japan

##### *Abstract*

This study focused on the development and validation of a new leg form impactor for application in impact tests simulating car-pedestrian accidents. The responses of this newly developed impactor were reasonably close to the published experimental results obtained using postmortem human subjects.

#### Submission ID 214-W

##### Surveys of Child Restraint Use in New South Wales

H. Vertsonis  
Roads & Traffic Authority, NSW  
Australia

M. Paine  
VDR  
Australia

##### *Abstract*

In order to determine the quality of installation of child restraints in New South Wales surveys were conducted of (a) child restraints fitted to vehicles in shopping centre car parks and (b) people attending family restaurants or child care centres with children. Results are presented.

#### Submission ID 219-W

##### Pedestrian Injury Projection In Australia If Vehicles Achieved A Higher Pedestrian Star Rating

C. Coxon  
Transport South Australia  
Australia

##### *Abstract*

Predictions on pedestrian injury levels are made if different proportions of the Australian vehicle fleet achieved different star ratings by the EuroNCAP test and assessment protocols. Consumer interest is low, which could be corrected by including the pedestrian rating in a single vehicle safety rating.

**Submission ID 326-W**

**Pedestrian Head Impact Testing and PCDS Reconstructions**

J. Stammen, R. Saul  
National Highway Traffic Safety Administration  
United States  
B. Ko  
The Ohio State University  
United States

***Abstract***

Pedestrian research and testing at the NHTSA Vehicle Research and Test Center have recently focused on assessment of proposed ISO and EEVC head impact test procedures, and extension of these procedures to additional vehicle frontal surfaces. In addition to test parameter sensitivity testing, reconstruction of PCDS cases have also been conducted. This paper presents the results of this research.

**Submission ID 380-W**

**A Study of The Upper Leg Component Tests Compared with Pedestrian Dummy Tests**

Y. Okamoto, A. Akiyama, M. Okamoto  
Honda R&D Co., Ltd  
Japan

***Abstract***

The recent accident analysis data indicates that upper leg injury occurs in accidents with utility vehicles more than with passenger vehicles. Full dummy impact tests are conducted to confirm the impact force and moment to the femur and pelvis. The test conditions for the utility vehicle are paid special attention and they are compared with EEVC WG17 test results.

**Submission ID 395-W**

**Daytime Running Lamps (DRLs) - A North American Success Story**

P. Bergkvist  
General Motors Corporation  
United States

***Abstract***

Presentation of GMs Daytime Running Lamps (DRLs) Effectiveness Study.

**Submission ID 440-W**

**Field Test of a Pedestrian Safety Zone Program for Older Pedestrians**

A. Clevon  
Dunlap and Associates, Inc.  
United States  
  
M. Levy, M. Vegega  
National Highway Traffic Safety Administration  
United States

***Abstract***

This paper presents the results of a novel approach for targeting countermeasures to reduce crashes involving elderly pedestrians. Behavioral and engineering countermeasures were targeted to specific zones with a high incidence of older adult pedestrian-related crashes. Results showed that while overall pedestrian-related crashes increased in the city under study, older adult pedestrian-related crashes decreased by 13.7 percent. The decreases were greatest in the targeted zones. The zoning procedure was also associated with substantial cost savings.

**Submission ID 443-W**

**Characterization of Leg Injuries from Motor Vehicle Impacts**

D. Porta  
Bellarmine College  
United States

T. Kress  
The University of Tennessee  
United States

***Abstract***

The objective of this investigation was to understand relationships among loading characteristics as they affect the kinematics and injury of a pedestrian's lower extremity. Real-life pedestrian and motor vehicle collision scenarios were modeled by impacting 604 human cadaver intact legs and long bones with a cart/guide rail impacting system designed to simulate the front end of an automobile. Documented data for various specimens include, but are not limited to, specimen anthropometrics, fracture patterns, failure force levels, and calculated bending moments.

**Submission ID 452-W**

**Ambulance crashworthiness and occupant dynamics in vehicle-to-vehicle crash tests**

B. Donnelly, A. Blatt  
Center for Transportation Injury Research  
United States  
N. Levick  
Johns Hopkins University  
United States

***Abstract***

There are no dynamic safety testing standards specifically for ambulance vehicles in the USA. This study demonstrates occupant safety and crashworthiness of ambulance vehicles in vehicle to vehicle intersection type crash tests. The ambulance vehicles were configured with instrumented ATDs to represent 95th percentile male, 5th percentile female and 3 year child occupants. The findings demonstrated life threatening safety hazards for all occupants. The urgent need for improvements to ambulance crash safety standards and designs are discussed.

