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Foreword

This report of the proceedings of the Eleventh International Technical Conference on Experimental Safety Vchicles was prepared by the National Highway Traffic Safety Administration, U.S. Department of Transportation.

We wish to thank the authors and all those responsible for the excellence of the material submitted, which aided materially in the preparation of this report.

For clarity and because of some translation difficulties, a certain amount of editing was necessary. Apologies are, therefore, offered where the transcription is not exact.

Attendees

BELGIUM

Henssler, Herbert
Commission of the European Communities

Marks, Horst
Comite des Const. D'Automobiles du Marche Commun

CANADA

Baird, Robert C.
Technical University of Nova Scotia

Campbell, Gordon D.
Transport Canada

Dalmotas, Dainius J.
Transport Canada

Miller, Charles
Technical University of Nova Scotia

Newman, James A.
Biokinetics and Associates, Ltd.

FEDERAL REPUBLIC OF GERMANY

Albrecht, Horst
Volkswagen AG

Anrecht, H.
Volkswagenwerk AG

Bauer, Robert
Bayern-Chemie

Brasche, Reiner
Ford Werke AG

Burchard, Klaus-Dieter
Federal Ministry for the Economy

Carli, Helmut
Volkswagen

Czernakowski, Wally
Romer-Britax

Danner, Maximilian
HUK-Verband

Eggelmann, Hans-Harold
Daimler-Benz AG

Ensslen, Arnold
Volkswagen

Fellerer, Jorg
BMW AG

Friedel, Bernd
Bundesanstalt fur StraBenwesen

Frielingsdorf, Wolf R.
Daimler-Benz AG

Grandel, Jurgen
DEKRA

Groesch, Lothar
Daimler-Benz AG

Haberl, Josef
BMW AG

Hoefs, Rainer
Porsche AG

Kallieris, Dimitrios
University of Heidelberg

Kallina, Ingo
Daimler-Benz AG

Klanner, Wilfried
ADAC

Koch, Hubert
Institut fur Zweiradsicherheit

Kraft, Hans-Joachim
BMW AG

Kramer, Florian
Technische Universitat Berlin

Kunert, Heinz
Sekurit-Glas Union GmbH

Langwieder, Klaus
HUK-Verband

Lewandowski, Jurgen
Suddevtsche Zeitung

Menzel, Guenther
Volkswagen

Merlino, Charles
MERCO, Inc.

Mitzkus, Jurgen
TRW Repa GMbH

Nilsson, Karl
Bayern Chemie

Otte, Dietmar
Accident Research Unit Hannover

Pfanzeder, Rolf Dieter
Bayerische Motoren Werke AG

Richter, Bernd
Volkswagen AG

Roehr, Ernst-Ruediger
Daimler-Benz AG

Rompe, Klaus
TUV Rheinland

Schmidt, Rudiger
Volkswagen AG

Schmidt-Clausen, Hans-Joachin
FG Lichttechnik, T.H. Darmstadt

Seiffert, Ulrich
Volkswagen AG

Sievert, Wolfgang
Bundesanstalt fur StraBenwesen

Sorsche, Joachim H.
Daimler-Benz AG

Sporner, Alexandria
HUK-Verband

Stamm, Rolf
Federal Ministry of Transport

Stednitz, Werner
Technische Universitat Berlin

Ulrich, Seiffert,
Prof. Volkswagen AG

Zech, Gunter
Adam Opel AG

Zobel, Robert
Volkswagen AG

FRANCE

Bohers, Serge
Peugeot RD

Brutel, Gilles
Peugeot RD

Cesari, Dominique
INRETS

Cheynet, Jean-Pierre
U.T.A.C.

Chillon, Claude
Peugeot RD

Cord, Paul-Philippe
SNPE of France

de Beaumont, Marc
Regie Nationale des Usines Renault

Dobias, Georges
INRETS

Doin, Bernard
SNPE of France

Duchesne, Alain
Davy-Bickford

Edouard, Jacques G.
PSA

Gauvin, Bernard
Ministry of France

Gommendy, Jean Pierre
General Motors France

Guasco, Raymond
C.L.E.P.A.

Kozyreff, Michel
Autoliv Klippan SA

Phelps, John
International Organization of Motor Vehicle Mfrs.

Rogers, Nicholas
BPICM

Stcherbatcheff, Georges
Renault

Tarriere, Claude
Peugeot SA-Renault

ITALY

Ardoino, Pier Luigi
Fiat Auto S.p.A.

Danese, Gaetano
Department of Transportation

Pastorino, Alessandro
Fiat Auto S.p.A.

Rossi, Franco
Department of Transportation

JAPAN

Fukuda, Yasutaka
Ministry of Transport

Fukunaga, Yukio
Nissan Motor Company, Ltd.

Furukawa, Yoshimi
Honda R&D Co., Ltd.

Goto, Kenichi
Japan Automobile Res.Inst.

Haruo, Ohmac
Japan Automobile Research Institute, Inc.

Horii, Mitsuo
Japan Automobile Research Institute, Inc.

Hasegawa, Akira
Yamaha Motor Co., Ltd.

Hirakawa, Yoshio
Subaru Research & Design

Igarashi, Masaru
Suzuki Motor Co.

Iizuka, Haruhiko
Nissan Research Lab.

Iwata, Yoichi
Kawasaki Heavy Indus., Ltd.

Kamiya, Kouichi
Mitibuchi Motors Corp.

Kenzo, Inagaki
MITI, Automotive Div.

Kobayashi, Saburou
Honda R&D Co., Ltd.

Kodama, Yukio
Subaru Research & Design

Kondoh, Yutaka
Toyota Motor Corp.

Kysaka, Keiji
Kawasaki Heavy Indus., Ltd.

Masanori, Motoki
Japan Auto. Res. Inst.

Masanori, Uchida
Columbia Import & Export Co., Ltd.

Matsushita, Kiyomi
Nissan R & D, Inc.

Matasumoto, Shinichi
Suzuki Motor Co.

Motoki, Manasori
Japan Automobile Res. Inst.

Nagayuki, Marumo
Nissan Motor Co., Ltd.

Nakamura, Yoshio
Honda Motor Co., Ltd.

Nakano, Mickey
Yamaha Motor Co., Ltd.

Nishimoto, Y.
Honda Motor Co.

Ohmae, Haruo
Japan Automobile Res. Inst.

Okuyama, Teiji
Aisin Seiki Co., Ltd.

Onoda, Atsushi
Toyota Motor Co.

Kobayashi, Saburo
Honda R&D, Ltd.

Saitoh, Seiichi
Isuzu Motors, Ltd.

Sakata, Masao
Nissan Motor Co., Ltd.

Sasaki, Shigeru
Japan Automobile Mfrs. Assn.

Shibuya Mukota
Subaru Research & Design

Tadokoro, Hidetoshi
Japan Automobile Mfrs. Assn.

Taguchi, Mori
Yamaha Motor Co., Ltd.

Tanaka, Yuji
Yamaha Motor Co., Ltd.

Yamamoto, Takenori
Honda R&D Co., Ltd.

SPAIN

Chicharro, Ricardo
I.N.T.A.

SWEDEN

Abrahamsson, Anders
Saab Scania Car Division

Aldman, Bertil
Chalmers University of Technology

Bengtsson, Sven
Volvo Car Corp.

Carlsson, Gero
Volvo Car Corp.

Eklund, Olof
Swedish Road Safety Office

Eriksson, A.
Volvo Car Corp.

Haland, Yngue
Eleltrolux Autoliv

Hansson, Thomas
Volvo Car Corp

Helmersson, Tore
Saab-Scania AB

Kajzer, Janusz
Chalmers University of Technology

Mellander, Hugo
Volvo Car Corp.

Nilsson, Stefan
Volvo Car Corp.

Nilsson, Ulf
Volvo Car Corp.

Nordgren, Curt
Assn. of Swedish Auto Mfrs. and Wholesellers

Nordstrom, Olle
Swedish Road and Traffic Research Institute

Nygren, Ave
Folksam R&D

Salomonsson, Ove
Volvo Car Corp.

Strandberg, Lennart
Swedish Road and Traffic Research Institute

Tingvall, Claes
Folksam R&D

THE NETHERLANDS

Decoo, Peter
TNO Road-Vehicles Res. Inst.

Janssen, Edgar
TNO-Roard-Vehicle Res. Inst.

Meekel, Gerard
Ministry of Transport and Public Works

Oskam, Henk
Volvo Car BV

Paar, Hans
Ministry of Transport and Public Works

Reys, Bernard
TNO-Delft

Schlosser, Leo
Ministry of Transport

Sinnige, Theo
TNO Netherlands

Van de Werve, Leon
Volvo Car BV

Van Kampen, Boudewyn
Institute for Road Safety Research SWOV

Wismans, Jac
TNO Road-Vehicles Res. Inst.

UNITED KINGDOM

Baker, Bill
Ford Motor Co., Ltd.

Bowker, Alan
U.K. Department of Transport

Cart, John
Lucas Girling, Ltd.

Coles, Robert
Society of Motor Manufacturers and Traders, Ltd.

Dale, Keith
Motor Industry Research Assn.

Dennis, A.H.
Norton Motors, Ltd.

Doe, Gerald
Lotus Cars, Ltd.

Edge, Stanley J.
Sheller-Clifford, Ltd.

Edwards, Brian
Lucas Girling, Ltd.

Foot, Douglas
U.K. Department of Transport

Furness, John
Institute of Mechanical Engineers

Grew, Nicholas
Austin Rover

Grime, Geoffrey
University College London

Happian-Smith, Julian
Transport and Road Research Lab.

Hardy, Roger
Cranfield Impact Centre

Harms, Peter L.
Transport and Road Research Lab.

Hill, Kenneth
Middlesex Polytechnic

Holmes, Keith
U.K. Department of Transport

Hope, Fred
Hope Technical Development, Ltd.

Jelly, Rachel
Lotus Cars, Ltd.

Jones, David V.
U.K. Department of Transport

Lewis, Richard W.
Ford of Europe

Lowe, William Thomas
Leyland Trucks, Ltd.

Lyness, David
U.K. Department of Transport

Mackay, Murray
University of Birmingham

Mills, Roger
Ogle Design Ltd.

McCormick, Stephen
Jaguar Cars

Morris, Julian
Oxford Metrics

Neilson, Ian
U.K. Department of Transport

Sadeghi, Majid
Cranfield Impact Center

Riley, Brian
Transport and Road Research Lab.

Peter, Alexander
The Middelsex Polytechnic

Searle, John A.
Motor Industry Research Assn.

Suthurst, Gary
Ford Motor Co., U.K.

Teece, Brian
Jaguar Cars

Tree, David
Jaguar Cars, Ltd.

Watson, Peter
U.K. Department of Transport

Williams, Christopher
Ford Motor Co., Ltd.

UNITED STATES

Abbe, Charles
Takata Corp.

Accambe, Debbie
Volvo Cars of North America

Alderson, Samuel W.
Humanoid Systems

Allan, Sean
General Services Administration

Allen, William
Volvo Cars of North America

Ancker-Johnson, Betsy
General Motors Corp

Appleby, Michael
Automobile Club of So. Calif.

Asbury, Jim
Radar Control Systems Corp.

Aston, Benjamin
European Communities

Barber, Maura
Nissan R&D, Inc.

Bartol, Aileen M.
Systems Research Labs., Inc.

Bauer, Noel
Breed Automotive Corp.

Baxter, W. L.
Automotive Engineer Consultant

Bennett, James
General Motors Research

Bergman, Robert
House Energy & Commerce Comm.

Bischoff, Donald
NHTSA

Black, Donald
Fiat Auto S.p.A.

Boehly, William
NHTSA

Bowditch, Fred
Motor Vehicle Mfrs. Assn.

Bowie, Noble
NHTSA

Bradford, Lynn
Institute for Safety Analysis

Brewer, H. Keith
NHTSA

Brantman, Russel
Breed Automotive Corp.

Breed, Allen
Breed Automotive Corp.

Breed, David
Breed Automotive Corp.

Breed, Ria
Breed Automotive Corp.

Brown, William E.
Ford Motor Co.

Brunner, Paul
A. B. Kelley Corp.

Burnett, James
NTSB

Burnley, James
Dept. of Transportation

Busby, David
Auto Importers of America

Bush, Ken
American Suzuki Motor Corp.

Butt, Alex
Suzuki Motor Corp, U.S.

Calcagno, Roy
Chrysler Corp.

Camp, Louis
Ford Motor Co.

Carlson, James A.
American Motors Corp.

Carr, Thomas
Motor Vehicle Manufs. Assn.

Carroll, Diane
Insurance Institute for Highway Safety

Chu, Siou-Ming
NHTSA

Chesterfield, David
Dynatech

Claybrook, Joan
Public Citizen Group

Clarke, Robert
NHTSA

Dale, Lewis
General Motors Corp.

Dana, Gregory
Automobile Importers of America, Inc.

Daniel, Roger
Ford Motor Co.

Davis, John W.
Radar Control Systems Corp.

Davis, Robert W.
General Motors Corp.

Davis, Stanley
Radar Control System Corp.

Deng, Yih-Charng
General Motors Corp.

Denton, Robert A.
Robert A. Denton, Inc.

Detloff, Clement A.
General Motors Corp.

Digges, Kennerly
NHTSA

Dlugos, James
Volvo Cars of North America

Dole, Elizabeth Hanford
Dept. of Transportation

Donohue, Robert
General Motors Corp

Donovan, James P.
Wilson, Elser, Moskowitz, et. al.

Drexl, Klaus
Mercedes-Benz of North America, Inc.

Driggs, Michael A.
Office of Policy Development
The White House

Dugoff, Howard
ICF, Inc.

Duncan, William
Japan Auto. Mfrs. Assn.

Edwards, John A.
Carr Engineering

Evans, Leonard
General Motors Research Labs

Ervin, Robert
Univ. of Michigan Transportation Research Inst.

Fancher, Paul
Univ. of Michigan Transportation Research Inst.

Farber, Eugene
Ford Motor Co.

Felrice, Barry
NHTSA

Finkelstein, Michael
NHTSA

Fitzpatrick, Michael J.
Fitzpatrick Engineering

Flaim, Thomas
General Motors Corp.

Fleming, David
American Honda Motor Co., Inc.

Forbes, Lyman
Ford Motor Co.

Frenchik, James
Fisher Guide Division, GMC

Friedman, Donald
Liability Research

Fujii, Yoichiro
Toyota Gosei Co., Ltd.

Fuller, Peter M.
University of Louisville

Gambardella, Bruce C.
Automotive Engineer Consultant

Gardner, Graham
Land Rover, Ltd.

Gloddeck, Alfred
Subaru of America

Goto, Susumu
Isuzu Motors of America, Inc.

Griffin, Charles
Radar Control Systems Corp.

Haase, Oswald
A.S.S.e.V.

Hackney, James
NHTSA

Haenchen, Dietmar
Volkswagen of America

Hagie, Roger
Kawasaki Motors Corp., U.S.A.

Hale, Chet
American Honda

Halloran, Paul
General Motors Corp.

Hamilton, Michael
Transportation Research Center of Ohio

Hansen, Larry
Morton Thiokol, Inc.

Harington, Toni
American Honda, Inc.

Harris, Joe
Radar Control Systems Corp.

Harvey, Thomas
D.O.T./TSC

Hasegawa, Tetsuo
Nissan Motor Co., Ltd.

Hayahsi, Tomoyo
Nissan R&D, Inc.

Hedlund, James
NHTSA

Henson, Sherman
Ford Motor Co.

Hespeler, Gebhard
Mercedes Benz of North America

Hight, Philip
Accident Research Consultant

Hofferberth, James
NHTSA

Holthe, Bjorn
Volvo Cars of North America

Hoover, Jerrold B.
Goodyear Tire and Rubber Co.

Houren, William T.
Sheller Globe Corp.

Howell, Larry
General Motors Res. Labs.

Howland, Arthur
Ford Motor Co.

Hultman, Robert
Ford Motor Co.

Humphrey, Richard
General Motors

Hutchinson, Philip
Volkswagen of America

Iida, Teij
Toyota Motor Corp.

ATTENDEES

Itagaki, Tom
Yamaha Motor Co.

Jefferies, Robert
Radar Control Systems Corporation

Jenson, Robert F.
American Motors Corp.

Johannessen, George H.
American Seat Belt Council

Johnson, Evan
Center for Auto Safety

Johnston, James D.
General Motors Corp.

Jones, Erika
NHTSA

Jones, Ian S.
Insurance Institute for Highway Safety

Kadoya, Sadato
Mazda North America

Kahane, Charles
NHTSA

Kaminaga, Seiji
Nissan R & D, Inc.

Karasudani, Takahisa
JETRO, New York Automobile Division

Kataoka, Schio
Nissan R&D, Inc.

Kato, Hiroshi
MMC Services

Kelleher, Barbara
Hartley Associates, Inc.

Kelley, Benjamin
A. B. Kelley Corp.

Kennebeck, Joseph
Volkswagen of America, Inc.

Kennedy, Christopher
Chrysler Motors Corp.

Kerns, John
American Honda

Keryseki, John
NHTSA

Kessler, John
Transportation Research Center of Ohio

King, Albert
Wayne State University

King, William K.
Ford Motor Co.

Kissenger, J. Peter
NTSB

Koike, Jim
Yamaha Motor Corp., U.S.A.

Lake, Leo
Yamaha Motor Corp., USA

Leasure, William
NHTSA

Lisowski, John
Morgan, Melhuish, Monayhan, Etc.

Louis, Francois
Renault, Inc.

Luchter, Steve
NHTSA

Lucki, Richard
Peugeot-Citroen

Machey, John
NHTSA

MacLaughlin, Thomas
NHTSA

MacLean. Robert B.
Ford Motor Co.

Maeda, Toshio
Nissan R & D., Inc.

Mahan, David
DGA International, Inc.

Malone, Daniel P.
General Motors Corp.

Markison, Marlene
NHTSA

Maness, Alan
Senate Commerce Comm.

McCormick, Walter B.
Senate Committee on Commerce, Science, and Transportation

McPherson, Walter
Transportation Research Center of Ohio

Mertz, Harold
General Motors Corp.

Miller, Herb
NHTSA

Miller, Jeffrey
NHTSA

Miller, Patrick M.
MGA Research Corp.

Millet, Ralph
Automobile Importers of America, Inc.

Milliken, William
Milliken Research Associates, Inc.

Miyoshi, Akihiko
Japan Auto Mfrs. Assn.

Molinaro, Ralph A.
Chrysler Corp.

Monk, Michael
NHTSA

Morgan, Richard
NHTSA

Morris, John
NHTSA

Munson, Robert
Ford Motor Co.

Muzzy, William
Naval Biodynamics Lab.

Miyoshi, Akihiko
Japan Auto. Mfrds. Assn.

Nagahara, Hiroshi
Nissan R&D, Inc.

Nagamoto, Y.
Mazada of North America, Inc.

Nakahama, Ryoji
MMC Services, Inc.

Nakajima, Giko
Takata Corp.

Nakayma, Yoshikazu
Takata Corp.

Nash, Carl
NHTSA

Negro, Alberto
Fiat Auto S.p.A.

Nicholson, Robert
NHTSA

Nield, George
Automobile Importers of America

O'Toole, Stephen E.
General Motors Corp.

Owen, Ronald
Parker, Johnson, Owen & McGuire

Palframan, Ken
Land Rover.Ltd.

Perry, David J.
Subaru of America

Petrauskas, Helen
Ford Motor Co.

Petrucelli, Elaine
American Association for Automotive Medicine

Pike, Jeffrey
Ford Motor Co.

Powell, Samuel F.
U.S. Coast Guard

Prasad, Priya
Ford Motor Co.

Preuss, Anthony C.
Volkswagen of America, Inc.

Pulley, Charles H.
American Seat Belt Council

Radlinski, Richard
NHTSA

Rangarajan, Nagarajan
GESAC

Rasmussen, Roy R.
U.S. Air Force

Reed, Donald
American Seat Belt Council

Reed, Gaylene
American Seat Belt Council

Reidelbach, Heinrich
Mercedes-Benz of North America, Inc.

Reinfurt, Donald
Univ. of North Carolina

Repp, John
Ford Motor Co.

Riley, Warner W.
Warner Riley Enterprises, Inc.

Robbins, Ronald E.
Consultant

Rockow, Ralph
Dynamic Science, Inc.

Rogers, Robert
General Motors, Inc.

Romeo, David
Romeo Engineering International, Inc.

Sances, Anthony
Medical College of Wisconsin

Saul, Roger
NHTSA

Sawada, Kuniyoshi
Japan Auto. Mfrs. Assn.

Schneider, Larry
University of Michigan
Transportation Research Inst.

Scollon, Teresa
Mazda of North America, Inc.

Scully, William
BMW of North America

Seif, Hank
Motor Vehicle Mfrs. Assn.

Shapiro, William
Volvo Cars of America

Sheets, Philip
Kawasaki Motors Corp. of America

Shulman, Michael
Ford Motor Co.

Siracuse, Phil
U.S. Suzuki Motor Corp.

Slechter, Albert J.
Chrysler Corp.

Smith Jeffrey
General Motors Corp.

Smith, Jennifer L.
Mike Masaoka Associates

Smith, Larry
Chrysler Corp.

Smith, Lynne
NTSB

Smith, Martin
Art Center College of Design

Smith, Paul C.
House Committee on Energy and Commerce

Smolkin, Howard
NHTSA

Smreker, John
American Motors Corp.

Snider, John N.
University of Tennessee

Sonosky, Jerome
Mercedes-Benz

Souchock, Peter
Ford Motor Co.

Spilman, Charles
Traffic Safety Now, Inc.

Stahl, Melvin R.
Motorcycle Industry Council, Inc.

Stalnaker, Richard L.
Ohio State University

Steed, Diane K.
NHTSA

Stocke, James
General Motors Corp.

Stumcke, E.J.
Jaguar Cars, Ltd.

Sullivan, Lisa
NHTSA

Sweedler, Barry M.
NTSB

Szydlowski, Robert J.
General Motors Corp.

Taguchi, Mori
Yamaha Motor Co., Ltd.

Takada, Kazuhiko
Takata Corp.

Takechi, Nobuyshi
MMC Services, Inc.

Taormina, Ted
General Motors Corp.

Tubin, Thomas W.
Wilson, Elser, Moskowitz, et. al.

Turpin, Francis
NHTSA

Utans, Paul
Subaru of America

van Deelen, Wim
Commission of the European Communities

Verma, Mukul
General Motors Corp.

Versace, John
Ford Motor Co.

Viano, David C.
General Motors Corp.

Vick, Elizabeth
Japan Auto. Mfrs. Assn.

Wagenaar, Alexadria C.
University of Michigan Transportation Research Inst.

Walker, Jerry
U.S. Dept. of Energy

Walsh, Michael
CRS Research, Inc.

Walsh, William
NHTSA

Wasko, Ronald
Motor Vehicle Mfrs. Assn.

Weir, David
Dynamic Research, Inc.

Weiss, Marc S.
Naval Biodynamics Labs., Inc.

Werner, John
State Farm Insurance Co.

White, Richard Jr.
Systems Research Labs, Inc.

Wilbur, Van
Austin Rover

Willen, William
American Honda Motor Co., Inc.

Williams, James K.
National Research Council

Wilson, Bud
Suzuki Motor Corp.

Wilson, Richard A.
General Motors Corp.

Wong, Jack
Insurance Institute for Highway Safety

Yamada, Albert
Mike Masaoka Associates

Yano, Yushihiro
Japan Automobile Mfrs. Assn.

Yasuda, Hidenori
Nissan R&D, Inc.

Yokoyama, Hiroyuki
Toyota Motor Corp.

Yoshida, Kenichi
Nissan R&D, Inc.

Yoshie, Takashi
Toyota Motor Corp.

Yoshikura, Takio
Nissan R&D, Inc.

Yukevich, Sharon
Volvo Cars of America

Zellner, John W.
Dynamic Research, Inc.

Ziwica, Karl-Heinz
BMW

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Section 1
Opening Ceremonies

Welcoming Address:

Diane K. Steed,
Administrator,
National Highway Traffic Safety Administration,
Department of Transportation,
United States

I am honored to welcome you to the eleventh annual international conference on experimental safety vehicles—the first held in this country since 1976, our bicentennial year.

Over the past two decades—thanks in no small part to the efforts of many here today—we have seen significant technological advances in automotive safety. Many of the safety improvements that are on today's vehicles were made possible through the research of the governments, manufacturers and suppliers, and individuals represented here today.

At the National Highway Traffic Safety Administration we take our mandate to save lives and reduce injuries very seriously. In one sense, we are trying to save the same life in as many ways as possible. Let me take a few moments to explain what I mean. Picture for a moment, a hypothetical traffic fatality.

It is night. It is raining. The crash takes place on a rural road with poor alignment. The driver is a young salesman returning home from a dinner meeting where he'd been drinking. He is driving too fast, in a vehicle with worn tires. The driver brakes on a turn and the car skids out of control. It crashes into a tree and the driver, who wasn't wearing his safety belt, smashes into the steering column and ultimately is ejected from the car as it rolls over. The police arrive on the scene and they call an ambulance. The driver is taken to the nearest hospital where he dies the next morning of internal injuries.

The outcome is all too familiar. But what is the cause of death? There is no single answer, although a lot of people will try to identify one. The police officer might cite speed or drinking on his report as the cause. The brake engineer might wonder if a car with antilock brakes would have skidded. The biomechanics expert could blame the fatality on the failure to develop the next generation of collapsible steering columns because there is still not enough known about soft tissue impact tolerance. The state motor vehicle inspector might blame worn tires. The truth is, we in highway safety need to be concerned about *all* factors that contributed.

We believe that effective intervention in one or more of the areas I just cited on that long list of contributing factors can make the difference in preventing the crash fatality I just described.

Ours must be a broad focus, a balanced program that considers equipment as but one area of improvement in our continuing quest to save lives. Nevertheless, safety research into design and equipment improvements is and will remain a vital part of our program.

At earlier conferences, we have considered the value of such safety devices as air bags and automatic safety belts, windshield glazing to protect against facial lacerations, high-mounted rear brake lights to reduce the chance of rear-end collisions, and anti-lock braking systems to enhance vehicle control on wet roads.

We have also worked to harmonize safety regulations with other countries to see that safety innovations are more readily available to all.

To further *that* safety goal, I announced at Oxford my intention to form a Motor Vehicle Safety Research Advisory Committee. Today, that intent is a reality and appointments to the Committee will be announced over the next few months. This Committee will represent a unique opportunity for research people from government and private industry. Through this program we will be able to avoid duplication of effort and foster greater harmonization.

In just five years we have already seen the benefits of efforts to work together in the use of common symbols on vehicle control displays and recent changes in lighting standards, and we are close—very close—in our efforts to harmonize braking standards for passenger cars.

By working together to eliminate conflicting regulations that make it burdensome for manufacturers with customers in both foreign and domestic markets, we are helping to remove the non-tariff trade barriers that restrict international commerce. Harmonization also helps reduce costs to consumers and the industry. We are also able to promote safety by upgrading standards and encouraging the sharing of safety technology.

We've entered a new era in highway safety, for this is the year when automatic crash protection became more than regulatory rhetoric.

How times have changed!

Back in 1956 the Ford Motor Company introduced a safety package that included a deep-dish steering wheel, padded dash, and safety belts. Unfortunately that car was surpassed by a competitor and, didn't set any sales records, giving rise to the notion that "safety doesn't sell."

Over the years, that notion became the prevailing wisdom. As the Chairman of General Motors, Roger Smith, said recently, "Back in the early '70's, GM was the first auto manufacturer to design, build, and sell an air-cushion restraint system—we were the world leader—but we may have been a little ahead of our customers."

"But," he added, "people's tastes change."

And, as we begin four days of what I know will be a positive exchange of information, it is obvious that he is right.

On my recent trip to Japan and South Korea, I was pleased to see a number of safety regulatory programs underway and to learn that nearly all the Japanese companies are hard at work on air bags. Honda will offer driver side air bags on the Acura Legend beginning next month and other companies have plans to introduce this technology in the relatively near future.

In the parking lot across the street from this hotel are 18 vehicles that demonstrate what automakers around the world are offering in the way of automatic crash protection. At 12:30 some of you joined with people from around the world in viewing an air bag demonstration.

Just one of a number of interesting discussions and demonstrations you will experience this week.

Your work is of great benefit. We eagerly anticipate the reports, the panels, and the private conversations and exchanges of information that lie ahead.

Now, I am proud to have the opportunity to present someone who has made transportation safety a national and international issue, a lady who has made a positive difference in all our lives, Elizabeth Hanford Dole.

Keynote Address

The Honorable Elizabeth Hanford Dole,
Secretary of Transportation,
United States

I'm delighted to participate in the opening of this 11th International Technical Conference on experimental safety vehicles. On behalf of the American delegation, I bid you welcome to Washington. I'm confident that this will be a worthwhile and informative conference.

Since the first conference in 1970, tremendous strides have been made in the technology of motor vehicle safety—advances toward which all nations have contributed, and from which every nation has benefitted.

The nations which participate in this conference share a common goal—to increase automobile safety for the traveling public. Since the automobile is the preferred means of transportation throughout the industrialized world, developing ever safer motor vehicles is of paramount importance to our nations. Motor vehicle deaths transcend national boundaries; no nation is immune from the tragedies of deaths and crippling injuries due to automobile crashes.

In fact, we inhabit a world where national boundaries are no longer seen as natural barriers, to culture or commerce. And so we at DOT are deeply involved in a worldwide campaign called Harmonization. We seek to harmonize American vehicle safety standards with those in other lands—not only to lower consumer costs but also to enhance our ability to compete in foreign markets and to ensure that we devote every ounce of strength we have to remove all foreign trade barriers to our products. Even now, we are looking for areas where we can coordinate with European governments the adjustment of standards. We've already succeeded in putting common symbols on vehicle control displays; now we are looking to make similar rules for passenger cars and brakes.

That's just the beginning of changes I see on the American road. Even more striking examples come to mind. Who would have thought that the American public would so readily accept mandatory child safety seat laws? The seed was planted in the state of Tennessee in 1978 with the first of such safety seat laws. Today, every state in the union, along with the District of Columbia, has similar legislation on the books. Usage rates for children under five has jumped from just 15 percent in 1979 to 75.8 percent last year. And our studies show that child seats, when properly installed, reduce the risk of death or serious injury for young children by about 70 percent.

Many European countries have had a long and successful history of mandatory safety belt laws, but it took a great deal of effort to get the ball rolling here. Indeed, the biggest single challenge I faced when arriving at the Department four years ago was to review and settle, once and for all, the U.S. regulation on automatic crash protection for passenger car occupants. Our decision in 1984 has contributed much to a nationwide awakening on occupant protection. Twenty-seven states and the District of Columbia have now passed safety belt laws. And last fall, we officially entered not just another model year, but also a new era in highway safety—the year when automatic crash protection became more than just regulatory rhetoric. This year, the auto industry is manufacturing some one million cars which will offer either automatic safety belts or air bags. And by 1990, automatic protection will be standard equipment in all new passenger cars unless states representing two-thirds of the population of the United States have enacted effective mandatory seat belt use laws. While I don't have to tell you the significance of this safety milestone, I can't help but note that for the first time in the long 15-year history of this rule, we're looking at reality—not just a prototype of the future—and lives are being saved.

Who would have thought, just a few short years ago, that one would open *Time* or *Newsweek* and find two-page advertising spreads touting auto safety initiatives? A nationwide NHTSA survey found over three-quarters of Americans favoring safety belt laws for the driver and front seat passenger. And in states where mandatory laws have been enacted, an even higher percentage want them to remain on the books.

I've spoken of changed expectations as well as changed designs. Before I leave this subject, may I point to the single most encouraging example of grassroots citizens leading their government toward safer highways. For while engineers were responsible for anti-lock brakes, improved steering columns and anti-lacerative windshields, it was citizens by the millions who changed the way we view the drunk driver in this country. Some of our European friends have had much tougher drunk driving laws, but America is finally beginning to catch up. A decade ago, too many Americans regarded a drunk driver as only a nuisance. Today, we see him as a potential killer—and rightfully so. DOT is working hand in hand with aroused groups of citizens and state legislators across the country to change attitudes and laws. And we will not rest until we get every last drunk driver off the roads and highways of this country, nor will we accept toothless laws and lenient judges. This is one change still unfolding, and we have a way to go on this front.

In 1984, we vigorously supported—and President Reagan signed into law—a bill encouraging states to set 21 as their legal minimum drinking age. Forty-seven states have now done so. Although we normally defer to the states on traffic law issues, as the President said, a uniform drinking age will do away with "blood borders," where teenagers have a positive incentive to drink and drive, to cross state lines to take advantage of lower drinking age laws and then make the return trip home "under the influence."

Statistics show that setting 21 as the legal minimum drinking age works. While drunk driving remains the leading cause of death for our young people, the proportion of teenage drunk drivers has dropped from 28 percent in 1982 to 20 percent in 1985, a significant and encouraging decrease.

The human factor forms but the first leg of what I call the safety triad for our highways. The second rests on the condition of our highways and bridges. There's progress there as well. Our interstate highway system—the safest, most efficient highway network in the world—is almost complete, and we're rehabilitating and repairing roads and bridges at record rates. We're preserving and protecting the system of highways we depend on so heavily, both for our commerce and our travel.

Then there is the third and final leg in the safety triad—the one which many of you share in your daily work. I speak, of course, of motor vehicle design. My Department joins with our auto industry in looking for vehicle safety improvements that are practical and cost effective. One new feature resulting from that search is the high-mounted stop lamp, now standard equipment on new cars. I approved that requirement in 1983, after years of research, field testing, and careful consideration of costs and benefits. Just last week, we reported that vehicles equipped with the high-mounted stop lamp were 22 percent less likely to be struck in the rear by another vehicle while braking. We are very pleased that the results so far confirm our earlier determination that this simple, inexpensive safety feature is an effective means of preventing many of the rear-end collisions that occur each year. We estimate that once installed throughout the nation's fleet, the high-mounted stop light will prevent roughly 900,000 accidents a year and save 40,000 injuries and nearly half a billion dollars in property damage.

Meanwhile, research and development continues on a wide array of safety technologies. To date, at least six manufacturers have announced plans to provide air bags as standard or optional equipment on some or all of their lines in the years just ahead. And the automakers are committed to produce millions of air bags by the early 1990's. While the air bag is undeniably useful, it is most useful in conjunction with safety belts. But whatever the final range of systems offered, it is safe to say that consumer demand will play a large part in determining what the future will hold.

Since he first entered office, President Reagan has made plain his allegiance to market forces. For the fact is, that we in the Reagan Administration look upon transportation—which contributes $800 billion to our GNP—as the engine of the American economy. Make a car or truck one percent more efficient, and the added sales stagger the imagination. What better reason to experiment with lightweight, easy-to-mould engine parts in place of a metal engine? Or computer-driven brakes, now installed in some top-of-the-line models? Or engines no bigger than those which now power motorcycles, and which self-adjust to different grades of fuel?

If windshield wipers will know when to wipe and drivers can command cruising speed at the sound of their voice—it won't be because government mandated these things. On the other hand, a government that is sensitive to the creative dynamic—one that recognizes many years lead time—such a government can foster an atmosphere wherein individual genius can merge with corporate resources. A century ago, it was backyard inventors, like Selden, Goodyear, and Edison, who changed the face of industry. Today, it is teams of exceptional engineers who advance the frontiers of design and safety. Our commitment to safety remains paramount—safety must never be deregulated. What also hasn't changed is the need for government to clear the deck of burdensome economic regulation and reflect in its own actions some of the same experimental energy which translates a dream from the drawing board to the auto showroom.

We will, for example, continue to remove impediments to technological innovation. We intend our safety standards to encourage new safety technology and designs, not stifle them. And where the auto companies or any group can suggest ways to streamline and update our standards, I am eager to listen. To cite just one example, we believe that our vehicle lighting standards can and should be simplified. We have already made progress to permit new types of headlamps to be used in the U.S. If we could move toward a truly performance-oriented standard for headlamps for both the U.S. and other nations, it would reduce excessive design restrictions on auto manufacturers without compromising essential safety.

In the years just past, great strides have been made. Through both individual innovation and international cooperation, we now have the capacity to design automobiles that can withstand higher-impact collisions; that have better vehicle control and braking systems; greater occupant protection and restraint systems, and overall structural safety improvements. Out of forums such as this have come cars that burn less fuel, that combine safety and style. You have explored the outer reaches of modern technology, and in doing so, challenged the conventions of the field. Here in Washington, it is all too easy to fall into a mistaken line of reasoning, to see no further than the morning headlines or the evening newscast. One can soon begin to believe that people's lives are affected most exclusively by what happens at today's hearing or tomorrow's staff conference. In truth, lives are shaped by those who invent or manufacture a product as much as those who make a regulation.

I'm reminded of a story about the great American Justice, Oliver Wendell Holmes, who once found himself on a train, but couldn't locate his ticket.

While the conductor watched, smiling, the 88-year old Justice Holmes searched through all his pockets without success. Of course, the conductor recognized the distinguished justice, so he said, "Mr. Holmes, don't worry. You don't need your ticket. You will probably find it when you get off the train and I'm sure the Pennsylvania Railroad will trust you to mail it back later."

The Justice looked up at the conductor with some irritation and said, "My dear man, that is not the problem at all. The problem is not, where is my ticket. The problem is, where am I going?"

Where, indeed, we might very well ask ourselves the same question. But however we get to the future, one thing is for sure—we'll get there on four wheels. And however the vehicles of the future look, they will doubtless be the product of your imagination. Along the road, there will be plenty of fresh changes. For every custom was once an eccentricity; every idea was once a dream, including democracy—and democracy's favorite transport—the automobile. Through this forum, we've traveled a long way together. The road ahead looks more promising yet—and the United States Government looks forward to continuing the journey with you.

Awards Presentations

Awards for Engineering Excellence

Chairwoman: Diane K. Steed

In recognition of and appreciation for extraordinary contributions in the field of motor vehicle safety engineering and for distinguished service to the motoring public.

Federal Republic of Germany

Prof. Dr. Bernd Friedel
Federal Highway Research Institute

Professor Friedel, as a medical doctor, has addressed the problems of passive vehicle safety at the Federal Highway Research Institute. Together with other scientists, he founded the European joint biomechanical research project and has performed as technical advisor to the European Communities and the Economic Commission of Europe. In 1980 Professor Friedel was elected chairman of the European Experimental Vehicles Committee. For his major contribution to vehicle safety and his active participation in the International Experimental Safety Vehicles Program, Professor Friedel is especially recognized by this award for safety engineering excellence.

Dipl.-Ing. Rüdiger Schmidt
Volkswagen AG

Mr. Schmidt has been active in automotive safety engineering since 1971 when he joined Volkswagen in vehicle technology research. His development of a lightweight automotive diesel powerplant received worldwide attention because of its performance, reliability, and fuel efficiency. We recognize Mr. Schmidt with this award for safety engineering excellence.

France

Claude Robert Chillon
Centre d'Études PSA of Peugeot and Citroen

Mr. Chillon has been an active participant in automotive safety design and engineering since 1957. His work has addressed vehicle structures and aerodynamics, primary and secondary safety research and testing, aggressivity, side impact protection, and rigorous accident data analysis. In addition, Mr. Chillon has been an active participant in the International Experimental Safety Vehicles Program.

Georges Stcherbatcheff
Renault France

The results of Mr. Stcherbatcheff's safety research work in biomechanics, pedestrian protection, mathematical simulations, passive safety, motorcycle safety, side impact protection, and accident data analysis have truly been impressive. He has published numerous technical papers on these subjects and has been recognized worldwide for his extensive contribution to vehicle safety improvements.

Italy

Dr. Pier Luìgi Ardoino
Fiat Safety Center

Dr. Ardoino was appointed Director of the Fiat Safety Center in 1985 and in this position is responsible for all safety research conducted by the Fiat SPA. Prior to this appointment Dr. Ardoino was especially active in Fiat innovative research programs addressing the problems associated with passive safety, and he was responsible for the development of improved test methodology, test protocol and test equipment now currently in use by Fiat.

Japan

Dr. Masaru Igarashi
Suzuki Motor Co., Ltd.

Dr. Igarashi has made a significant contribution to automotive safety by his efforts to develop and apply simulations to improve small car crashworthiness and safety. The results of his research work advanced the use of crashworthiness simulation techniques to improve 3-point belted occupant protection. For his major contributions to vehicle safety, Dr. Igarashi is deserving of special recognition.

Sadao Taniguchi
Japan Automobile Mfrs. Assn., Inc.

Mr. Taniguchi has been on the JAMA technical staff in charge of safety matters for over 20 years. One of the many results of his efforts was a draft of the Traffic Safety and Nuisance Research Institute's Automobile Type Approval Test Standards.

Mr. Taniguchi has been an active participant in all Experimental Safety Vehicle Conferences and has functioned as the JAMA focal point for all Japanese arrangements in support of the International ESV Program.

Sweden

Hugo Mellander
Volvo Car Corporation

Since Mr. Mellander joined Volvo in 1974 as a specialist in biomechanics of impact, he has made major contributions to Volvo's effort to gain increased knowledge in biomechanical injury and protection criteria. One particularly noteworthy contribution was his initiation of a project which led to the development of a load-sensing face for crash dummies.

In 1983 he became Group Manager for Volvo's Advanced Engineering in Traffic Safety and has been active in engineering and in the introduction of new safety features in Volvo production cars.

United Kingdom

Anthony H.K. Denniss
Norton Motors (1978) Ltd.

For over 20 years Mr. Denniss has played an important part in the acceptance of safety features as essential components in motorcycles. Such features include mechanical antilocking brakes, unspillable fuel tanks, and daytime running lights. Currently, Mr. Denniss' research has involved the development of leg guard protection for motorcycle fairings. The demonstration safety motorcycle ESM3 presented at this conference is the result of Mr. Denniss' work.

William T. Lowe
Leyland Trucks Ltd.

Mr. Lowe is currently head of the Leyland Technical Center and is recognized for his work as chief engineer, designer, and project manager for the development of improvements in the safety performance of Leyland Trucks. Mr. Lowe is responsible for the TX 450 Leyland Technology Demonstrator, a heavy truck which incorporates many advanced safety features. For his outstanding efforts to improve heavy truck safety Mr. Lowe receives the award for safety engineering excellence.

Stanley J. Edge
Scheller-Clifford Ltd.

Since 1965 Mr. Edge has been responsible for improving the safety of steering wheels at Scheller-Clifford Ltd. In 1984 Mr. Edge produced a prototype steering wheel which met the pendulum impact tests developed to reduce facial and brain injury to drivers wearing safety belts. His first design was successful despite the fact that almost all existing production steering wheels failed. Regulations to require safety levels demonstrated by Mr. Edge's design improvements are now under discussion in Europe.