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# Technical Session 9

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## Developments in Restraint Systems (Airbags, Safety Belts)

### Submission ID 97-W

#### Dynamic Characteristics of End Release Seatbelt Buckles

D. Renfroe, H. Roberts, S. Andrews  
Renfroe Engineering, Inc.  
United States

#### *Abstract*

Dynamic tests of three end release seatbelt buckles indicate the longitudinal acceleration and jerk required to release the buckle.

### Submission ID 134-W

#### Potentials of Adaptive Load Limitation

G. Clute  
Autoliv GmbH  
Germany

#### *Abstract*

The ability of an occupant protection system, composing of an Adaptive Belt System, to adapt itself to dominant crash condition parameters, such as impact speed and type, occupant size and mass, offers a great improvement in occupant protection for a wider range of crash conditions, as well as occupants.

### Submission ID 169-W

#### A Preliminary Evaluation of Passenger Airbag Effectiveness in Australia

A. Morris, J. Barnes, B. Fildes  
Monash University Accident Research Centre  
Australia

#### *Abstract*

The effectiveness of passenger airbags was analysed using a case-control study of vehicles involved in frontal crashes. In a comparable sample of frontal crashes, the injury outcomes to 24 passengers in vehicles fitted with passenger airbags were evaluated against 88 passengers in vehicles in which no airbag was fitted. Injury reductions were observed in the airbag-equipped vehicles and the most notable reduction was observed in facial injuries.

**Submission ID 332-W**

**The Influence of Rear Loading on the Protection of Child Car Occupants in Child Restraints**

M. Le Claire, C. Visvikis  
TRL  
United Kingdom

***Abstract***

This paper describes analyses of accident data to demonstrate the occurrence of rear loading to restrained children in field accidents and presents the results of dynamic tests performed to explore the effect on different restraint types of limiting the load intrusion from the rear.

**Submission ID 338-W**

**Analysis of Occupant Protection Provided to 50th Male Dummies Sitting Mid-Track and 5th Female Dummies Sitting Full-Forward in Crash Tests of Paired Vehicles with Redesigned Air Bag Systems**

L. Summers, W. Hollowell, A. Prasad  
National Highway Traffic Safety Administration  
United States

***Abstract***

High speed crash tests were conducted with belted and unbelted 5th percentile female dummies seated full-forward in MY 1999 vehicles with redesigned air bag systems. Identical tests were conducted with the 50th percentile male dummies seated mid-track for comparison. The significance of crash pulse, chest-to-steering wheel distance, deployment timing and air bag size were examined. NASS data was also analyzed to estimate the air bag effectiveness of occupants in the full-forward vs. mid-track seat positions.

**Submission ID 345-W**

**Large School Bus Safety Restraint Evaluation**

L. Sullivan, L. McCray  
National Highway Traffic Safety Administration  
United States  
J. Elias  
Transportation Research Center, Inc.  
United States

***Abstract***

This paper details the National Highway Traffic Safety Administration's (NHTSA) current research and testing activities on large school bus safety restraints. The results of two crash tests, a frontal rigid barrier test and a heavy truck side impact test, are reviewed and the results of comparative sled testing for compartmentalization, lap belt and lap/shoulder belt restraint strategies in a frontal crash are presented.

**Submission ID 374-W**

**Study of Airbag Interaction with Out of Position Occupant by the Computer**

K. Kamiji, N. Kawamura  
Honda R&D  
Japan

***Abstract***

This paper describes the results of the airbag- out of position interaction by using computer simulation with the general Euler-Lagrange coupling method in regards to occupant position, bag and inflator characteristics. The results of simulation is correlated to laboratory out of position testing.

**Submission ID 381-W**

**A Methodology Using a Combined Injury Criteria Index to Study the Performance of Various Driver Restraint System Configurations**

J. Yang, H. Mellander, P. Lövsund  
Crash Safety Division, Chalmers University of Technology  
Sweden

***Abstract***

This study aimed to evaluate the effectiveness of a driver intelligent restraint system in car frontal impacts using mathematical models. The restraint system including an airbag, seat belt, load limiter, and pretensioner is developed to be adaptive to different crash conditions, such as severity of crash, belt use, sitting position, and passenger size. The models of the restraint system were developed and validated against impact tests. The effects of the system design changes on injury parameters were investigated in simulations of frontal car impacts.