United States

Alfred G. Beier
Navistar International Corporation

Mr. Beier made significant contributions to truck safety through his active participation and leadership as chairman of the truck brake committees for the Society of Automotive Engineers and the Motor Vehicle Manufacturers Association. Most notable among his contributions was the significant upgrading of medium duty hydraulic brake system performance initiated in the early 1980's which led the industry to the use of more effective brake systems.

Nancy A. Bundra
General Motors Corporation

Ms. Bundra headed the effort to develop data describing static and dynamic anthropometric measurements, functional reach, and functional accommodation preferences of the United States truck driver population. These data were translated into recommended test procedures and design guides for truck driver accommodation/packaging, including seat position steering wheel position and arm and foot reach. For her dedication to the design of truck cab environments to ensure a nonfatigued, alert driver, Ms. Bundra is deserving of special recognition.

United States

Peter Every
Kelsey Hayes, Inc.

Mr. Every has significantly advanced the safety of light trucks through his efforts to develop a low cost and highly effective rear axle antilock brake control system. The improved stopping performance, controllability during emergency braking, and cost effectiveness of this system has encouraged its adoption as standard equipment on many new model light trucks produced in the United States. Mr. Every is to be commended for his efforts to improve vehicle safety and as such is highly deserving of this special recognition.

John Repp
Ford Motor Company

Mr. Repp has made outstanding engineering contributions in the development of air bags for production cars. He led the technical team that developed the driver and passenger air bags installed in the 1981 Lincoln test fleet and more recently was responsible for developing the driver side air bag currently available on the Ford Tempo and Mercury Topaz. This work is particularly noteworthy since it demonstrates the application of air bag technology in a small, affordable car.

Section 2
Government Status Reports

Chairman: Howard M. Smolkin, United States

United Kingdom

David Lyness,
Head of Vehicle Standards and
Engineering Division,
Department of Transport

Recent trends in road deaths are set out in the following table

	1983	1984	1985	1986 (provisional)
Car occupants	2,019	2,179	2,061	2,245
Pedestrians	1,914	1,868	1,789	1,848
Motorcyclists	963	967	796	758
Cyclists	323	345	286	272
Bus and Coach Occupants	38	37	32	25
Others (mainly lorry or van drivers)	188	203	201	250
	5,445	5,599	5,165	5,398

The figures for total deaths on the road in Great Britain have shown no clear trend over the last few years. The provisional number of deaths in 1986 was 5,400 which is also the average of the preceding 3 years. That is slightly less than 10 per 100,000 of our population. Of the 5,400 deaths in 1986, 42% were car occupants, 34% pedestrians, and 14% motorcycle riders. This distribution is more orientated to car occupants than motorcyclists than was the case in previous years. This is largely explained by the fact that whereas car traffic continues to grow, motorcycle traffic has declined over that period. In 1986 there were 0.9 car occupant deaths per million car kilometres. The comparable rate for motorcycle riders was 14.

Compulsory Seat Belt Wearing

At last year's ESV conference I described the initial success of the regulation we introduced in 1983 to require drivers and front seat passengers to wear their seat belts. That regulation had to be renewed by Parliament within 3 years and the necessary debate took place towards the end of 1985. The evidence of public acceptance and effectiveness in saving many lives led Parliament to make the regulation permanent. We are particularly pleased with the very high rate of compliance with the law. This has varied very little throughout the 4 1/2 year period to date and continues at around 95%.

Seat Belt Fitment and Performance

Success with front seat belts has led us to introduce fitting requirements for rear seat belts in all new cars from April 1987. The regulations allowed the user to fit restraints for children or for disabled people instead of the normal adult belts, of which either two 3 point or three lap belts are permitted. We shall also be requiring lap belts for the exposed forward facing passenger seats in long distance coaches. These exposed seats are those which have no other high backed forward facing seat or suitable restraining barrier directly in front of them.

We are looking closely at the design and installation of seat belts and in our view small changes here could make a considerable improvement in acceptability, comfort and performance. We have also been looking closely at design of child restraints, and the UK has contributed a paper to the Conference suggesting some detailed improvements.

Improved Design of Steering Wheels

Improved design of steering wheels has clear potential to reduce facial injuries to drivers wearing seat belts. This was the subject of a report by TRRL to the Oxford Conference. Since then user trials have shown that padded steering wheels meeting an acceptable performance standard are also acceptable to users. Individual vehicle manufacturers have taken up the idea and discussions in the European Community are underway so as to establish a type approval specification.

Accident Studies

We have a programme of in depth accident investigation involving Department of Transport vehicle examiners, the TRRL, and Birmingham and Loughborough Universities which will continue until 1989. At present we have detailed computer access to some 1439 accidents involving 1618 vehicles and 2720 occupants for analysis purposes. Each accident contains 7 vehicle listings and 6 occupant listings containing between 23-114 variables in each listing. This will allow a very comprehensive range of questions to be addressed and TRRL is presenting a paper on the results from the first analysis of the data base.

Car Occupant Protection in Frontal Impact

Seat belt wearing has had a major effect in reducing the effects of many types of impact. This has exposed the effects of intrusion and lack of passenger compartment integrity in many medium to high energy impacts. Possible improvements are suggested in another one of the papers from TRRL being presented later this week, and some of these improvements are incorporated in the demonstration car ESV 87.

Side Impact Protection

We continue to regard this as an important priority for international cooperation to determine all the elements of a standard. Work since Oxford has brought us much nearer agreement on a usable dummy and on the specification of the barrier.

Pedestrian Protection

We in Britain are especially concerned with measures to reduce the risks to pedestrians who comprise about one third of all road user deaths. More than half of these clearly result from the pedestrian being hit by the front of a car.

The proposals for a simplified test procedure, put to you at the Oxford Conference and based on mathematical simulation, have now been supported by tests using dummies. Our demonstration car ESV 87 incorporates the design changes to reduced pedestrian injuries which were demonstrated in 1985.

Motorcycles

Casualty rates for motorcycle riders are far higher than for any other category of road user, and it is particularly tragic that so many young people are killed and seriously injured in motorcycle accidents.

On the vehicle safety side we believe much more effort is needed by all concerned to make motorcycles safer. The technology is available to improve both active and passive safety. The TRRL's latest ESM motorcycle presented here this week shows what can be done particularly as regards anti-lock braking and leg protection.

The anti-lock braking system demonstrated on that motorcycle is now half way through extensive service trials with police forces in the United Kingdom; first reactions are highly favourable.

Since the Oxford Conference TRRL have continued their work on leg guards to include moving vehicle tests. This is reported in the papers circulated this week. We are very close to having a practical specification which could form the basis of regulations.

Buses and Coaches

Buses and coaches already provide a high degree of protection for passengers. But efforts continue to improve the safety of buses and coaches in a number of aspects. We are now introducing regulations to require new coaches to be constructed so that their superstructure meets ECE Regulation 66. We shall be requiring speed limiters to be fitted to ensure that no coach can exceed 70 miles per hour (112 kilometres per hour) which is the legal speed limit for coaches on British motorways.

We are also working to formulate European standards for flammability of materials used in coaches and for the strength of their seats. Finally, we hope that the European Community will agree on proposals for mandatory fitment of anti-lock brakes to coaches and buses used on inter-urban services.

Goods Vehicles

At Oxford I reported a number of regulations being introduced on lorries and trailers to require side-guards, rear underrun guards and spray suppression devices. These regulations are now bearing fruit as an increasing proportion of heavy lorries on roads in Britain carry the new equipment. We have recently introduced the latest amendment to the European Community Braking Directive Requirements into United Kingdom legislation which gives an improved minimum braking performance of more than 10%. A further change in the European Community is being discussed which will allow Member States to require anti-lock brakes on heavy goods vehicles with trailers. Looking further ahead there are promising developments in front underrun protection described in one of the TRRL papers for this Conference and we are also researching new suspensions which we hope will not only reduce road damage but further improve braking and stability.

Vehicle Lighting

Finally I should like to draw attention to a requirement we have just introduced for all new vehicles to be fitted with dim dip lighting. This requirement is satisfied by a change to the vehicle's wiring so that when the sidelamps and the ignition are activated the headlamps are illuminated at around one-tenth their normal power. This prevents vehicles being driven on sidelamps alone, and provides a level of illumination to make vehicles conspicuous without causing glare—it is especially appropriate in conditions of good street lighting. We are very hopeful that this simple change will have a positive effect on road safety.

Federal Republic of Germany

Rolf Stamm,
Senior Advisor,
Federal Ministry of Transport,
Federal Republic of Germany

Nearly 11 years have gone by since the 6th International Technical Conference on Experimental Safety Vehicles, which took place here in Washington, D.C., in October 1977. Important aspects of our work may have changed in this decade, but our determination to cooperate on an international basis and exchange research findings and development data has remained the same and is also the moving force behind our gathering here once more in the hope to advance motor vehicle safety even further.

In 1984 and 1985 the trend of road traffic accidents in the Federal Republic of Germany was marked by a drastic decrease in the number of fatalities. There were 11,732 fatalities in 1983 compared to 8,400 in 1985, i.e. a decrease of nearly 30%, although overall mileage figures in both years rose by about 3%. The number of occupant fatalities decreased from 6,038 in 1983 to 4,182 in 1985, i.e., a decline of more than 30%.

In 1986, however, the fatality figures were clearly higher compared with those in 1985, that is to say they rose by 6.5% to about 8,950 deaths. Based on the mileage figures, this amounts to a percentage increase by 1.7%. Car occupant fatalities rose by 9.9%. However these values are still considerably below those for 1984.

As was already pointed out at the 10th ESV Conference in 1985, it is especially important in this connection that the noncompliance with the belt usage law in front seating positions incurs a fine of DM 40 in the Federal Republic since 1984. Wearing rates are encouragingly high since that time. The motorway wearing rates amounted to 98% in September 1986, the wearing rates on other rural roads to 96% and in cities to 93%. This applies to drivers and front seat passengers. Since July 1986, a fine for noncompliance has also been introduced for rear seat occupants. For the time being the wearing or securing rates in rear seats have still not reached a satisfactory level. This applies to adults and children. In September 1986, 51% of the adults in rear seating positions of passenger vehicles equipped with rear seatbelts (presently about 80% of all cars) were observed as having worn their belts. Although the rate has doubled compared with the time before the introduction of the fine for noncompliance, the increase in absolute terms is not as high as in the case of the front seat wearing rates after the penalty was introduced. Above all the level attained is incomparably lower. The overall securing rate for children in rear seating positions (sum of seatbelt wearing rate and child restraint usage rate) also hardly reached the 50%-mark in September 1986.

Autobahns (German motorways) continue to be the safest routes in the Federal Republic of Germany. The motorway accident rate (accidents per million vehicle km) amounts to 0.16, while it amounts to about 0.6 on other roads outside built-up areas. Within the framework of a comprehensive exhaust gas emission test the effect of a short term 100 km/h speed limit regulation on accidents was investigated. However, the results did not induce the Federal Government to introduce a speed limit on motorways.

The comprehensive program for the improvement of road safety, which the Federal Government presented in 1984, is being gradually put into effect by introducing a variety of measures. In the meantime, the two-stage licensing of motorcyclists and the probationary licensing of novice drivers have been enacted. Mofa riders are required by law to wear crash helmets. Other measures are being prepared, e.g., the introduction of antilocking systems (ALS) for heavy trucks and coaches, improved mirror systems for trucks to afford a better view of pedestrians and cyclists in the area immediate to the truck. The envisaged model experiment "Fewer Traffic Signs" described in the 1984 Road Safety Program of the government is in progress. The purpose of this model experiment is to reduce the number of signs or improve signposting in built-up areas, the conditions and the criteria under which this could be accomplished. In all, 39 cities applied to participate in the experiment; in three cities measures to reduce and improve signposting were taken and accomplished by the end of 1986. The related accident studies are expected to take another two to three years so that a final report on the evaluation of the safety effects of these measures will not be available before 1989.

In the field of accident research, activities have continued to emphasize the questions of occupant safety and active safety of passenger cars since the last ESV Conference. In particular, the activities of the Federal Government, car industry, and motor vehicle insurers have to be mentioned.

With respect to the motor vehicle insurers' accident research (HUK), the following items are to be looked at:

An investigation of 800 passenger car accidents with respect to "Injuries despite belt wearing" revealed that head injuries, above all to the driver, are still dominating and require intensive efforts to further improve steering column and wheel. By means of design modifications it should be possible to prevent steering columns becoming displaced in an accident and moving inwards and upwards. All measures possible should additionally be taken to eliminate or mitigate head impacts, such as, e.g., safety belt tensioners and airbags. The investigations revealed no major head injuries, not even in accidents resulting in extreme car decelerations, unless the head impacted on a rigid part. Attention is now focussed on setting up a data base of current accident data on the effects of airbags, safety belt tensioners, and modified steering column designs.

The wearing of seatbelts in the rear of cars is not only a vital measure of self-protection but also a measure to protect the other occupants in the car. A research project, which has been completed in the meantime, revealed that in about one out of six accidents occupants run the risk of mutual injuries caused by the occupants who do not wear their belts.

Investigations into child accidents are planned for 1987.

On the sector of active car safety, a study of 2,000 accidents (300 cars equipped with ALS) involving cars of the same model has been undertaken to compare the behavior of ALS-controlled cars with that of cars without ALS. The study is not yet completed, but the safety effects of ALS in critical situations are confirmed by the findings thus far. The accident involvement of ALS-equipped motor vehicles still needs to be investigated. Special studies on 300 truck accidents and 200 bus accidents confirmed the predicted benefits of ALS, namely prevention of about 5% and mitigation of about 15% with respect to accident consequences.

Comprehensive accident material is now available for the first time with respect to truck accidents:

To supplement an investigation based on 1,100 truck accidents into the exterior safety of trucks and partner protection, a study on truck occupant safety has been undertaken, again in collaboration with FAT (Research Association in Automotive Engineering), by investigating 800 truck accidents resulting in injuries to the driver or damage to the driver's cab. Truck safety priorities can thus be rated based on concrete facts.

The car-truck collision tests of the German Motor Vehicle Insurers now point to a solution to the problem of truck front protection which appears to promise success: a supporting structure with a configuration of deformation elements affixed to it.

New tests on motorcycle safety have confirmed the HUK-Association concept that the trajectory can be influenced by special design features, such as, e.g., leg protection, optimized position of fuel container, steering system and sliding feature. In high-speed crashes, a trajectory causing the least possible harm can be achieved by features enabling on-the-spot separation of rider and vehicle, preventing the rider impacting the other vehicle in the crash to the widest possible extent. In minor crashes, grazing collisions or falls, the concept ensures better leg protection. A new series of tests confirmed that airbags, also for motorcycles, can be of considerable advantage—the practical application would however still require tests on the safety of the activation characteristics and the effectiveness of airbags in this field. These questions will be dealt with in a series of tests beginning in 1987.

The accident research institutions of the government continued work on a number of important projects and specified new major research areas.

Since 1984, the on-site accident investigations have been modified based on a new random sampling procedure. It is now possible to also investigate accidents occuring during the night and over the weekend. The accidents investigated are exclusively accidents in the investigation area involving at least one injured accident victim, irrespective of the severity of the injury suffered. A number of special evaluations has also been carried out, e.g., with respect to the protective clothing of motorcyclists, the reconstruction of multiple car crashes, problems regarding the field of vision from commercial vehicles and the comparative effectiveness of different antilocking systems for trucks. A study on the technical defects of bicycles revealed a wide field where action is needed. Within the framework of the on-site accident investigations, a preliminary study on the feasibility of eye tests on accident victims has also been undertaken. The study revealed that the incorporation of such screening tests into the on-site investigations is technically no problem. A main study is expected to provide information on the extent to which the vision of accident victims had been impaired and possibly been the cause of accident. The on-site investigations furthermore included tests on accident victims with respect to various drugs and alcohol.

The Federal Ministry for Research and Technology continues to sponsor research and development projects aimed at improving passive and active safety features of motor vehicles. After the successful completion of the research project "Design of cars affording optimum occupant protection from the viewpoint of the economy"—this project was reported at the last ESV Conference—the projects now in progress are focussing on the improvement of active safety by means of modern information technologies. With the aid of a new driving simulator, the analysis and evaluation of the performance of active car safety features prior to use will be undertaken.

The project also includes especially the optimization of an on board route guidance system and of cockpit design, the survey and analysis of the effects of the route guidance system on driver behavior, and the analysis and evaluation of driving situations.

Within the framework of the European EUREKA research initiative, the car industry, information technology sector, science, and administration have combined resources in the comprehensive joint PROMETHEUS research project—Programme for a European Traffic with Highest Efficiency and Unprecedented Safety—to utilize the possibilities which information technologies are offering to pave the way for a safe, environmentally acceptable, and efficient future road traffic system. The main objective is the real improvement of active safety. This objective should be achieved by means of collecting all information relevant to safety, and especially the information items which are liable to support drivers in critical situations. The broad spectrum of development possibilities has been subdivided into the following three main areas of research:

- development of computerized systems of car features capable of actively/passively assisting drivers with their task of driving (solutions representing autonomous on board systems without outside control)
- development of communication networks among motor vehicles providing a range of electronic "vision" far beyond a driver's normal visual perception range
- development of communication and information systems between roadside and on-board computers for an optimal private car traffic management system.

In a comprehensive project, the possible contribution of the ALI Scout automatic driver information and control system to the improvement of road safety and the reduction of noise and exhaust gas emissions is being investigated. In the city of Berlin, the infrastructural measures necessary for this investigation are being implemented, and it is planned to equip about 900 motor vehicles with the information displays. The bidirectional exchange of data between the infrastructure and the vehicle is achieved by means of infrared signalling devices installed beside the controllers of traffic lights.

In this connection, the development of an accident data recorder also needs to be mentioned. The recorder enables the exact reconstruction of accidents. For this purpose, only the data relevant to accidents are recorded within a time interval of about 60 seconds before an accident and transferred to destruction-proof and manipulation-proof storage devices. Equipment of this nature will especially help the courts. The standard equipment of cars with accident data recorders was called for on several occasions by the Annual Conference of Traffic Court Judges. In view of the European legislation governing equipment parts, this demand has hardly any chance of success. But it may be possible to persuade drivers to use such devices on a voluntary basis for reasons of self-protection.

Still another research project concentrates on the development of a tire which remains operable after a breakdown, i.e., it does not only ensure the operation of the vehicle when it becomes deflated but also retains performance characteristics ensuring the safety of car operation-safe steering characteristics and driving stability. The development efforts are based on a new safety tire concept: the tire bead lies on the inside of the rim channel and not as at present on the outside of the rim flange.

The development of TOPAS, a tractor-trailer based on a new safety concept with optimized passive and active safety features—in this case a tanker truck—has been successfully completed. The essential design feature is the 30 cm lower center of gravity which considerably improves the overturning limit. The knowledge acquired in this project points to the following possibilities of improving the safety of future tanker trucks, e.g.:

- improved driving dynamics by lowering the center of gravity
- introduction of antilocking systems
- monitoring the performance of the safety features of various types of trucks by electronic devices
- monitoring loading and unloading procedures by electronic devices
- measures to improve the fitness of truck drivers
- automatic route guidance systems and automatic headway warning devices
- side guards for trucks.

With respect to the driver and vehicle behavior in critical situations, the work undertaken to systemize and classify critical traffic situations has been completed. Accidents involving passenger cars have been subdivided into groups which differ in the number and combination of disturbed loop components (driver, vehicle, environment). Another project concentrates presently on the vehicle characteristics which are relevant to the accident regime. The characteristic driving maneuvers in accidents are evaluated based on on site accident studies to enable computer simulations to be carried out.

Since the vehicle component is to be considered more than has been done hitherto in the interpretation of accident causes, the joint analysis of vehicle and accident data is required. As a first step in this direction, the accident data records of a Federal state have been combined with vehicle data, such as, e.g., kind, model, and design of vehicle. The absolute number of vehicles in each category of vehicle types involved in accidents has been qualified by relating it with the total number of registered vehicles. First analyses for example focused on the influence of engine power and wheel suspension systems of cars. The type of car accident taken into exemplary consideration in this project is an accident on a rural road caused by speeding, and the resulting loss of control over the vehicle.

As a continuation of the investigations on side collisions, the deformable element of a movable barrier has been slightly modified to comply better with specifications. The element can now be considered as ready for application. By means of a dynamometric force measuring wall, the stiffness of the front structure of current production cars is measured. Based on the resulting findings, the force-deflection characteristic of the barrier element will be adjusted, if necessary.

In respect of side collisions, a project has been undertaken to study the effect of the speed of the struck vehicle. Further details on this project are reported in another conference contribution.

A comparison of tests using the EUROSID dummy in collisions with the EEVC barrier in crabbed mode and with a barrier in 90° mode revealed that the forces generated in the crabbed test constellation are lower. Having subjected the EUROSID dummy to a series of full scale tests, it can now be considered as nearly checked-out for application.

All parties concerned now agree that clear evidence with respect to elimination of submarining should be incorporated into a regulation on frontal collisions. It has therefore been proposed to require the measurement of the forces in the lap belt of dummies in addition to the strain gauges, or submarining detectors used. It has been demonstrated that the additional interpretation of the lap belt force would be a better proof of the elimination of submarining. However, it still needs to be checked whether or not this requirement is sufficient to solve the problem.

With respect to pedestrian safety, a research project for component tests has been started after proposals for a full scale test have been worked out.

At a symposium on rear seat belts which was held jointly with the German car industry it has been pointed out that in view of better wearing rates and the penalty for noncompliance, the geometrical design of these belts and their interaction with the rear seat need to be improved. Such improvements have already been incorporated in the design of some car series recently gone into production.

Studies in the field of the emergency medical service (EMS) system revealed that, among other factors, an accident involvement of about 3,500 rescue vehicles on call will have to be expected on an annual basis including 50 serious injury accidents and 14 fatal accidents. In general rescue vehicles using priority vehicle lights and a special signal horn while on call run an accident risk which compared with other motor vehicles is higher by a factor of 8.

A research project, which is currently in progress and cosponsored by the car industry, deals with the safety relevance of the indicators, controls and switches in motor vehicles.

The range of application of the risk compensation theory is being studied and analyzed under controlled field test conditions. In this connection, the effects of an antilocking system on the accident regime and the behavior of taxi drivers will be observed over a period of several years.

The technical inspection intervals for passenger cars have also been studied. In this connection the possible effects of reducing inspection intervals for older cars were assessed from the economic viewpoint. The study revealed that a reduction of the current two-year intervals—three years in the case of new cars—to one year is not justified. The resulting maximally possible benefits of safety improvements are far from covering the costs of technical inspection of passenger cars.

A study on buses in connection with an ECE draft regulation revealed that the evaluation of the load on passengers in the proposed test method requires that the seats be firmly anchored in the passenger compartment.

The braking test regulations for passenger cars, which have been harmonized between the U.S. and Europe, have to be practicable and satisfying from the viewpoint of the inspection practice. In some points, further improvements should be possible.

The stability of motorcycles at high speeds is still a largely unresolved problem. The influencing parameters have therefore been subjected to a systematic analysis. Suggestions were presented as to how to reduce the weave mode caused by the rider by means of design modifications.

A number of the projects described were undertaken in close cooperation between state authorities and the car industry.

The main research activities of the car industry are the topic of numerous other contributions to this conference.

Environmental impact problems with regard to the car are characterized above all by noise pollution and exhaust emissions. In EEC countries, the noise emission limits for motor vehicles were reduced in the past years and it is intended to reduce them still further. The maximum reduction, applying to passenger cars, buses and trucks, has already been fixed for 1988/89.

As an additional measure, a definition of "noise-controlled motor vehicle" has been incorporated into the German Vehicle Code (StVZO) by the Federal Government. Apart from tougher drive noise limits, limits for other sources of noise have been fixed for trucks. The inclusion of the noise-controlled motor vehicle definition into the StVZO has paved the way for the introduction of user benefits. This fact together with recommendations to environmentally responsible operators (especially those of the state) is hoped to accelerate the commercial availability of "noise-controlled trucks".

Further reductions in the noise pollution of residential areas are expected from traffic restraint measures (e.g., the introduction of a 30 km/h speed limit and design alterations to create traffic or speed retarders, elimination of through traffic), appeals to drivers to drive at low speed, elimination of manipulations and the use of low noise road surfacings.

In the Federal Republic of Germany, the percentage share of motor vehicles in the total of emissions in 1984 was as follows: 58% in the case of nitrogen monoxide (NO_x), 48% in the case of hydrocarbons (HC) and 57% in the case of carbon monoxide (CO). In 1983 the government had already urged that car emissions must be reduced fast and drastically.

A comprehensive exhaust gas emission test with a speed limit of 100 km/h on motorways did not result in the reduction of NO_x emissions expected by various sides. After difficult negotiations, the emission limits shown in the table below were passed by the EEC in 1985 (based on the European car emission test method—ECE Regulation 15) :

Car emission limits in EEC countries

Category of motor vehicles (engine displacement)	Applicable for new models/new motor vehicles as of	Emission limits (g/test)	
> 2l	1 October 1988 - 1 October 1989	OC: $HC + NO_x$: NO_x:	25 6,5 3,5
1.4 ≥ 2l	1 October 1991 - 1 October 1993	CO: $HC + NO_x$:	30 8
< 1.4l	A: 1 October 1990 - 1 October 1991 B: 1 October 1992 - 1 October 1993	CO: $HC + NO_x$: NO_x: To be fixed in 1987	45 15 6

These European limits, just like the currently applicable U.S. emission limits, have already become part of the German legislation in the definition of the "emission-controlled car". This is also the precondition for the official introduction of this car which is planned by the Federal Government as a two-stage measure:

- At the first stage, incentives are offered to promote the purchase (on a voluntary basis) of emission-controlled cars. Car tax law amendments enable savings in car taxes of up to DM 2,200.
- At the second stage the emission limits shown above will become legal on the dates specified. In addition, there will be law amendments to offer tax incentives to car owners willing to have subsequent alterations to the combustion system of used cars undertaken to obtain emission reductions.

The introduction of unleaded fuel, which is the condition for the introduction of the catalytic converter, has been accelerated by a series of measures, the most important being the mineral oil tax concessions of DM .07/l unleaded fuel till April 1, 1987 and DM .06/l at present. As a result of this measure unleaded fuel is now DM .03/l cheaper than the fuel containing lead. More than 11,500 filling stations (out of about 17,500) sold unleaded fuel at the end of 1986, which reached a market share of about 15% at that time.

After the private car traffic, truck traffic comes second in causing emissions. The Federal Government in its "commercial vehicle concept" of 1985 therefore decided on the limitation and reduction of the gaseous pollutants and particulate matters emitted by these vehicles. Negotiations on the introduction of limits in respect of the gaseous pollutants are now being conducted in the EEC. The ECE Regulation 49, which has been in force for a number of years, should be adopted as EEC directive for this purpose. As a first step, it is planned to reduce the limits of this Regulation by 20% (CO and NO_x) and 30% (HC). As a consequence of a voluntary agreement of the German car industry, the 20% lower emission values (compared with the ECE Regulation 49) have already been observed since the beginning of 1986 in the case of new engines.

Since the last ESV Conference, a large number of research projects has been completed, continued, or taken up. The objective of further road safety improvement is a central issue of the joint European PROMETHEUS research project. We hope that the possibilities offered by the information technology will lead to improvements of active safety, and help make road traffic more efficient and environmentally acceptable.

France

Georges Dobias,
Director General,
Institut National de Recherche sur
les Transports et leur Sécurité,
France

In the field of road safety you can never take anything for granted: in 1985, the reduction of the number of road accident victims was very important, which led us to estimating that "the prolongation of the trend observed in 1985 during the next years will allow us to attain our objective (defined in 1982: reduction by a third in five years) in August 1987, which will then represent a yearly number of deaths inferior to 8,500".

This estimation was certainly based not only upon the good results in 1985 but also and above all upon the *significant improvement* obtained since 15 years back: in fact, since 1972, the black year of road traffic (16,617 killed, 388,067 injured, 274,476 accidents with personal injury), progress of safety had been notable though irregular; fifteen years later on, at the end of 1986, we stated that the number of deaths had regressed by 34% compared with 1972, the number of injured and the number of accidents with personal injury going down by an equivalent percentage (−33%), while the number of registered motor vehicles had increased by 56% during the same period (28 millions in 1986) and the overall traffic flow by 50% (360 milliards of kilometers in 1986).

Thus the road user's accident risk per km run had been divided by 2.3 in 15 years. Nevertheless France remains at the bottom of the twelve EEC countries: 10th for the number of deaths per 100,000 inhabitants, 7th for the number of deaths per 10,000 motor vehicles.

However, facts in 1986, as they appear in the following table, are worrying:

	Fatal accidents	Deaths	Injured
1984	199,464	11,525	282,485
1985	191,096	10,447	270,745
1986	184,626	10,961	259,009
Evolution 85/84	−4.2%	−9.4%	−4.2%
Evolution 86/85	−3.4%	+4.9%	−4.3%

Certainly the reduction of the number of accidents with personal injury and that of the number of injured have continued; this is encouraging.

But the increase in the number of persons killed is considerable after the exceptional improvement in 1985; it expresses a *new increase in the average severity* of accidents with personal injury (6 deaths in 100 accidents with personal injury in 1986 compared with 5.5 in 1985). If the growth of traffic on main roads and motorways represents 6.2% compared to 1985, the *death rate* for 100 million vehicles × km attains 2.92, marking thus a *growth of 1.2%* compared with 1985.

A remarkable fact is that this aggravation does not seem to be specifically French; in fact, various data allow us to state that Belgium, Spain, the Netherlands, the FRG, as well as other European countries have recorded a significant increase of fatalities: a cruel paradox made that the European Road Safety Year became a year of increase in accident risk.

In France, according to a first analysis, three main causes seem to be at the source of this regress:

- the deterioration of obedience to speed limits (the average speeds increased by 1-3 km/h according to the road types, the percentages of exceeding speed limits by 2-8% according to the road types!);
- a still important amount of blood alcohol contents;
- the deterioration of the rates of safety belt use during the last few years, in spite of a clear recovery at the end of the year after a specific campaign.

Thus, whether it is a matter of drawing up the balance sheet or giving the main possible explanations, the people in charge of Road Safety state that Road Safety policy should manifest itself by a *reinforced effort* and *continuous management* having become indispensable by the inadmissibly high cost in human life and the very heavy economic cost of road unsafety (almost 82 milliard French francs).

Road Safety Action

So it is in a perspective of continuity and reinforcement that we can describe the Road Safety policy implemented during the last few years. Let us state the most significant facts:

Decentralized Action

The worrying standstill between 1979 and 1981 already stated had led us to considering that, in the field of Road Safety, decentralization prospects should be fully reached so that local action could relay and specify central action. The programmes REAGIR and −10% CONTRACTS tried to increase the "responsibilization" of citizens and social actors, above all territorial authorities and especially local councils. These programmes suppose duration: to the statement of unsafety facts (enquiries into several thousands of serious accidents), to the mobilization of teams of numerous experienced analysts, we should add the necessary prolongation of grouping and co-ordinating actions of public and private partners and the implementation of a departmental *plan* of Road Safety elaborated and proposed by Departmental Commissions.

Various operations and programmes are in keeping with the decentralized action of Road Safety (PLAN Contracts between Government and some Regions, the Programme "Town with more safety, districts without accidents" devoted to car traffic layout experiments, and others).

As far as the philosophy behind the decentralized action is concerned, it was the subject of two events that attracted attention: the EVALUATION 85 Symposium gathering together many international researchers and engineers and the EUROPEAN FORUM held in Aix-en-Provence in 1986 allowing the comparison of decentralized policies and the presentation of very significant case studies.

Social Communication

The mobilization of many actors in decentralized Road Safety policy requires the uniting of conditions of a diversified and active social communication in which the very institutional communication takes place without any veto.

The year 1985 was marked by the organization of the "ROUND-TABLE Conference on Road Safety: New Initiatives" directing its works towards great actors potentially interested in motor vehicle traffic and Road Safety: analysis of the part that the *insurance* can play in the enterprise of accident prevention; action taken by *HEALTH professions* not only in the therapeutic field but also in a perspective of accident prevention and road user training; speech and actions of communication professionals, *advertising agencies*, marketing specialists, mass media people.

In 1986, the organization in Paris of the international congress on "Road Unsafety" by the ATEC allowed us to go beyond the framework of exchange between specialists offering free speech to practicing engineers and allowing to associations of road users and accident victims to contribute to the progressive consciousness that is the base of durable action.

Regulations

However rich the whole set of regulations may be, progress in road safety requires in this field above all updating and operative translation of regulations, but also adoption of new regulations:

- the progressive introduction of means of *technical vehicle control* should allow the diagnosis of thousands of vehicles over five years old on the occasion of a transaction. This law is completed by a decree foreseeing the confiscation of the registration document of a severely damaged vehicle and its restitution after verifying the good quality of the repairs made.

The problems raised by these regulations were dealt with in a round-table conference. On the other hand, in the perspective of the project of EEC regulations in the field of periodic technical motor vehicle control, France is making national consultations in order to prepare a whole project of mandatory repairs of the main safety components.

- In the field of the fight against *Drinking-and-Driving*, the main innovation besides testing and introducing new control means (ethylotests and ethylometers) consists in the preparation and adoption of a new law (17 January 1986) allowing the *immediate confiscation of the driving license* for a maximum duration of 72 hours in case of detection of blood alcohol content in the driver, of manifest drunk driving or refusal to undergo detection, and the firm suspension of the driving license, by an administrative decision, as soon as the detection result is confirmed; this law also allows the immobilization of the vehicle if there is no qualified driver.
- The Law of 6 January 1986 on emergency medical assistance and ambulance transport creates a committee at the departmental level having the mandate to control the quality of distribution of emergency medical assistance and its adjustment to needs; this law foresees the organization of the SAMU medical services (determined in a decree) and in particular the operation of the centres for reception and control of calls.
- Driver training is dealt with in two particular actions:
  - on the one hand, extension to 22 departments of the experimental "anticipated learning to drive" as soon as 16. This is a new type of training aiming at allowing the young driver to discover progressively the driving situations in an atmosphere of confidence and cautiousness in order to facilitate his adaptation to driving after having obtained his driving license.
  - On the other hand, the reform of the training of driving instructors by the creation of a Professional Certificate of Driving and Road Safety, which as soon as 1986 replaced the CAPEC certificate. This new Certificate will raise very considerably the level of training to be given by institutions presenting reinforced conditions of approval.

On the other hand, let us note the recent decision to develop a "national programme of driver training", which will serve as a framework and a guide to driving instructors who, moreover, will increase their qualifications by participating in refresher courses.

- As far as penalties are concerned, we note that they are not dealt with in special regulations or rules, but that the concern of making the road users respect the main safety rules leads to a reinforcement of control and penalties by the rise of penalty rates, the simplification of the administrative confiscation of the driving license, the generalization of equipment of Police and Gendarme forces. In parallel, it was decided to modernize the national data bank of driving licenses. A new bill being carried in Parliament multiples by 2 and 4 imprisonment and fines for drunk drivers in cases of accidents.

Technical Action

The action aiming at improving infrastructure and the road network, a permanent action, continued in 1985 and 1986. Besides the detection and suppression of "black accident spots", it contains: a policy of systematic taking into account of safety in the "coordinated strengthening" programme; layout of numerous isolated points (especially round-abouts), conventional or new road equipment (for instance installation of emergency exit beds on motorways); a specific action of installing 2,000 speed-reducing humps in special areas. Government also accelerated the rhythm of motorway construction, which will go beyond 200 km/year.

We should also note the organization of a great study cycle on the theme "Infrastructure and Road Safety", in which a great number of engineers and technicians of departments and cities participated.

In the field of the motor vehicle, the year 1985 was marked by inviting tenders for "Aids to Driving" allowing in the perspective of inciting to innovation to select technical research works in various fields: in-vehicle road information devices, devices of detection of lowered vigilance, various detection and alarm systems (anti-collision radar devices, insufficient tire pressure, and others). In 1986, this interest in using the possibilities of electronics led the car manufacturers and other industry partners to participate in the first phases of European projects elaborated in the framework of the EUREKA programme (PROMETHEUS, EUROPOLIS, CARMINAT, and others).

Research

The fusion of ONSER and IRT allowed the creation of a new organization, INRETS, which is thus the main French research institute for road safety.

In the field of secondary safety, in which the ESV Conference takes a special interest, we will note some striking facts:

- The French researchers have actively collaborated in the definition of the testing procedure using the EUROSIDE anthropometric dummy aiming at works on side collisions. The project of a European regulation is being made.
- The studies on protection systems form the subjects of works aiming at verifying wear resistance and conditions of maintaining protection.
- Experimental research works on the protection of pedestrians by means of an adaptation of the forms of the fronts of motor vehicles are being made and may be susceptible of developments at the European level;
- Finally, the last phase of elaboration of the experimental lorry VIRAGES has begun.

Prospects and Proposals

We stated above the paradox of a European Road Safety Year during which appeared a considerable increase of accident risk. This fact has the meaning of an alarm signal and should attract the attention of all the Road Safety partners and especially of decision-makers, on the one hand, and researchers, on the other hand.

In the framework of this international conference, it is useful to think about our common conditions of progress and, taking into account European perspectives, about necessary convergence of some efforts. Among others, we will mention three fields of co-operation for research and for action.

- *Management of speed limits* is a permanent and capital element of a Road Safety policy; it is time to admit this and draw all the useful consequences of it. Especially in this field, co-operation governs success;
- Development of *road transport of goods* has many positive aspects for economy; but it supposes a concerted device of surveillance and the control of the road unsafety it generates. Any evolution of regulations, organization, economics or finances should be examined drawing up an inventory of its potential effects in the field of safety.
- Passenger car or professional driver training depends on educational systems and institutions whose means finally determine the effectiveness and conscience of operators; a socioeconomic analysis of driver training made on a comparative basis commands the attention of all those who consider Road Safety as a major objective.

Italy

Dr. Gaetano Danese,
Direttore Generale della Motorizzazione,
Civile e dei Trasporti in Concessione,
Ministero dei Trasporti

Since the last ESV Conference, many improvements have been introduced in the field of motor vehicle safety. In particular, in Europe and also in Italy, the year 1986 was devoted to traffic safety, during which some noteworthy initiatives were developed. Among these I would like to mention the establishment of the EEC ERGA Safety Working Group which not only had an active role during the "Year of Safety" but is still working at problems of more difficult solution. After more than one year of meetings between Government and test laboratory experts, some concrete results, as well as indications for the future, have been provided by the Group to the European Common Market Commission. The impression I received—based also on the reports by my colleagues—is that in this type of discussion there is often the desire to conclude the work undertaken at any cost. This partly neglects the fundamental objective, which is: the achievement of scientifically sound tradeoffs between the practical feasibility and needs of new generation vehicles. Therefore, it is important for the enhancement of safety to abandon extreme positions even if they sometimes appear valid in the light of available, but sometimes limited, knowledge. After more careful and thorough consideration, it appears that those test methods or legislative requirements which might be desirable now could be much more effective if they are harmonized with the actual needs. These considerations are not meant to reduce the importance of establishing, beforehand, performance criteria capable of simulating, with sufficient accuracy, the behaviour of both man and vehicle: and this is particularly true when considering the impact tests criteria.

In establishing performance criteria for a safety standard two elements, namely man and vehicle, should be considered together. It is important that this need be recognized, otherwise regulations will be in conflict with one another, and will not be based on the reality of actual accidents. Legislative improvisation in fact is no longer an appropriate method of writing safety standards.

It is vital that the effectiveness of safety standards be assessed and that every single safety regulation be meaningful, effective and formulated in objective terms. In order to find out whether a legal measure meets this criterion a parallel research is required where the feedback from accident analysis is obtained to evaluate the extent of the benefits and of the disadvantages connected with the introduction of any safety related requirements. However, a proper implementation of this research depends on adequate knowledge coming from multi-disciplinary accident analysis and experimental biomechanical studies. Both these areas of research require more extensive development before the present generation of safety standards can be soundly based.

As regards the results obtained so far, due note should be taken of the many advances in the field of active and passive safety. For active safety it is very difficult to quantify the benefits which have been achieved. However, it is enough to drive a modern car or truck and then to drive one dating from the early 1970s to realize that very substantial improvements have occurred. These relate to improved fields of view, better mirror systems, heated rear windows, rear window wipers, and improved lighting and signalling systems.

A second area where advances have been made and in which Italian vehicles have gained recognition for their performance is in braking and handling. Tire adhesion, particularly under wet conditions, has improved greatly in the last decade, as well as the braking and handling of modern cars. Brake fade is no longer a significant problem and antilock braking systems are becoming more widely available, particularly on commercial vehicles.

Improved ergonomics and comfort, and reduced noise have safety related benefits in terms of a reduction in driver fatigue. Many of these factors are behind the reductions in crash rates. Most of these measures have not been the result of regulations, but have already been introduced by vehicle manufacturers as a result of in-house research and development.

In the field of passive safety, we have seen very significant improvements in seat belt technology. All these improvements and the structural characteristics of the passenger compartment and the deformable structures around it can be used to provide optimum levels of protection for the occupant, only if he or she is correctly wearing a seat belt.

However in a severe collision even a correctly restrained driver risks injuries to his face and head, because contact with the steering wheel is still possible. A great deal of research has to be done to define a more biomechanically correct approach in this area.

As regards the voluntary adoption of safety devices in our country, we must recognize that European vehicles are now fitted for the most part with head restraints. However, I would like to point out that devices such as these are useless if passengers are not aware of the importance of a correct adjustment. The same consideration also applies to the seat belt anchorage adjusting systems being investigated in Europe and likely to be fitted to some vehicles.

The last decade has seen many improvements in vehicle design. Further improvements are intrinsically more complex because they involve the basic structure of the car, both in terms of its dynamic crash characteristics and the energy absorbing characteristics of the interior of the passenger compartment. For an improved pedestrian safety, the exterior shape and structure of the car should be considered as well. These developments often require new materials and new production methods as well as sophisticated design. For these reasons further levels of crash protection will be increasingly expensive to achieve.

This equally applies to commercial vehicles (for example lateral protective devices), where an adequate compromise between conflicting requirements for the protection of other road users and the operability of the vehicle must be found.

In summary it should be objectively recognized that in the past decade significant improvements in traffic safety have been achieved due to numerous changes in vehicle design. Further improvements will only occur in minor steps, notwithstanding the introduction of extensive vehicle design changes.

In contrast, the European highway infrastructure offers many opportunities for major improvements in road safety which would be extremely cost effective. In addition improvements can be achieved in the area of road user behaviour.