**Submission ID 480-W**

**Development of Advance Restraint Features to Mitigate Driver Out-of-Position Injury**

W. Mu  
Daimler Chrysler  
United States

***Abstract***

In this study, coupled structural/computational fluid dynamics and rigid body dynamics is employed to simulate the OOP occupant and airbag interaction by using MSC/DYTRAN and TNO/MADYMO. Experimental tests are conducted to validate the computational prediction. Base on the simulation and test results, the effectiveness of airbag design parameters on OOP injury is prioritized. Numerous advanced restraint design features for the OOP injury mitigation is developed that yield very promising results.

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# Technical Session 10

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## Developments in Side Impact Protection (Legal, Technical)

### Submission ID 387-W

#### Side Impact Air Bags - GM Approach

M. Scherba  
General Motors Corporation  
United States

#### *Abstract*

In 1998, side crashes resulted in 9482 fatalities or approximately 25% of all vehicle fatalities in the United States. Side air bags which intersperse themselves between the occupant and the vehicle are considered to be effective in reducing injuries for both children and adults. To maximize side air bag effectiveness they must be carefully engineered to minimize the potential for causing injury while at the same time provide as much restraint capacity as practicable.

### Submission ID 466-W

#### Investigation on the influence of lateral side impact against curbstones on side airbag sensing

S. Olders, M. Philipps  
Institut für Kraftfahrwesen, Aachen  
Germany

#### *Abstract*

In this lecture investigations on the influence of lateral side impact against curbstones on side airbag fire / no fire situations are discussed. Especially the dynamic effects in the area of the suspension have a significant influence on the experimental results. A special test procedure developed at the Institut für Kraftfahrwesen Aachen will be explained which shows repeatability and allows easy parameter variations.

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# Technical Session 11

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## Safety of Heavy Trucks and Buses (Lanekeeping, Stability, Tire/Road)

### Submission ID 270-W

#### Front underrun protection systems for trucks. Considerations about the bullet and target vehicles for a test procedure

J. Ayuso, M. Lozano  
INSIA  
Spain

#### *Abstract*

The present paper describes the activities of the INSIA (University Institute for Automobile Research) for the definition of the bullet and target vehicles required in the test procedure for the validation of a Front Underrun Protection System for trucks. Based on this aim, the next objectives have been developed:- Proposal of the main guidelines for the definition of the target and the bullet vehicles.- Proposal of the ideas for the evaluation criteria in the test.

### Submission ID 414-W

#### Excessive yaw behaviour of commercial vehicles, a fundamental approach

J. Pauwelussen  
TNO-Automotive & Delft University of Technology  
Netherlands

#### *Abstract*

This paper treats yaw-stability for a single heavy vehicle in a fundamental way, i.e. based on the full non-linear vehicle behaviour where critical points are discussed within a phase plane representation for all combinations of tyre behaviour plus suspension compliances, kinematic effects, axle configurations, etc. A method will be discussed to estimate the domain of attraction of the stable points. These effects will also be presented in terms of the handling-diagram. The results are extended to tractor-trailer combinations.

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# Technical Session 12

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## Intelligent Transportation Systems (ITS) Collision Avoidance

### Submission ID 310-W

#### An Algorithm for Rear-end Collision Avoidance Warning Systems

G. Preziotti  
Johns Hopkins University Applied Physics Laboratory  
United States

A. Carter, A. Burgett  
National Highway Traffic Safety Administration  
United States

#### *Abstract*

The National Highway Traffic Safety Administration (NHTSA), supported by The Johns Hopkins University Applied Physics Laboratory, has developed an algorithm for use with rear-end collision avoidance systems that alerts drivers to potentially dangerous driving situations and the need to take evasive action.

### Submission ID 321-W

#### Rear-end Collision Warning System Field Operational Test - Status Report

J. Ference  
National Highway Traffic Safety Administration  
United States

#### *Abstract*

This paper provides an overview of a cooperative research agreement between General Motors and the National Highway Traffic Administration to conduct a field operational test of vehicles outfitted with a prototype rear-end collision warning system and adaptive cruise control. A summary of research results from the first year of the program are also presented in the paper.