There are relatively few proven programs which can be shown to actually improve road user performance so that accident involvement is reduced. Dealing with alcohol abuse is one of such programs. In the long term traffic education at school level is necessary for effective and safe use of the highway system.

New interesting possibilities are offered by modern technology, in particular by the use of electronics. For example, an electronic control system that senses road conditions, driver's behaviour, and vehicle load conditions can immediately vary suspension spring and shock absorber characteristics. It is thus possible to make suspensions rigid and safe for the driver who negotiates curves in a sporty manner, or soft and comfortable for relaxed driving. Even more important is the application of electronics to brakes. Wheel antilock systems, already fitted to fast and luxury cars, will become more popular as cost decreases.

For commercial vehicles a partial antilock system—namely, a system not operating on all wheels but nevertheless capable of preventing vehicle skidding—could be fitted.

Great care shall be taken not to create a "mistaken" sense of safety which will result in a demand for higher vehicle performance because of the new devices. For example, a wheel antilock system with sophisticated performance should not lead the motorist to believe that he is a racing-car driver and that performance of his vehicle is much higher than standard, thus inducing him to exceed his own limits and those of the vehicles.

I would like to mention also several provisions, introduced by the Italian Government in the field of safety. To begin with, there is the mandatory use of the crash helmet for motorcyclists, and new rules for the certification of two-wheeled vehicles. Attention was also given to heavy vehicles such as buses and trucks which make up a large part of total road traffic. For these vehicles, there is a stage-by-stage plan for the adoption of speed limiting devices, antiskid devices, and side and rear backward-reflecting indicators. We shall also be looking carefully at the information gained from this conference, to examine what part it may play in the adoption of new legislations.

Nevertheless, my government is convinced that all this praiseworthy research into vehicle safety should not continue to be seen as a separate factor, but should be included in a more general overview of transport policy. Indeed, our Italian 1984 law provided for drawing up of a General Transport Plan, which was prepared and approved by the Government in May, 1985. This plan points out: the need for a rationalization of the institutional structure governing the transport sector, the course of action to be taken to fit action to need, and the necessary laws and legislation; it also deals with a series of problems related to the social aspects of the transport problem, including safety. The plan contains precise information regarding the policies to be followed for road safety, understood as a component of the national transport system.

It is in this context that the Italian Government is following the proceedings of this ESV Conference with keen interest.

Sweden

Prof. Bertil Aldman,
Department of Traffic Safety,
Chalmers University of Technology,
and
Olle Eklund,
Head, Vehicles Department,
Swedish Road Safety Office

Accident Statistics

The positive trend in Sweden, indicated by decreasing numbers of police-reported road accidents since 1970, was unfortunately broken 5 years ago. From 1968 to 1982 the number of fatalities decreased by 40% but has since then increased again by 10%. For nonfatal cases there was a 20% decrease in that period followed by an increase of 15%.

The most negative trend during the last 3 to 5 years was found among car occupants. Driver fatalities and injuries increased by 35% and passenger casualties only slightly less. During the last 5 years the increase in traffic volume was 13%.

Studies have shown that the average speeds on the Swedish roads increased during the eighties and this is believed to be the reason for this negative tendency. However, stricter enforcement of speed limits seems to have changed this unfortunate development during the last months.

For motorcyclists and pedal cyclists the negative trend which began around 1980 seems to have been broken in recent years.

In 1985 the total number of people killed in road accidents in Sweden was 808; 20,671 were injured, and 5,814 of these suffered serious injuries. The complete official statistics for 1986 are not yet available but 844 fatalities have been confirmed.

At the end of 1986 the number of cars in use was nearly 3.5 million.

A New Traffic Policy

Within the Swedish Government work on a revision of the current traffic policy is in progress. The ambition is to make a proposal to the national parliament in 1988.

In this work road safety and environment matters have a central position. Among the items which will be given particular consideration, the following can be mentioned:

- Driver education,
- Speed adaption,
- Anti-locking brakes on heavy vehicles,
- Requirements on tires,
- High mounted stop lamps, and
- Road safety measures within the road maintenance program.

A number of authorities, organizations as well as companies and private persons are now working together in Sweden to achieve better road safety. For some of the institutions road safety is their main objective; others are involved in this work to a lesser degree.

Coordination and Planning

The Swedish Road Safety Office is the central administrative authority for matters related to safety on the roads. A few years ago the office was given increased powers for the task of coordinating the efforts of all institutions involved in this kind of work.

In the fall of 1984 the Swedish Government decided that a special council linked to the office should be appointed for the task of planning and coordination of road safety activities in Sweden. It was also decided that a new staff function, a planning department, should be established.

The new directives also stipulated that the Swedish Road Safety Office should produce a traffic safety plan every year.

The council for coordination and planning consists of representatives from nine leading authorities and organizations in the field. Its function is an advisory one but it is expected that each authority and organization should carry out its share of jointly decided activities.

In this context the word coordination can be defined as the total long-term planning of all the activities of the parties involved.

The parliament has formulated the objectives for this work. These include a progressive reduction of the total number of casualties in all road user categories as well as a progressive reduction of the risk factors to which these people are exposed.

The new staff function, the planning department within the Road Safety Office, was formed at the end of January 1986. This department will serve the council with the information necessary for its decisions.

The 1987 Traffic Safety Plan

In accordance with its instructions the Road Safety Office has published a traffic safety plan for 1987. It addresses the following problems:

1. Speed adaption
2. Unprotected road users
3. New driver license holders
4. Drunk driving

5. Disabilities among road users
6. Drivers' perception
7. Children in traffic.

This plan will be the basis for all activities of the authorities and organizations represented in the council as well as for all other efforts in this field.

Regulations for Vehicles

The Road Safety Office is also responsible for regulations concerning vehicles and vehicle components. Among the activities in this area the following can be mentioned:

- Regulations regarding type approval of protective clothing for motorcyclists have been established and were set in force in December 1985.
- Measures have been taken to improve the visibility of motorcycles.
- The use of wild-bars (bull-bars) on vehicles has been prohibited due to their aggressivity to unprotected road users.
- The use of seat belts is mandatory in the rear seat from July 1, 1986.
- Methods for measuring the tire/road noise have been developed in cooperation with a working group within the Economic Commission for Europe (ECE).

Road Safety Research

The Swedish Transport Research Board has published a long-term program in which priority is given to projects aiming at the construction of models and formulation of theories regarding the function of man as a road user. The need for this kind of project is indicated particularly in behavioral research and in biomechanics.

Among the research activities in progress in Sweden a few will be mentioned here.

A comprehensive study on the use and effectiveness of different types of child restraints has been conducted jointly by The Folksam Group, Chalmers University, and VTI. The analysis of the results has begun and a complete report will be published later this year.

The injury mechanisms in rear-end impacts and the effect of large head motions on the central nervous system in car accidents are the subjects of a joint clinical and experimental study at Chalmers University and the University of Göteborg. A comparison is also made between long-term complaints after traumatic loading of the neck in car accidents and similar symptoms from static loading among industrial workers.

Many accident avoidance problems with heavy goods vehicles are related to their great dimensions and variations in weight. A study conducted in four Nordic countries in 1986/87, with measurements of decisive quantities in the air brake systems and the braking characteristics of these vehicles, will be described at the international conference "Roads and Traffic Safety on Two Continents" organized by TRB and VTI in Göteborg in September 1987.

During the winter periods 1985-1987 investigations were carried out by VTI in a program for improved ECE regulations for antilock braking systems to ensure acceptable performance under winter conditions.

Within the long term road accident research program at Chalmers University of Technology an attempt has been made to design a low cost device which can be mass produced and is capable of indicating in a simple way the severity of a car accident. A report of the function and feasibility of this device will be presented at the 1987 International IRCOBI Conference, September 8-10, in Birmingham, United Kingdom.

The European Experimental Vehicles Committee

Prof. Dr. Bernd Friedel,
Director,
Bundesanstalt für Strassenwesen,
The European Experimental Vehicles Committee

As I mentioned at the 10th ESV Conference, 1986 was declared road safety year in Europe by the European Communities. A large number of activities were undertaken in the different member states to promote traffic safety on the roads. It is difficult to assess the benefits of such a comprehensive programme—but there is no doubt that road safety is an issue which demands the continuous attention of the world's governments and administrations, of the public, and last but not least, of the research sector. Against this backdrop, there can be no denying the necessity for further improvements in motor vehicle safety.

Since 1985, the EEVC has therefore continued its work on car safety, especially with regard to side impact protection. At the Kyoto conference five years ago, an EEVC report was published on Structure-

Improved Side Impact Protection in Europe. Reviewing the accident data available, recommendations were made at that time for a suitable test procedure consisting of a full scale test in which the car being tested remained stationary while being struck in the side by a movable deformable barrier with a 90° lateral impact. Since that time considerable research has been conducted in different countries to develop the test procedure so that it would be available for consideration for legislation in Europe. For example, two different types of barrier face have been developed on the basis of the EEVC specification. Various activities of European institutions towards the proposed test procedure have been sponsored by the Commission of the European Communities (EEC). The results of all this work have been presented by the EEVC on such occasions as the NHTSA Public Meeting on Side Impact held one year ago here in Washington, D.C.

The developed barrier faces worked well in crash tests with real cars. At the end of 1986 the specifications of the stiffness of the barrier were reviewed. It was also recognized that the initial inertia effects of the masses of components at the very front of cars give rise to initial peaks. The problem of determining the appropriate height of the barrier face above the ground level was also tackled. The results of this reconfirmation will be presented in detail at this conference in the technical session devoted to side impact protection. The proposed test is still a 90° test at 50 km/h as announced in 1982. The ground clearance of 300 mm is now preferred if the aim of the regulation is intended to improve the safety of today's cars. It seems some deviations from the force/deflection corridors are unavoidable. In general, the work on the test conditions has been finalized. Therefore our results have been handed over to the Economic Commission for Europe (ECE) as well as to the Commission of European Communities (EEC) as scientific input for drafting appropriate regulations and/or directives.

At the last ESV Conference in 1985, we mentioned our efforts to develop a European Side Impact Dummy (EUROSID). Guidance on the overall features of the design of this dummy has been provided for many years now by the EEVC Ad Hoc Working Group on Side Impact Dummies under the chairmanship of Mr. Neilson from the Transport and Road Research Laboratory (TRRL) in the United Kingdom. First prototypes have been built. A validation programme was conducted which was finalized at the end of last year with the financial support of the EEC and in very close cooperation with INRETS and the Association of Peugeot and Renault from France, TNO from the Netherlands, BASt from the Federal Republic of Germany, TRRL from the United Kingdom and several associated organisations. This programme was set up to provide information about a large number of aspects of the dummy's performance such as biofidelity, scaling of injury criteria values, repeatability of response to similar impacts, reproducibility, and sensitivity of response and durability.

At this conference EEVC will now present the results of about 500 tests (e.g., impactor, sled, and full scale tests) conducted on these aspects and referring to the different body areas injured in side impacts. EUROSID has been shown to be at a very satisfactory state of development. The EEVC main committee has therefore decided that the dummy in its present form is ready to be evaluated in laboratories and testing institutions around the world. A few changes in detail may be necessary after the tests have been carried out by these institutions. The dummy is specified for use as a test measuring tool. The above-mentioned EEVC Working Group will continue its work until the end of this year, particularly in suggesting appropriate injury criteria and protection criteria values and evaluating possible design adjustments. A consortium of three companies was set up last year to produce EUROSID. The dummy and spare parts are marketed by TNO, Netherlands.

At the end of 1986, a seminar on EUROSID was conducted in Brussels in order to present the dummy to interested parties in the national administrations, automobile and component industry, and research and test organisations.

The Commission of the European Communities has started discussions among the twelve member states to develop a new directive on side impact protection using the EEVC proposal for both the barrier and EUROSID. The Commission has repeatedly expressed a firm wish for international harmonization. The EEC would like the governments of the United States of America and Japan to enter into international negotiations with the European governments concerning this issue of lateral protection.

Working in close cooperation with the Commission, the EEVC has loaned one of the prototypes to NHTSA for test purposes. EUROSID is on display at the exhibition being held during this conference.

International cooperation is also under way with CCMC, MVMA, JAMA, and Transport Canada regarding the European Side Impact Dummy. In all these cooperative efforts EEVC is looking to facilitate an exchange of scientific knowledge and to discuss the results of research and development.

Since the 10th ESV conference, EEVC has conducted a study on Heavy Goods Vehicles, also under the chairmanship of Mr. Neilson (TRRL). We are pleased to present our results at this conference. They relate particularly to the accident statistics for our different member countries and to safety measures which should improve accident avoidance and injury protection.

In 1986 the Government of Spain decided to join the EEVC. Seven European governments are now represented on this committee. The European Commission is also involved in our work as an observer.

From the time of its inception, the European Experimental Vehicles Committee has put its effort into coordinated research and has relied upon international cooperation which has always been forthcoming. This also holds true for this 11th ESV Conference.

Japan

Kenzo Inagaki,
Acting Deputy Director,
Automobile Division,
Ministry of International Trade and Industry

It is my great pleasure to be given this opportunity to deliver this status report by the Japanese Government on the issue of automobile safety. Nearly two years have elapsed since the opening of the 10th International Technical Conference on Experimental Safety Vehicles at Oxford, Britain, in July 1985, and in the cause of making automobiles a truly integral part of human society, it is significant that experts in automobile safety technology from many countries have gathered here to share and discuss their research findings.

When we think of automobiles, we are apt to focus our attention on designs and performance, but I believe that the safety issue has the most importance in our attempt to win a full acceptance of automobiles in society. I should add that traffic safety is a vital ingredient for the development of both our industry and our culture.

For this reason, in this status report from Japan, I will focus my attention on new developments in safety issues in Japan since the last conference two years ago.

Current Status of Traffic Accidents in Japan

In 1986, there was a total of 9,317 people killed in traffic accidents in Japan. This was a 0.6% increase compared to 1985. It is a sad fact that the number of traffic deaths has increased moderately but at a steady pace for the past several years, despite our efforts to reduce traffic accidents. However, if we note that the number of automobiles in use has increased by 4.2% and the number of traffic accidents has increased by about 4% in the past one year, the 0.6% increase in traffic deaths is statistically consistent with these trends.

One of the features of traffic accidents in Japan today is an increase in the number of accidents involving people 70 years or older. This is a result of an increase in the number of aged drivers, in parallel with the aging of the Japanese population as a whole. Since the percentage of senior citizens will continue to increase for many years to come, the Japanese Government is engaged in various activities to promote safer driving by older citizens.

For instance, the Government is discussing the possible introduction of more easily recognizable traffic signals, and has introduced a self-checking system for the aged to measure their own aptitude for driving, while expanding traffic safety education programs for senior citizens.

As a factor contributing to the small increase in traffic deaths, I should mention that it has become mandatory for drivers and passengers to use seat belts. The use of seat belts became mandatory from September 1985 for driving on highways, and from November 1986 for driving on ordinary roads. As a result of this enforcement, the rate of seat belt usage on the highways climbed sharply from 52.3% before the enforcement to 95.3% after it came into force; the corresponding figures for ordinary roads were 56.8% before and 95.9% after.

Since then, the seat belt usage rate has further improved, and today the rate is 99.2% for highway driving. I believe that the current level of seat belt usage in Japan is very high compared to other countries.

Automobile Safety Standards

Japan has been expanding the scope of its automobile safety standards according to the "Second Program Plan for Future Automobile Safety Standards" formulated in October 1980. As you are aware, at the previous 10th International Technical Conference on Experimental Safety Vehicles, we reported on the three safety standards that we planned to strengthen. This plan was adopted in September 1985, after notification to GATT. Let me now briefly explain the standards we actually strengthened.

(1) Seat Belts
First, it has become mandatory in Japan to furnish all automobiles with safety belts on all seats, and to equip the driver's seat belt with an emergency lock retractor device. The only exceptions to this are route buses which do not run on highways.

(2) Windshields
Second, it has become mandatory to use HPR laminated glass for automobile windshields.

(3) Fuel Leakage in Collisions
Third, new requirements have been introduced with regard to fuel leakage caused by rear-end collisions, whereas the previous requirements for fuel leakage pertained only to front-end collisions. In addition, trucks no larger than 2.8 tons GVW have been made subject to these fuel leakage regulations.

International Harmonization of Automobile Standards

Automobile standards to secure safety and pollution control differ from one country to another, reflecting different traffic and social conditions in different countries. Nevertheless, if we consider the internationality of automobiles as a commodity distributed on a worldwide scale, there is no doubt that automobile standards must be internationally harmonized as much as possible, while taking the different traffic conditions of various countries into account.

For this reason, on the basis of the Action Program decided in July 1985, the Japanese Government took steps to improve the automobile certification system, and in addition, implemented various actions for the international harmonization of automobile standards.

For example, the Japanese Government actively participates in the ECE WP29 meetings, where in March this year, Japan proposed a worldwide harmonization of installation requirement for lighting and light-signalling devices.

For another example, at the forum of the Council for Transport Technology, members of the Council heard the opinions of people knowledgeable in the field, including people from other countries, and held discussions on the issues of international harmonization. Furthermore, Japan recently organized a Symposium of the International Harmonization of Motor Vehicles Regulations in Tokyo.

In addition, as a step toward the harmonization of standards between Japan and Western countries, Japan has abolished the requirement to furnish speed warning devices and parking lights, and is planning to create a new center specialized in the promotion of international harmonization some time in the current fiscal year 1987.

I hope that you will understand our active commitment to the harmonization issue, and I would like to ask for your support, for Japan is determined to continue its efforts to promote such harmonization.

Automobile Safety Measures

With respect to safety measures relating to vehicle structure, I should mention that safety structures protecting against front-end and rear-end collisions have already been incorporated into newly produced cars, in accordance with the ESV and RSV experiences. As a measure to protect passengers in accidents, automobiles equipped with air bags are now under production.

Since the prevention of traffic accidents is the basis for safety, Japanese automobile manufacturers are working hard to develop methods of preventing accidents by using electronics technology. In addition to antilock braking systems, the manufacturers have already put to practical use electronically controlled suspensions, electronically controlled real time four-wheel drive systems, and four-wheel steering systems.

Also, research is underway to develop warning systems for maintaining a proper distance between automobiles and preventing the driver from dozing. Furthermore, studies are in progress into the possibility of utilizing high-level communications systems to support the driver by providing traffic information from outside the automobiles.

Research for Automobile Safety

In Japan, the Government and automobile manufacturers are actively engaged in research into automobile safety. The collection and analysis of data on traffic accidents are most important for determining the future course of safety policies and research activities, and statistical analyses of these data are performed by each institution conducting the research.

For passenger cars, studies are conducted to determine relationships between the driver's steering behavior and the occurrence of accidents, the importance of steering stability in four-wheel steering, and the effects of worn-out tires, among other research subjects.

For large trucks, investigations are carried out into passengers' behavior upon collisions, the running performance of trailers, and other subjects.

Concerning motorcycles, research subjects include steering stability, antilock braking, and passenger protection. For both two- and four-wheelers, research is underway to formulate a standard for headlight performance and to discover more about the visibility of rear lighting devices.

At the present eleventh conference, from tomorrow, Japanese automobile manufacturers and other Japanese researchers are scheduled to report on research activities in Japan, and in ending this status report from the Japanese Government, I would like to ask all participants to share with us their frank opinions and insights, in order to gain the greatest benefits from this conference in the interests of traffic safety.

Canada

Dr. Gordon Campbell,
Director General,
Road Safety and Motor Vehicle Regulation Directorate,
Transport Canada

Canadian Accident Environment

Since the early seventies, the number of persons killed annually in Canada in traffic-related accidents has declined dramatically. This number peaked in 1973 when approximately 6,700 traffic fatalities were recorded. By comparison, fewer than 4,100 fatalities were recorded in 1986, the lowest number recorded in Canada since 1962. The reduction is all the more impressive if one takes vehicle travel into account. Between 1973 and 1986, the traffic fatality rate per 100 million vehicle kilometres has declined by almost 50 percent, from 4.2 to 2.2. The 1986 traffic fatality rate is the lowest ever recorded in Canada.

The last decade has seen great emphasis placed in Canada on increasing the wearing rate of seat belts and on the use of child restraint systems. The use of federally-approved child restraint systems is now compulsory in all of Canada's ten provinces for infants and younger children travelling in motor vehicles. The use of seat belts by older children and by adults is presently compulsory in eight provinces. Within the year or so, however, it is anticipated that seat belt use legislation will be introduced in both of the two remaining provinces. Although seat belt use has not yet been made mandatory in either of Canada's two territories, the passage of legislation in one jurisdiction appears imminent.

National estimates of seat belt use by drivers are obtained annually by direct observation in roadside restraint use surveys conducted by Transport Canada. While the long-standing goal of an 80% national restraint use rate has yet to be realized in Canada, substantial progress towards it has been made. The last decade has seen more than a three-fold increase in the usage rate of seat belts by drivers, from less than 20 percent in the mid-seventies to a level now exceeding 60 percent. The restraint use rate of drivers continues to increase steadily. In the context of the above-noted goal, it is particularly encouraging that the latest restraint survey data show seat belt usage by drivers exceeding 80 percent in a number of major cities in Canada.

Crashworthiness Research

Transport Canada's research efforts to improve occupant safety in frontal collisions were outlined in the Canadian Government Status Report at the last ESV conference, held in England in 1985. To date, these research efforts have produced two test devices which are in an advanced stage of development.

The first of these devices is the Belt Test Device (BTD) which permits seat belt fit to be quantified on the basis of a simple in-vehicle static test. The test device consists of a standard SAE H-point machine modified to accept pelvic and thoracic body forms. Each form incorporates a series of scales which allow the position of the seat belt to be defined in relation to specific anatomical landmarks. A small number of kits which allow the H-point machine to be converted to a BTD have been fabricated, and are presently being made available to interested agencies for evaluation purposes.

The second piece of hardware developed is a modified G.M. Hybrid III head form. The modified head form incorporates a frangible facial insert formed from methyl methacrylate. The insert is designed to fracture at impact energy levels based on available cadaver data. To further assess the appropriateness of the design of the modified head form, additional head impact response and facial fracture tolerance data will be gathered this summer as part of a cooperative research project with the Collision and Biomechanics Laboratory of INRETS (Institut National de Recherche sur les Transports et leur Sécurité) in France.

In addition, the research efforts produced a modified Hybrid III chest assembly that more closely resembles the human thorax. Comparative sled and barrier crash testing of the modified and unmodified chest assemblies revealed little difference in the peak deflections measured at the mid-sternum location when the dummies were restrained by three-point seat belt systems. Overall, the testing suggested that the existing Hybrid III chest produces human-like defections at the mid-sternum under loading rates represented in a 48 km/hr barrier crash when the dummy is restrained by a three-point seat belt.

Over the next two years, it is anticipated that a steadily increasing proportion of the Department's research activities in the areas of accident data analysis and vehicle crash testing will focus on the issue of side impact protection. Specifically, the Department will be initiating a comparative crash test programme using anthropometric test devices and testing procedures developed in the U.S. and Europe to assess side impact performance on the basis of a dynamic test of a vehicle when impacted in the side by a moving deformable barrier. The upcoming test programme and accompanying accident data analysis are intended to assist the Department in evaluating the appropriateness, in the context of the Canadian accident situation, of the various regulatory options advanced to date to assess side impact performance.

In addition, the Department is presently examining the potential benefits and costs associated with the mandatory installation of manual three-point seat belt assemblies in the two rear outboard seating positions of passenger vehicles.

Crash Avoidance

Recent developments in Canada in the area of crash avoidance relate primarily to vehicle lighting. Consideration by the Department of the potential benefits of improvements in vehicle conspicuity prompted the promulgation of two additional federal requirements for vehicle lighting.

The first of these pertains to the fitment of a centre high-mounted stop lamp in all passenger vehicles sold in Canada after January 1, 1987. It is anticipated that this measure will reduce the number of passenger car rear-end collisions by some 25 percent. The technical requirements associated with this regulation are identical to those introduced in the U.S.

The second regulation recently introduced pertains to the mandatory installation of a daytime running lights system on all new vehicles sold in Canada, commencing December 1, 1989. It is estimated that this measure will reduce daytime multiple vehicle collisions by some 10 to 20 percent. To promote international harmonization, the technical requirements associated with this regulation are compatible with those in Sweden, Norway, and Finland, where the use of daytime running lights is also compulsory. In this context, we are very pleased by the response of the U.S. administration to our initiative. Measures are in hand to permit the operation of vehicles equipped with daytime running lights in the United States, and we are presently cooperating with them in the development of an evaluation programme for the standard.

Research efforts are also in progress to further improve heavy vehicle safety, particularly in the area of braking and stability. A national survey of the condition of the braking system of heavy vehicles was completed recently by the Department. A study of injury-producing accidents involving heavy trucks is also in progress to establish and rank causal factors. The potential benefits of improved heavy truck brake performance resulting from the mandatory installation of front axle brakes are also being examined.

The Department also participated in a major cooperative research project, funded jointly by federal and provincial governments and industry, on the effects of vehicle weight and dimensional variations on the stability and control characteristics of commercial vehicles and their effects on the strain and deflection response of roadway pavement. The study was intended to provide objective data to support the adoption of a more uniform set of vehicle weight and dimensional regulations across Canada, while maintaining operational safety and preserving the highway infrastructure. The results of the study are currently being used by an implementation committee charged with the responsibility for updating the uniform Canadian operating standards for motor vehicle size and weight.

United States

Michael M. Finkelstein,
Associate Administrator for Research and Development,
National Highway Traffic Safety Administration

Since the Experimental Safety Vehicles (ESV) Conference held in Oxford in July 1985, the National Highway Traffic Safety Administration's (NHTSA) motor vehicle safety program has made substantial progress in a wide variety of areas.

When we last reported on the status of motor vehicle safety in the United States, we were just beginning to see laws enacted requiring the use of safety belts. As a result of safety belt use laws now in effect in approximately half the States, more than 1,500 Americans are alive today. They have been saved by the belt. With respect to passive restraints, almost one million passenger cars equipped with either air bags or automatic safety belts will be sold to

American consumers this model year. Restraint system technology that was developed by the research community is now available in auto showrooms all over the nation.

In addition to our success in increasing the use of restraints by motor vehicle users, we are also succeeding in reducing the number of alcohol impaired drivers on our highways. Efforts throughout the United States have reduced the proportion of intoxicated drivers involved in fatal crashes and we are now expanding our research to cover drugs and impaired driving.

Two years ago, we reported on the National Academy of Sciences publication of *Injury in America*. This marked the completion of a study sponsored by NHTSA to examine the need for a well-coordinated, national trauma research program. Today, we can report on a 10 million dollar injury prevention research program managed by the Centers for Disease Control in conjunction with NHTSA. This program has recently funded five centers of excellence to pursue trauma research and has awarded more than 30 research grants (selected from more than 400 applications).

All in all, we have achieved much in the two years since the last meeting. But very clearly, more has to be done if we are to alleviate the deaths and injuries that are still occurring on our nation's highways.

The Accident Environment

Since the early 1980's, the fatality rate has been dropping. Fatalities per 100 million vehicle miles travelled were 3.34 in 1980 and had declined to 2.47 in 1985. Based on preliminary data for 1986, 46,000 persons died in traffic crashes, an increase of about 2,000 from the 1985 level. This fatality increase is attributable to a significant increase in travel. The fatality rate still remained at 1985's all-time low of 2.47 per 100 million vehicle miles travelled (Table 1).

On average, in each of the last five years, there have been approximately 6 million police-reported accidents from a fleet of 180 million vehicles travelling nearly 1.8 trillion miles. These crashes involved more than 10 million vehicles and injured more than 3.3 million people. Our best estimate is that serious injuries in motor vehicle crashes still exceed 160,000 each year, with fatalities averaging slightly in excess of 44,000 each year (Table 2).

In the U.S., passenger car occupants account for the largest proportion of crash fatalities—approximately 54 percent in 1986. And in 1986, fatalities among light truck and van occupants almost equalled the number of pedestrian fatalities—each group accounting for 16 percent of the highway death toll. The largest remaining group are the motorcycle riders, who accounted for 10 percent of fatalities last year (Figures 1, 2, and 3).

Table 1. Motor Vehicle Traffic Fatalities 1980, 1985, and 1986.

Type of Vehicle	1980	1985	1986*
Passenger Cars	27,455	23,198	24,890
Light Trucks/Vans	7,486	6,690	7,383
Medium Trucks	285	156	170
Heavy Trucks	977	821	773
Busses and Others	580	587	694
Motorcyclists	5,144	4,570	4,530
Nonoccupants	9,164	7,773	7,560
Total Fatalities	51,091	43,795	46,000
Fatality Rate	3.34	2.47	2.47

*Preliminary

Table 2. Magnitude of the Highway Safety Problem 1982–1985.

	1982	1983	1984	1985
Reg. Motor Vehicles	165,253	169,446	171,997	177,135
Licensed Drivers	150,310	154,221	155,391	156,868
U.S. Population	231,534	233,981	236,158	238,740
Vehicle Miles of Travel	1,593	1,658	1,717	1,775
All Reported Accidents	18,100	18,300	18,800	19,300
Police Reported Accidents	5,825	5,861	5,908	6,081
Tow-Away Accidents	2,130	2,221	2,314	2,331
Injury Accident	2,158	2,310	2,372	2,248
Property Damage Accident	3,667	3,551	3,534	3,833
Involved Vehicles	9,875	9,869	10,093	10,452
Involved People	15,318	14,852	15,473	16,108
Fatalities	43,945	42,584	44,241	43,795
Injured People	3,192	3,371	3,563	3,363

Note: All values in thousands except Vehicle Miles of Travel in billions and Fatalities in units.

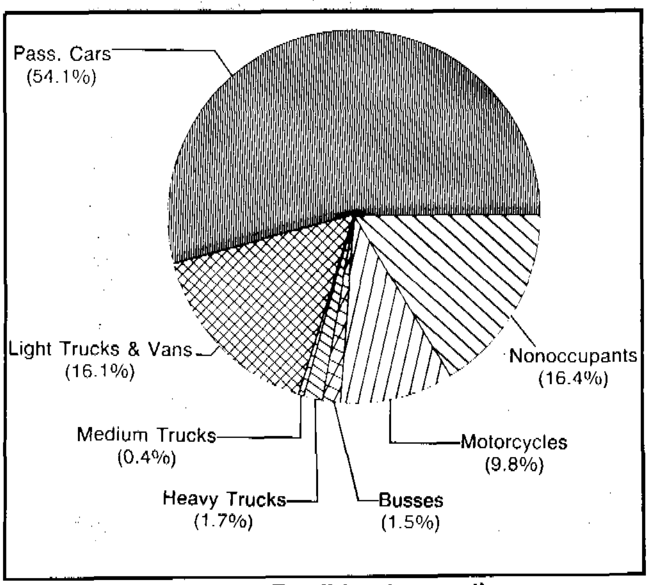


Figure 1. 1986 Traffic Fatalities (percent)

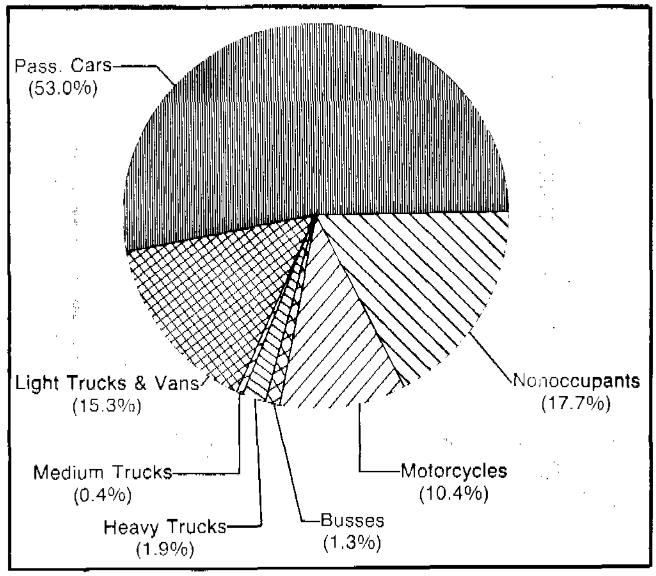


Figure 2. 1985 Traffic Fatalities (percent)

Accident Data Collection and Analysis

Most of the accident data cited throughout this report are derived from the Fatal Accident Reporting System (FARS) and the National Accident Sampling System (NASS).

FARS is a computerized data base containing information on all fatal motor vehicle accidents occurring in the United States. The system became operational in 1975 and currently has records on almost 560,000 fatalities. FARS data are acquired directly from each State's records. The FARS file provides the most comprehensive, detailed, and accurate data on the U.S. national motor vehicle fatality toll.

NASS is a network of trained accident investigation teams that collect data on a nationally representative sample of police reported accidents. Data are compiled and evaluated from detailed accident site inspections, measurements and assessments of damaged vehicles, driver interviews, medical records, autopsy data, and other pertinent records. The NASS system collects information in significantly greater detail, both in the number of variables and the precision of observations, than is available from police records. NASS presently contains over 65,000 cases from 1979 through 1986.

Since the Oxford ESV Conference, we have thoroughly reviewed our data needs, and as a result are in the process of making substantial changes to the NASS system. We will be concentrating NASS on what it does best—the investigation of injury producing crashes—and look to other sources for general estimates of the traffic environment and for information on crash avoidance. The revised system will be in place by January 1988.

The newest of our accident data analysis systems relies on police accident records compiled by the States. Work continues on the development and refinement of this Crash Avoidance Research Data File (CARDFile). CARDFile now uses the three most recent years of data from six States. The file consists of nearly four million police accident records. At this conference we will report on the use of CARDFile in our crash avoidance research program.

Crashworthiness Research

Since Oxford, NHTSA's crashworthiness research has concentrated on the mitigation of injuries sus-

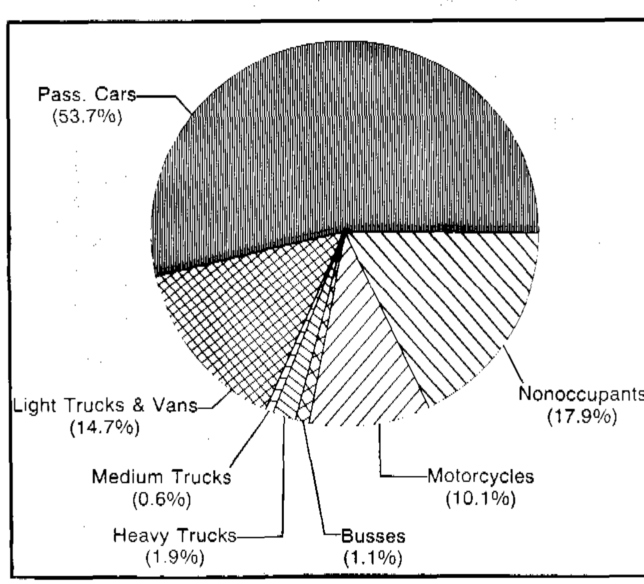


Figure 3. 1980 Traffic Fatalities (percent)

tained in side and frontal crashes for restrained and unrestrained vehicle occupants and on increasing pedestrian protection.

Side Protection

Since 1985, full vehicle side impact crash testing procedures and injury criteria have been refined; and detailed procedures for side impact testing have been published.

An extensive experimental crash test program was conducted to evaluate a variety of production (baseline) and modified cars. In addition, research into alternate test procedures using head and thorax component devices is currently being pursued.

We have also been addressing vehicle aggressiveness in a program which assesses striking vehicle structural characteristics to determine how they affect crash survival in side-struck vehicles.

Frontal Protection

Our frontal crashworthiness research program seeks improved protection of both restrained and unrestrained vehicle occupants involved in frontal impacts. The steering assembly, dashboard, windshield, and A-pillars are the main sources of injury in frontal crashes and our research is examining potential safety improvements in these areas.

We have concentrated most of our effort on steering assemblies, where we are currently testing designs to reduce facial injuries to belted drivers; and abdominal, chest, and head injuries to unbelted drivers. We are also evaluating windshields and side glazing designed to reduce facial lacerations and ejections and we are examining the effects of padding A-pillars to reduce head injury.

Pedestrian Research

Pedestrian protection research, which addresses pedestrian upper body injury, has been progressing on schedule. Since the last conference, further analyses of the accident environment have been performed, experimental methods of simulating pedestrian head and thorax impacts against vehicle surfaces have been developed, injury criteria linking experimental dynamic responses to real-world injury have been derived, and current production vehicles have been tested to identify design features that might play a role in reducing pedestrian injury.

Biomechanics

All of our crashworthiness research is based upon an increasing understanding of the biomechanics of injury. Work continues on the investigation of injury causation, with our current emphasis on frontal impacts for both the driver and passenger.

The biomechanics research has also included the evaluation, modification, and testing of production and prototype dummies developed both by the U.S. and foreign governments as well as by private industry. The dummies were developed for both frontal and side impact crash testing. Research to develop injury criteria for head, neck, thoracic, and abdominal body regions to use in conjunction with these dummies is in progress.

Air Bag Fleet Demonstration Programs

Since 1983, NHTSA has supported the development, procurement, and evaluation of driver-side air bag equipped vehicles in State police fleets and in the Federal fleet. NHTSA financed the development and installation of retrofit air bag systems for more than 500 State police cars. These vehicles were equipped with retrofit driver air bags using conventional air bag technology. NHTSA also supported the General Services Administration (GSA) in its purchase of 5,000 1985 Ford Tempos equipped with manufacturer installed driver-side air bags.

These two fleets have accumulated an estimated 200 million miles of highway travel. These vehicles have been involved in a total of approximately 750 crashes of which 107 crashes were sufficiently severe to cause an air bag deployment. In all cases, the systems worked as expected and these fleets continue to accumulate data on air bag field performance.

We are still working on the development of a retrofit driver air bag with a self-contained, all-mechanical crash sensor. The crash testing to date has been very encouraging. This system appears capable of accurately sensing a wide variety of crash conditions. Currently, the units are undergoing environmental qualification testing.

Crash Avoidance Research

Crash Avoidance Research is being pursued in a variety of areas. We are working on lighting and visibility, handling and stability, and heavy truck research.

Lighting and Visibility

Our major work in lighting and visibility is concentrated on efforts to develop a simplified performance-based vehicle headlighting standard. Our goal is the development of a system which will reduce design restrictions without degradation of seeing distance or increased glare for oncoming drivers. We will be working to expand and upgrade the capability of the existing headlighting computer simulation assessment models. We will then be paying particular attention to enhancing the model's capability to evaluate the effects of glare and seeing distance.

We are also evaluating the Center High-Mounted Stop Light (CHMSL), a requirement of FMVSS No. 108 beginning with MY 1986, and a product of NHTSA's research program. Preliminary data indicate that the CHMSL reduces the likelihood of a rear end crash involving braking vehicles by 22 percent.

Handling and Stability

In the handling and stability area, NHTSA has developed complex test equipment for the accurate measurement of inertial and suspension properties of passenger cars, light trucks, and vans. These data will allow us to make more reliable use of computerized vehicle dynamic simulations to study the relationship between vehicle handling characteristics and crash involvement.

We are turning our attention to the examination of the handling and stability problems of light trucks and vans. We will thoroughly characterize the handling and stability of this class of vehicles during the next few years.

Heavy Duty Vehicle Research

Even though they comprise less than 4 percent of the motor vehicle fleet, heavy trucks continue to be involved in approximately 10 percent of the fatal accidents. The goal of the Heavy Duty Vehicle Safety Research Program is to improve the accident avoidance capabilities and crashworthiness of vehicles with gross vehicle weight ratings in excess of 10,000 lb. through improvements in vehicle performance and driver/vehicle interaction.

Current heavy truck research is continuing to focus on high priority crash avoidance programs aimed at improving the dynamic performance of heavy vehicles in braking and steering maneuvers. Tractor-trailer brake system compatibility problems have been studied in a joint government/industry effort and the data developed is now being utilized. Research is also being initiated to evaluate the performance of second generation anti-lock brake systems through a multi-year in-service evaluation fleet program.

Driver and Pedestrian Safety Research

While this conference is focused on the motor vehicle safety research, NHTSA does have an active program which addresses the behavioral components of traffic safety. Our major efforts continue to concentrate on impaired driving (alcohol and drugs) and on safety belt and child restraint use.

Alcohol and Drug Safety Research

The goal of the alcohol/drug safety program is to develop countermeasures which effectively reduce alcohol/drug impaired driving and related accidents.

Alcohol/drug safety research is focused on four areas:

- General Deterrence—Development of combined enforcement, public information, adjudication, and licensing programs designed to increase the public's perception of the risk of being detected if driving while intoxicated or impaired.
- Specific Deterrence—Development of programs directed at identified impaired drivers and designed to prevent future offenses.
- Prevention—Development of education, public information, and local community training programs designed to instill responsible attitudes towards alcohol/drug use and driving, and to promote cooperative action for avoiding DWI offenses.
- Intervention—Development of programs designed to identify techniques that will enable and motivate third parties (e.g., bartenders, hosts/hostesses, companions) to take action in an alcohol/drug use situation that will deter potential DWI incidents.

Safety Belt Use Research

Since the last meeting two years ago, the number of safety belt use laws has grown steadily. Twenty-seven States and the District of Columbia have enacted safety belt use laws since Secretary Dole's July 1984 occupant protection decision.

NHTSA's research is concentrating on the development of programs that will result in the most effective implementation of these laws. We learned a great deal from our participation in the 1985/86 OECD project on safety belt use laws and our current research concentrates on: (1) assessing the impact of belt use laws through the analyses of crash data and tracking belt use rates; (2) exploring the situational and demographic variables associated with nonuse of belts; and (3) field testing and evaluating both traditional and innovative techniques to achieve higher belt use rates.

Rulemaking

Much of our research has as its objective the modification of motor vehicles to enhance their safety. This is achieved through regulation and information dissemination—the two principal responsibilities of NHTSA's rulemaking organization. Since the Tenth ESV Conference, some significant regulatory actions have occurred.

Crashworthiness

In the crashworthiness area, we issued three important amendments to FMVSS No. 208. In November 1985, we amended the comfort and convenience requirements for both automatic and manual safety belts and delayed the effective date until September 1, 1986, to coincide with the effective date for installation of automatic restraints.

In July 1986, we issued a final rule adopting the Hybrid III test dummy as an alternative to the Part 572 test dummy. Manufacturers have the option of using either the Part 572 or the Hybrid III test dummy until August 31, 1991. After that date, the Hybrid III will replace the Part 572 dummy as NHTSA's means of determining a vehicle's conformance with the performance requirements of FMVSS No. 208.

Finally, on March 30, 1987, we issued an amendment to FMVSS No. 208 providing a one-car credit to a manufacturer that produces a car with a non-belt automatic restraint system for the driver and a dynamically-tested manual lap/shoulder belt for the right front passenger, until September 1, 1993. This amendment to Standard No. 208 was in response to a petition from the Ford Motor Company to extend the one-car credit beyond the phase-in period. This limited extension was granted to encourage the orderly development and production of passenger cars with full-front air bag systems.

Crash Avoidance

In the crash avoidance area, regulations have been promulgated addressing lighting, braking, and controls and displays.

In the lighting area, amendments to FMVSS No. 108 were issued to permit two additional standard replaceable light sources, the HB-3 and HB-4. Action is being initiated by the United States to have these light sources, as well as the HB-1, approved for use in Europe. We are submitting a formal proposal to WP29 to modify all appropriate Economic Commission of Europe (ECE) standards. Simultaneously, we are proceeding with the rulemaking analysis concerning possible use of the HB-2 light source in the United States.

Another amendment was issued which permits the use of a new sealed beam headlamp configuration designated as Type F. Another change to that standard allows a new simplified mounting construction for headlamps. A further rule change now permits the use of modulated headlamps on motorcycles during daylight hours to improve motorcycle safety.

In an effort to increase the daytime conspicuity of passenger automobiles, the agency has issued a notice of proposed rulemaking to allow such vehicles to be equipped with daytime running lights. This would allow vehicles produced in conformance with the proposed Canadian Motor Vehicle Safety Standard to be sold in the United States. Final action on this proposal is pending.

A major rulemaking program to reform the headlighting requirements of FMVSS No. 108 has been initiated. The objective of this program is to develop new headlighting requirements which are vehicle oriented and performance oriented, and thus reduce many of the design constraints which are imposed on manufacturers. A request for comments has been published and notices of proposed rulemaking are scheduled for this summer and next summer.

FMVSS No. 101 has been amended to remove design restrictions and permit greater flexibility in the illumination and identification of controls and displays, and to accommodate new display technologies, including sequencing and retrieving of messages.

With respect to splash and spray reduction devices for heavy trucks, the U.S. Congress has recently amended the statutory requirements. The law now requires that spray suppression devices be mandated unless there is no available technology which can significantly reduce splash and spray and significantly improve visibility of drivers. In view of this change in the law, the agency is planning to hold a public meeting this summer to examine these issues.

New Car Assessment Program (NCAP)

The rulemaking organization is also charged with providing consumers with comparative information on the crashworthiness, damageability, and repairability of motor vehicles.

Under the New Car Assessment Program (NCAP), the agency has tested a total of 211 vehicles since the program began in 1979. Since the Oxford meeting, we have experimented with the use of a Deformable Moving Barrier (DMB) in the NCAP tests. This was initiated to better illustrate the effect of vehicle mass and structure on occupant injury levels. During 1986, nine head-on impacts between a DMB and a production 1985 vehicle were run, each moving at 35 mph (a closing velocity of 70 mph). The DMB was 3,000 pounds and the mass of the nine vehicles tested in the program varied from 2,000 to 3,750 pounds. The DMB and the barrier test data for these nine vehicles are being analyzed to examine the relationships that may exist between the two crash test modes and to compare the test results with real-world accident data. The results will be available later this year.

International Harmonization

Finally, in bringing this status report to a close, it is appropriate to restate NHTSA's commitment to fostering international harmonization of motor vehicle safety standards. This policy is, of course, governed by our legal and procedural requirements and by our overriding concern that motor vehicle safety in the United States not be compromised.

Our current efforts have been directed toward brakes, lighting, and side impact protection for passenger car occupants. A great deal has transpired in each of these areas since the 10th ESV Conference.

Brakes

The effort to harmonize brake standards for passenger cars on a world-wide basis began in the early 1980's. At the last ESV Conference, we reported the issuance of an NPRM to establish a new standard, FMVSS No. 135, Passenger Car Brake Standards. Extensive comments were received from the industry, both domestic and foreign, as well as from WP-29's Group of Rapporteurs on Brakes and Running Gear (GRRF). Review and analysis of those comments and some further testing resulted in a Supplemental Notice of Proposed Rulemaking in January 1987. A nine-month-long comment period was established to permit thorough examination of the latest proposal. The Group of Experts on Construction of Vehicles (WP29) has recently agreed to convening an informal meeting of the GRRF in early July 1987 for the purpose of reviewing and commenting on this latest proposal.

Lighting

At the last ESV Conference we reported on the amendment of FMVSS No. 108 which lowered the minimum permitted mounting heights of headlamps, adopted the 19-point grid of European standards for measuring the photometrics of stop, tail, turn signal, and parking lamps, and lowered the minimum intensity of yellow rear turn signals. Following that action, we made several proposals to the ECE for further harmonization of lighting standards. Included are:

- That the photometric requirements of yellow rear turn signal lamps (ECE Regulation No. 6) be amended to increase the maximum intensity permitted.
- That the test procedures for measuring the photometrics of stop, tail, turn signal, and parking lamps be harmonized by adopting the 5 zone alternative test of FMVSS No. 108. This would involve the amendment of ECE Regulation No. 7, Red Rear Lights and Stop Lights.
- That the ECE develop and issue a new regulation that would permit the installation of center high-mounted stoplamps. This proposed new regulation would be based upon FMVSS No. 108 requirements for such lamps.
- In its efforts to simplify FMVSS No. 108 and at the same time to achieve wider harmonization of headlamp requirements, the NHTSA has proposed that the Europeans and Japanese join with us in agreeing on a harmonized passing beam pattern for headlamps. Such agreement would lead to simplification of headlamp standards and make such standards more performance oriented.
- With regard to replaceable bulb headlamps, the U.S. delegate to the Group of Rapporteurs on Lighting (GRE) distributed copies of drawings for the HB-1, HB-3, and HB-4 headlamp bulbs used in U.S. replaceable bulb headlamps at the 16th session of that group in November 1986. This was done to alert the GRE of a future U.S. proposal that the ECE modify its replaceable bulb headlamp regulations to permit such bulbs. The NHTSA has submitted that proposal to WP-29 for consideration at its 82nd session in June 1987.

Side Impact Protection

NHTSA, the ECE and the Common Market have all been actively engaged in the subject of side impact protection for occupants of passenger cars for several years. The ECE, through its Group of Rapporteurs on Crashworthiness (GRCS), has drafted a proposed regulation, but important provisions dealing with injury criteria, test dummies, and movable deformable barrier have yet to be specified. The Common Market (EEC) has been working on a deformable barrier and a dummy for use in such a regulation. NHTSA has performed a large body of research on the same topics and the automobile industry, both foreign and domestic, has expended resources toward the same objective—arriving at practicable and reasonable requirements to provide better protection to occupants in the event of a lateral collision.

To further the possibility of achieving at least a harmonized test procedure for U.S. and European standards in this area, NHTSA conducted a public meeting in Washington in May 1986, to discuss the various facets of this work. Representatives of European governments and manufacturers, Japanese manufacturers, and U.S. manufacturers participated. The questions of the dummy to be used, the injury criteria to be applied, and the movable deformable barrier to be used in a systems test were discussed during the two-day meeting.

NHTSA has performed some testing of a prototype EUROSID and the results will be published later this year. NHTSA is awaiting delivery of two additional EUROSID dummies, modified according to the latest European design, for further testing. Finally, NHTSA still wants to test an agreed upon European barrier using NHTSA's current procedures as a means of comparing the performance of the various barriers.

Section 3
Results of the International Experimental Safety Vehicle Program

Chairman: Michael M. Finkelstein, United States

Panel One: *ESV/RSV Original Goals and Objectives*

Volkswagen's Participation at ESV Conferences

Prof. Dr. Ulrich W. Seiffert,
Volkswagen AG,
Federal Republic of Germany

Beginning with the first ESV Conference 1971 in Paris under CCMS-sponsorship, the idea of an international program for increased vehicle safety was initiated. North America, Europe and Japan reached a consensus for international cooperation. Because of government activities, the efforts of research institutes and work by the automobile companies and suppliers, the spirit of 1971 is still alive. Very often the question is raised, whether ESV conferences should continue to be held. In my very personal opinion, the success of the conferences can be seen in the existence of a forum which permits an open and progressive discussion of all questions associated with automotive safety. This sometimes is more important than the development and construction of demonstration prototype vehicles. Although the time sequence of the ESV conferences should be defined in relation to research results.

Volkswagen like other automobile manufacturers has actively participated in the ESV Programme. The following short descriptions and pictures show the highlights and some of the results of the different projects:

ESVW I, ESVW II, IRVW I-III, M.I.V.

The various cars or concepts also demonstrate the different priorities in vehicle safety research. In the beginning the 50 mph crash test led to unrealistically heavy vehicles characterized by excessive costs and fuel consumption. Although the vehicles made by some manufacturers more closely approximated the vehicle population then in production, benefit-cost ratios, effectiveness of special features, accident analysis, economy, recycling, compatibility, increase in comfort and active safety exerted considerable influence on the design of production vehicles.

Volkswagen, with the ESVW II and RSV research projects showed alternatives to the results achieved for the ESVW I-vehicle.

At the same time, the first components such as the passive seat belt system (VW-RA) and structural reinforcements became available on production cars.

The most important work with respect to production vehicles were the IRVW I to III vehicles ("Integrated Research Volkswagen"). In addition to questions of vehicle safety, fuel economy, noise and exhaust emissions were also optimized.

Along with the modified concept cars, the ESV-Conference changed its content. Increasingly, questions related to overall traffic safety and the results of vehicle research and not just issues related to passive safety became the subject of valuable discussions. Included also were accident analysis and legislative questions.

At the last conference in Oxford, the question of side impact had a high priority. Volkswagen has worked together with NHTSA on the M.I.V. Project to optimize two contradictory design considerations—the greatest possible reduction in dummy loadings at the lowest possible vehicle weight increase with the precondition that the design be suited to mass production. NHTSA's design goals were the 35 mph head-on fixed barrier impact and the 30 mph side impact with the new deformable crabbed barrier and the new HSRI side impact dummy.

There again it could be demonstrated that not individual requirements, but overall accident performance must be taken into consideration. Based on the M.I.V. work and results of considerable previous research, we are able to present now a new test procedure concept for the evaluation of the performance of passenger cars involved in side impacts.

This new COMPOSITE Lateral Test Procedure combines the advantages of component and full-scale tests without accepting their respective disadvantages. It consequently pursues the two principal features of a meaningful assessment of lateral protection,

- structural integrity
- compartment padding.

In principle, the test procedure consists of the following 4 steps:

Step I

Quasi static structure test by means of a deformable element such as the face bar of a moving barrier. The stroke of the ram is temporarily stopped after contact of interior door panel with the front seat.

Step II

Occupant/door interaction by application of a simplified human torso surrogate to the interior side door structure.

Step III

Continuation of the deformation of the exterior side door structure up to the point of equivalent energy dissipation according to a 30 mph deformable barrier impact.

Step IV

Computer simulation of a full-scale impact test on, e.g. PC.

Input data: Force/Deflection characteristics measured in the structure and padding tests, Steps I to III.

Results: Computed dummy loads and possibly prediction of injury severities.

This new COMPOSITE Lateral Test Procedure provides a reproducible assessment of vehicle performance as well as occupant loads without complicated, expensive and time consuming test methods. It avoids test dummies in the process of development, the most critical element for compliance verification.

Another aspect to be considered is the question of accident avoidance. A wide variety of research has been performed to date in this field. Increased comfort and visibility, handling characteristics, reliability, antiskid braking and fourwheel drive concepts have positively influenced vehicle performance. In addition, progress in accident avoidance characteristics of today's vehicles has led to new research to further reduce the probability of accidents. Most European vehicle manufacturers and many universities and research institutes are participating in the research project PROMETHEUS (Program for a European Traffic with Highest Efficiency and Unprecedented Safety).

The objective of this 8 year research program is to find a global and integrated solution for the total highway traffic system. The highway traffic of the future will become cooperative, conflict free and more compatible. In detail this means enhanced safety, improvement of environmental compatibility, minimizing energy consumption and increased comfort for the individual. To achieve the objective, more intelligence must be installed in future vehicles by means of microelectronics and AI methods so that the vehicle will no longer be isolated in the traffic flow, but will communicate with nearby cars and the environmental infrastructure by means of new communication networks. These new technologies will help the driver avoid accidents and assist him in critical situations. In this manner many human deficiencies may be eliminated although the driver must always have the final responsibility for his car and the ultimate decision made.

While this European project deals with global aspects of traffic including the car as only one factor, future tasks for this type of conference should nevertheless continue to concentrate on the side impact, pedestrian accidents, motorcycle safety and investigation of accident avoidance. Specifically in the field of the interrelationship between man, vehicle, road and environment many unknowns must be explored. The ESV Conference is an excellent forum for the international discussion in these important fields.

Consideration might be given to extending the interval between conferences to more than two years to permit greater progress to be achieved and demonstrated.

ESVW I (1972)

Passive Safety: ○ Crashworthiness in tests: – 50 mph frontal fixed barrier
- 75 mph head-on car-to-car
- 30 mph car-to-car side impact
- 40 mph rear-end car to-car
- pole, roof and bumper tests

○ First passive restraint system and preloader (shoulder and knee belt)
○ Benefit/cost analyses of standards

Active Safety: ○ Anti skid system
○ "Silent co pilot"

Engine and Transmission: ○ 4-cylinder air-cooled rear engine (100 DIN hp)
○ Automatic gear box
○ 30 70 mph/ 16,3 sec

Emissions: ○ Complies with 1973 US standards

VOLKSWAGEN Research

ESVW II (1974)

Passive Safety: ○ Crashworthiness in tests: – 40 mph frontal fixed barrier
- 60 mph head-on car-to-car
- 30 mph car-to-car side impact
- 30 mph rear-end car-to-car
- 43 mph rollover
- pole and bumper tests

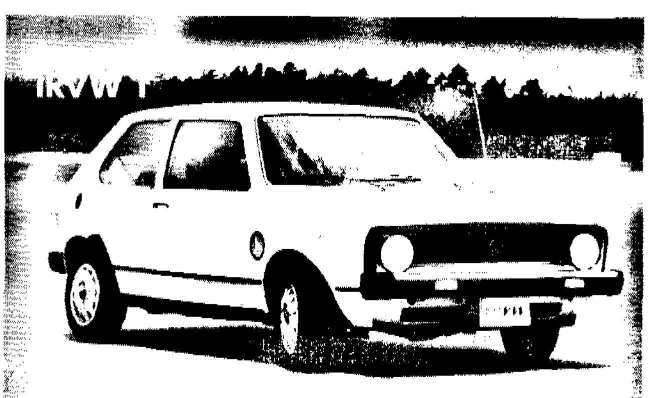
○ Passive preloaded restraint system (shoulder belt and knee bar)
○ Pedestrian protection
○ Hydraulic bumper

Active Safety: ○ Meets all US requirements

Engine and Transmission: ○ 4-cylinder water-cooled front engine (70 DIN hp)

Emissions and Fuel Economy: ○ Complies with 1973 – US standards

VOLKSWAGEN Research



IRVW 1 (1977)

Passive Safety: ○ According ESVW II

Active Safety: ○ Meets all US requirements

Engine and Transmission: ○ 4-cylinder Diesel engine turbocharged (70 DIN hp)
○ 5 gear box
○ 0 - 60 mph: 13.5 sec

Emission: ○ Exhaust: – 0.23 g/m HC
- 0.83 g/m CO
- 0.96 g/m NO_x

○ Noise 71 dB (A)

Fuel Economy: ○

City	Highway	Composite
56 mpg	69 mpg	60 mpg

VOLKSWAGEN Research

RSVW (1975)

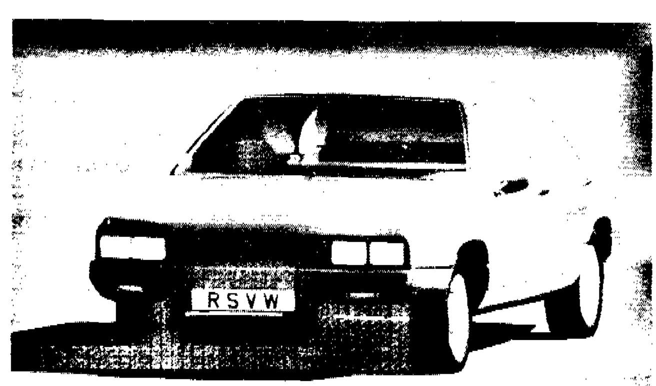
Passive Safety: ○ System-analyses:
- US traffic and accident projections
- Economic and automobile usage trends
- Possible safety measures supported by benefit/cost analyses
- Principle of "Consistent Conditions"
- Compatibility study

Active Safety: ○ Crash avoidance study:
- VW driving simulator
- Real vehicles
- Development of specifications
- Measures to improve active safety

Engine and Transmission: ○ Power plant system-analyses

Emissions and Fuel Economy: ○ Power plant system-analyses

VOLKSWAGEN Research



IRVW 2 (1980)

Passive Safety: ○ Crashworthiness in tests: – 40 mph frontal fixed barrier
– 30 mph car-to-car side impact
– 30 mph rear-end barrier-to-car
○ Three-point belt restraint system with preloader

Active Safety: ○ Torsion-beam rear axle with track-correcting bearings

Engine and Transmission: ○ 1,3 l 4-cylinder engine (75 DIN hp): – 0 - 100 km/h: 15 sec
– top speed: 169 km/h
– 3 + E gear box

Emissions: ○ Exhaust: – 15.85 g/test CO 67 g/test
– 20.3 g/test HC+NO_x 20.5 g/test
○ Noise 73 dB (A)

Fuel Consumption:

○ City	90 km/h	120 km/h	combined (1/3)
8	5.3	7.4	6.9 l/100 km/h

○ Measures: – Engine-transmission managem. (fuelsaver, stop/start)
– High compression with knock control 13 : 1
– Optimized aerodynamics c_D = 0.33

VOLKSWAGEN Research

IRVW 3 (1984)

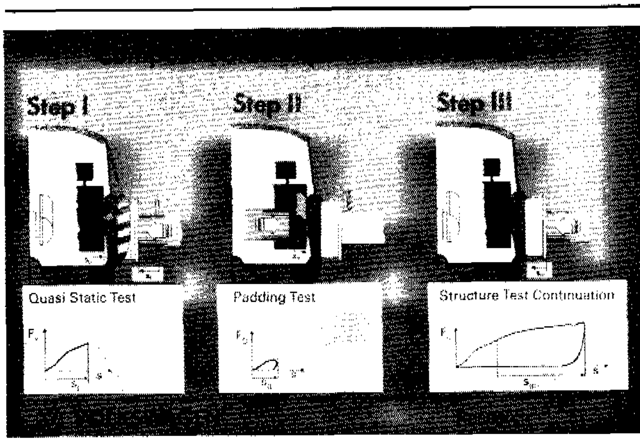
Passive Safety: ○ Complies with all US standards
○ Three-point belt with clamps at the height adjustable upper anchor point

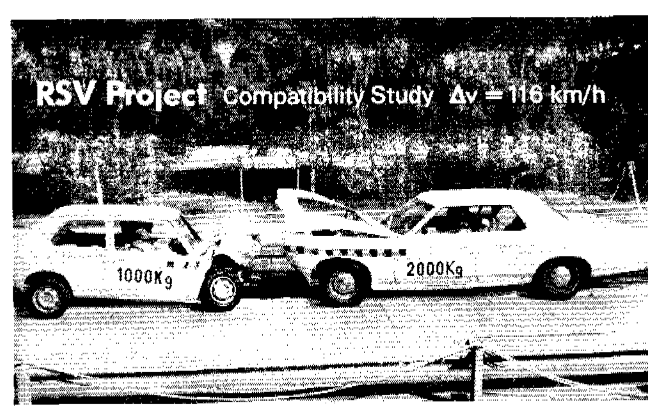
Active Safety: ○ Air springs at the front and rear axles, controlling ride height, comfort and drag coefficient
○ Load dependent damping at the rear axle
○ Anti skid system
○ Anti slip system
○ Navigation system
○ Speed dependent power steering
○ Tires with emergency running property

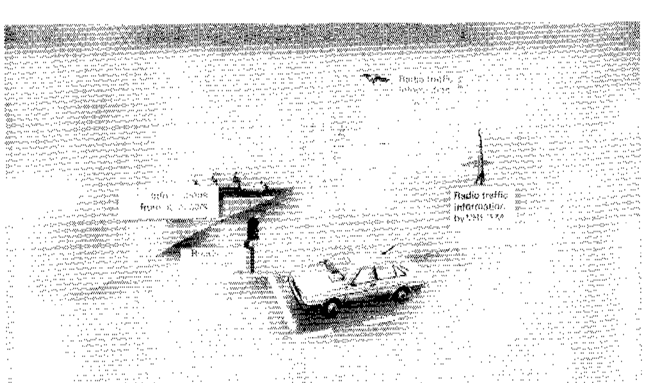
Engine and Transmission: ○ 1,8 l 4 cylinder engine supercharged (Digijet)
○ M5 A gear box: automatically shift between 4th and 5th gear
○ 0 100 km/h: 7.4 sec
○ Top speed: 212 km/h (132 mph)

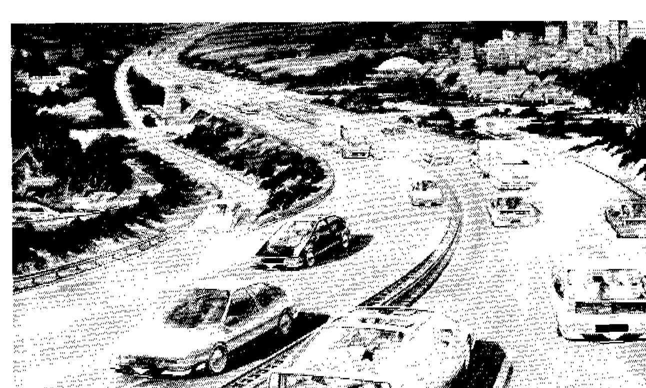
Emissions and Fuel Consumption: ○ Automatic radiator grille control
○ Complies with ECE 15/04 emission limits

VOLKSWAGEN Research









The Original Goals and History of the Nissan ESV Program

~~[redacted]Goto~~, Nagayuki Maruno
~~Japan Automobile Research Institute, Inc.~~
Japan Nissan Motor Co., Inc.

The theme I have been asked to speak on is the original goals and history of the ESV Program in Japan. I would like to address this topic by reviewing the course of our research and development work on the ESV.

In 1970, the U.S. Department of Transportation proposed that an international ESV Program be initiated for the purpose of improving vehicle safety. We were in full agreement with the aims of this program and decided to give it our complete support and cooperation. At that time in Japan, too, traffic accidents were rising sharply along with the increasing number of vehicles on the road. Therefore, we felt that it was important for countries to cooperate in carrying out research to enhance vehicle safety.

The international ESV Program can be broadly divided into the different phases. Nissan's R&D programs have progressed from our ESV, to the Nissan Safety Vehicle, to the Nissan Research Vehicle-II. At each stage we have incorporated our own ideas into the programs and have focused on the establishment of technologies for building safer vehicles. Let us take a closer look at the aims of each of the projects, the results achieved and some of the problems that were encountered.

DOT called upon countries around the world to participate in the ESV Project. In 1970, Japan became an official participant in the 2,000-pound class. The Japanese government and the Japan Automobile Manufacturers' Association worked out the specifications for Japan's ESV in reference to those of the U.S. vehicle. R&D programs were then launched by Nissan, Toyota and Honda.

Our main objective was to focus on improving safety technology for small cars in contrast to the U.S. project. Even before the first oil crisis, the Japanese automobile industry was working hard to improve the safety of small cars. At Nissan, we decided on a four-passenger ESV, weighing 2,500 pounds.

The Nissan ESV had the same fundamental aims as its U.S. counterpart, although we also incorporated our own specifications in several aspects. One of these was the condition for rear collisions. Since the moving barrier weighs 4,000 pounds, the collision speed was lowered to 40 miles-per-hour. That yielded an energy value equivalent to a collision at 50 miles-per-hour between the Nissan ESV and another vehicle of the same weight. We set the allowable safety limit for compartment intrusion at a maximum of 125 millimeters. It was felt that this would provide adequate space for occupant survival, in line with the occupant injury criteria already specified. The condition for visibility was selected in consideration of practical driving requirements.

The Nissan ESV yielded many basic safety technologies. The main features of the occupant protection system included an airbag in conjunction with three-point seat belt for the driver and an airbag in conjunction with lap belt for passengers. The periscope improved rear visibility and the urethane-covered front bumper provided better protection for pedestrians.

Our ESV project contributed greatly to the establishment of many basic safety technologies. These included simulation techniques for analyzing handling and stability properties. The mechanism through which the body construction absorbs energy was also clarified. However, the high collision target speed of 50 miles-per-hour had been achieved only by sacrificing other areas of performance. One problem, for instance, concerned the reliability of the new mechanisms developed for the airbags and preloaded seatbelt. Another problem was that the utility of the rear seat was greatly compromised by the feeling of oppression caused by the airbags. These and other drawbacks raised the question of whether an ESV vehicle was actually feasible in terms of cost effectiveness.

Upon completion of our ESV project, we began searching for the next direction to take in safety technology. That was around the time of the first oil crisis in 1973. The resulting requirements for energy and resource savings greatly increased the demand for compact cars. Subsequently, they also had a major impact on international ESV research. This led to the Research Safety Vehicle (RSV) Project, which reflected the idea of safety improvement harmonized with the three well-known E-factors—energy, economy and environmental protection—as well as aggressiveness and compatibility.

The RSV Project involved the 3,000-pound vehicle class, with a target speed of 50 miles-per-hour for frontal collisions. Nissan did not participate in this project directly, as we developed our Nissan Safety Vehicle in line with our own collision conditions, though we did refer to the RSV Project specifications.

We aimed to develop a four-passenger subcompact, weighing 2,200 pounds, which was intended for use in the 1980s. The objective of this experimental vehicle was to determine what levels of S3E performance could be achieved. A collision speed target of 40 miles-per-hour was set for the NSV. This speed was chosen in view of the cost effectiveness question which had been raised in our ESV project. Studies of accident data indicated that this speed would cover 95% of all fatalities and injuries sustained in frontal collisions in Japan and 75% of all fatalities in the United States.

One result of the NSV project was that it identified the issues involved in assuring occupant safety in subcompact cars in collisions at 40 miles-per-hour. It also yielded new insights and technical advances for reducing aggressiveness and improving other safety aspects.

The development of the first two vehicles clarified a number of issues regarding occupant protection technologies. Consequently, the focus of attention now shifted to the development of subsystems.

At the same time, the field of active safety, including the human-machine interface, came to be regarded as a key factor in building safer vehicles. In addition, the second energy crisis in 1978 saw oil prices double, causing near panic in some areas of the world. This situation made it necessary to achieve even higher levels of fuel economy. In view of these new requirements, we developed the NRV-II. In developing this 1,800 pound (850-kilogram) class vehicle our aims were to improve accident avoidance capabilities, utilize alternative fuels and achieve weight reductions, while maintaining the economy and utility of a subcompact car.

To attain the goals set for this vehicle, we made extensive use of the remarkable advances that were being achieved in electronics and composite materials at the time.

A "drive information system" and other techniques were developed to reduce the driver's workload. Research into drowsiness resulted in a drowsiness warning system. And a turbocharged methanol engine was developed to take advantage of substitute sources of energy.

Following the NRV-II, we have continued to push ahead with various programs aimed at achieving higher levels of vehicle safety. For example, our concept car, CUE-X, is a four-wheel drive vehicle, which incorporates more advanced electronic technologies, especially in the area of the human-machine interface.

Some of its technical highlights are a laser radar sysem, an electronically controlled four-wheel anti-skid system, a high-capacity, actively controlled suspension system, called HICAS, one result of four-wheel steering technology, and a satellite drive information system.

I have given you a brief outline of the aims, results and problems encountered at each stage of our ESV program. I would now like to sum up again the aims of the different projects.

First, the Nissan ESV project. This work was carried out in conjunction with the original DOT proposal. In this project we examined the technological possibilities for improving the safety of compact cars. The major objective here was to enhance occupant safety in collisions at 50 miles-per-hour.

Next, the NSV project. This project reflected the economic and social environment at the time of the first energy crisis. In this project, greater attention was given to the development of a subcompact car that would provide a practical balance of economy and utility, in addition to safety.

Then, in the 1980s, Nissan's NRV-II has been developed to meet the stronger needs for greater energy and resource savings following the second oil crisis. Electronic devices and new materials have been used extensively in this vehicle to improve safety technologies, focusing in particular on the human-machine interface. The CUE-X represents a further refinement of accident avoidance capabilities and the human-machine interface through expanded application of technological innovation.

In the process of carrying out these projects, many new advances and further refinements were achieved in safety technology. In addition, by incorporating those new developments into the experimental vehicles for evaluation, we were able to identify many of the issues involved in achieving good harmony between safety, utility and economy in cars. Solutions to those issues were then sought by shifting the focus of our work to subsystem development. A number of the new technologies that were developed in our ESV program have already been incorporated in our production vehicles, such as energy-absorbing vehicle structures, urethane bumpers, a four-wheel anti-skid braking system, and many others.

Safety issues have to be treated comprehensively in terms of three aspects: the vehicle, the driver and the environment. During this century, the automobile has become one of the most useful and convenient tools of modern society. On the negative side, however, we have the fatalities and injuries that occur in traffic accidents. It is our responsibility as 20th century citizens to minimize this negative aspect, so that we can pass on to the 21st century a more refined transportation system.

Another positive result of an integrated approach to traffic safety, including the ESV program, has been a significant reduction of traffic fatalities since 1970. In view of this achievement, I believe that the international ESV conference should be continued as a forum where representatives of government and industry from around the world can meet and exchange their experience and knowledge about automobiles and traffic systems.

Panel Two: *ESV/RSV Accomplishments*

What Was Accomplished in ESV/RSV?

Kenichi Goto,
Japan Automobile Research Institute, Inc.
Japan

I have been asked to discuss the achievements we have made in the ESV and RSV Projects. This is very difficult to answer the question. If we say that we made a great deal of accomplishments, we will be criticized unfavorably for not applying the accomplishments to new vehicles. If we say that we did not make many accomplishments, people will doubt our competence as automobile engineers and say that we wasted the taxpayers' money.

In these two projects, we aimed at ideal safety cars. We could have completed an ideal safety car in the form of a prototype vehicle, but extensive evaluations on production method and cost would have to have been made before they could be applied to a mass-production car. People will say that is why we are so slow, and we would have to answer that we are doing our best steadily.

After all, we may have to answer formally that we have made a considerable accomplishment. To my personal view, it might be too much to say that merits and demerits of the projects are just about offsetting. We have made significant accomplishments but it also is true that there were many points which should have been made in other ways.

To end the introductory remarks, I would like to first talk about the ESV and RSV Projects. According to the former DOT secretary, John A. Volpe, the experimental safety vehicle in mind is a vehicle which is filled, from front bumper to rear bumper, with maximum safety concepts such as superior driveability, better view, fire-proofness and a less-pollution engine in addition to offering passenger protection against collisions at 50 miles per hour and turnovers at 70 miles per hour. As for the ESV Project, the DOT showed specifications for each of the five items of (1) accident avoidance, (2) alleviation of injury at collisions, (3) safety after collision, (4) safety of pedestrians and (5) safety at stopping for the purpose of pursuing the ultimate limits of safety technologies. These targets were very high for that time, and I felt that it would not be easy to realize these objectives.

I examined the specifications carefully, and found that some specifications were unrealistic, insufficient, or obscure, and I thought that it could be better if they were a little more harmonious targets as a whole. Nevertheless, these targets were of great significance in the sense that they showed main directions for development.

As for ESVs in Japan, specifications proposed by DOT were partly modified considering that Japanese ESVs are small-sized vehicles. But tests on Toyota's and Nissan's ESVs revealed that both ESVs satisfied the specifications in all test items.

The RSV Project, on the other hand, aims at developing safety vehicles which meet consumers' trends, including environmental measures and effective utilization of resources and energy in addition to the performances targeted in the ESV Project with a view that they could be put into mass production in the middle of the 1980s.

It is true that these targets advanced those of the ESV Project one step forward because the targets of the ESV Project aimed only at safety causing disadvantages in the area of practicality. It is regrettable, however, that among the five companies that participated in Phase I, most of them kept paying efforts for measures against collisions and only two of them employed measures for avoiding accidents.

Two companies participated in Phase IV. When actually testing such cars, I found that they were yet to meet the targets in many points, and I felt that their level of completion was rather low. Some cars were good in individual performances, but lacked the balance in overall performance as cars for mass-production.

I am not quite sure about ESVs of other countries because I have not seen them personally, but I must say that the RSV cars' level of completion as commercial vehicles was low compared, at least, with Japanese ESVs. It would be fully worthwhile examining why they became this way while they were developed also with marketability in mind. One of the reasons I can think of is that they were also developed with much emphasis on measures against collisions, although they had a wide range of targets mentioned earlier.

Now, what were the accomplishments of the ESV-RSV Projects?

The foremost accomplishment of these projects can be that they changed the concept of car body design. When I looked at ESV specifications for the first time, I thought cars might look like tanks. I did not know the philosophy of car body design prevailing at that time in the United States and Europe. In Japan, the main emphasis in car body design was on durability. Road improvements were slow in Japan even at that time, and demands were high for vehicles which were equipped to run on bad roads. As roads improved gradually, more and more users demanded higher performance, and it was just about the time when the design of cars for lighter weight began. Lighter cars were examined, however, only for improving their durability.

The ESV Project was made public just about this time, and various discussions were made on how we could manage the rigidity of car body to satisfy the specifications. The answer was the development of a car body which had a structure for absorbing impact energies. It is a great accomplishment of ESV that the concept of collision safety has been implemented in the car body design.

Another field of accomplishment is the development of simulation technology. I said earlier that there was too much emphasis on measures against collisions, but it was not too bad for simulation technology because the development of simulation technology owes much to studies on collisions. Studies by simulation were carried out not only on car body rigidity but also on behaviors of passengers.

The survival space of small-sized cars, like Japanese cars, is small from the outset, and the permissible ranges for arrangements of the dash board, steering wheel and seats and others are limited, and their examination by simulation was very useful. The simulation technology is utilized widely also for design of current production vehicles.

As for the air bag, there were many difficulties in its development, but it was impressive to see that air bags for RSV were much better in reliability than those for ESV. As a result, air bags are being applied to production cars in other countries. In Japan, air bags were not usable because of the Explosives Control Act. The law has been revised since then and it is now possible to use air bags for cars from last year. I think that there will be production cars with air bags soon in Japan.

Seat-belts have been developed to meet the comfortability requirement of RSV, and seat-belts with ELR were developed. The use of seat-belts with ELR from 1985 was stipulated by law also in Japan, and this is the only law which implemented the accomplishments of ESV.

The development of anti-skid brakes was going on before the ESV project started, but it can be thought that the anti-skid brake is one of those of which development was accelerated by the ESV-RSV Projects. The number of cases where anti-skid brakes are used in production cars is increasing.

I have described those which appear like accomplishments, but Japanese automobile manufacturers are developing experimental safety cars by themselves even after the RSV Project. Toyota ESV III and Nissan NRV II, for example, were exhibited at the ESV International Conference held in Kyoto.

There is a trend of continued effort for safety measures, such as Project 2000 of the West German government, for developing prototype safety vehicles, and such a trend can be said to be one of the accomplishments of the ESV Conference.

Before ending my talk, I would like to add a few words. That is, it is 17 years now since the ESV project began; seven years have passed since the evaluation of RSV ended.

This may not be the time to discuss the old past problem of what the ESV-RSV was. I think that the discussions to be made in Part 3 following our session are far more important. When we have this conference next time, we should have ample time for discussion on what we should do in the future for safety problems of motor vehicles.

The discussions we had this time could be meaningful still as a review on ESV-RSV to conclude the age of ESV-RSV.

Panel Three: *Future Directions in Advancing the State of the Art in Motor Vehicle Safety*

Statement by

Bertil Aldman,
Chalmers University of Technology,
Sweden

It is indeed a privilege for an old academic to be invited to participate in this panel which turns to the future. The two other panels in this morning session have evaluated the past and summarized the present situation. Before I begin to discuss what I think could be an operative program for the future, I would like to make some short remarks about the value of what has been achieved so far.

There is no doubt in my mind that the ESV/RSV program, as it has developed over these years, has been very successful in at least two respects:

- first, it has brought together people from government, industry and research and made them work together towards a common goal: to save lives. This in itself is an achievement of great importance.
- second, it has influenced the design and construction of production cars, which are now clearly safer to the motoring public than fifteen years ago or before this program started.

When we now turn to the future we have therefore a sound basis from which to start and a great challenge to go further from these higher levels of knowledge and performance.

One problem which immediately comes to mind is whether the total vehicle development concept is viable in today's research activities. I believe it is, and would like to explain why I have come to this conclusion.

What has been learnt in several studies during these years is that the kinematics of the entire car and its occupant as well as several separate car structures influence the injury producing process. A restraint system is therefore not only an airbag, a three-point belt, or a head rest. The function of these components is greatly influenced by the construction of the seat, the floor, the steering assembly, and other car structures as well.

In our efforts to reduce the severity of accidental injuries the total vehicle development concept will have to be retained because of the complexity of the situations in which the injuries occur.

In this context I would also like to comment shortly on the place of the full-scale vehicle development in a safety program of this kind. For mainly the same reasons as I mentioned earlier I believe that there is a need for this. The fact that most automobile manufacturers present their own concept cars at intervals seems to point in the same direction. But perhaps it will not be necessary or even desirable to duplicate in the ESV research efforts what is already being done by the car manufacturers. However, some kind of coordinated effort may be needed to enhance the safety of all road users.

It is of course necessary to continue the transfer of technical knowledge into safer means of road transport, which if not started was anyhow catalyzed by the ESV/RSV program.

However, there is one link in this transfer, in which almost all of us here have some experience, but which has not really been scientificly studied or developed in this particular context. I am thinking of the process of transforming wishes, desires or formally expressed plans into standard requirements and rulemaking.

Normally, a group of people will undertake to look at one particular component or one particular crash mode and try to come up with the best possible standard and test procedure for this purpose. Such groups of well qualified people meet in different parts of the world in different organizations and make a marvelous job of producing perfect test methods, standards, and rules for their particular area of interest.

This is the way in which we have managed to create the conditions necessary for producing better and safer motor vehicles. But at the same time, this process is such that it does not automatically lead to an optimal solution in a total vehicle concept. I think nobody will deny that the imperfections of this system have also created problems. When we consider cars being produced for a world market, it seems unnecessarily difficult and costly that these vehicles should have to comply with a large number of different and sometimes conflicting rules and standard requirements.

It has become popular recently to raise one's voice and cry for international harmonization of standards. But, while harmony is a word with a nice ring to it, harmonization to almost everyone means a kind of bargaining which results in giving up something he feels important to his product, his country, or whatever. The reason for this is partly that a lot of work has been done to produce these standards in the first place and partly because most people think of this as such a complex problem that one can only deal with one standard or rule at the time. I am not going to join the group that cries for harmonization of the present standards on an international level now, but would like to propose a different approach to this problem.

Imagine as a first step a research program aiming at the creation of an optimal combination of rules and requirements in which all the different accident situations would simultaneously be taken into consideration.

In a second step the results from this endeavor could be compared with the present set of standard, rules and test procedures. The aim would be to assess the total, combined effects of the differences between this and the existing individual requirements, which constitutes the problems we have to cope with today.

A third step could then be to discuss the feasibility of globally substituting the new set of standard requirements for the present set of national rules.

In a program of this kind it would probably be necessary first to define a set of models, which eventually could be combined to simulate the entire system: the motor vehicle and its occupants, different driving conditions and traffic environments as well as other road users. The models would have to be designed to accept data about all kinds of accident modes, even some odd ones; their respective frequencies, and severities would be used with an appropriate weighting factor to simulate conditions in different parts of the world.

Much of this exists of course already but would probably have to be capable of being combined and used for this particular purpose in a systems approach to this problem. Theoretical studies in this field would probably also have to be complemented by practical tests using mechanical and biological models and eventually full scale dummies and cars.

An approach of this kind could be seen as a logical continuation of the present ESV/RSV program as it would address some of the problems which have surfaced in the process and would demonstrate what degree of safety, under all conditions and to all road users, it would be possible to build into production vehicles on the basis of the current state of knowledge.

Statement by

Georges Dobias,
Institut National de Recherche sur les Transports et leur Sécurité (INRETS), France

It is a difficult task to look to the long term future. First, I would like to make some short remarks on the work already done since 17 years.

A lot of excellent work has been done and the technical results made by car manufacturers are pretty good; with the improvement of the drivers' behaviour, it explains the evolution of safety data.

Some researches, in course, have to be completed, that is protection for side impact, protection for pedestrians, protection for small children. The most evident protections are behind us, except for heavy duty vehicles. The number of these vehicles is growing rapidly, together with their speed, their weights and dimensions. It is a worrying problem and new solutions have to be found to reduce the unsafe effects.

I must remind you that road safety works like a complex system; the car is only a part of this system between the driver, the other vehicles and the infrastructures. It is not sufficient to cope with the cars to improve the whole system.

I see three main changes for the future:

- First, the most evident problems have already scientific solutions, even if these solutions are not yet adopted in normal production.
- Secondly, the large introduction of electronics and we may expect, from it, an improvement of the safety. The PROMETHEUS Project, of the European car manufacturers, can improve the driver's behaviour—by aids—, the safety maintenance of the car, the driving on infrastructures—in bad weather, for example, and the mixing of the car in the general traffic—for example, to appreciate the safety distance.
  The normal effect may be a reduction of the number of collisions and, also, the speed of occurrence of the crashes. This change in primary safety should also affect the types of crashes and change also the types and priorities of secondary safety.
- Thirdly, the construction of cars will take more composite materials, which may decrease the aggressivity of the cars; the project CARMAT 2000, initiated by Peugeot SA, will precise the effects of the new components on safety.

As a consequence of the changes, it seems to be necessary to develop cost-benefits analysis to determine the new kinds of types of accidents and set up new priorities.

New tools will be developed, by mathematical simulation, first in biomechanics as said by Mr. Aldman, secondly in car stability as already said by Mr. Goto and Mr. Frig, but also in ergonomics to insure that the electronic aids given to the drivers will be used by them in the sense of safety.

But, I must also express my worries about the increase of the speeds measured on the roads and the speed limits of the new cars produced. If this progression is going too fast, the gains in safety may be less than expected.

All this work needs a closer international cooperation and the ESV meetings will have a more important role to play in the future.

Toyota ESV and Safety Development

Yutaka Kondoh,
Toyota Motor Corporation,
Japan

We developed Toyota ESV-1 under contract with the Japanese Government. I would like to review our R&D results regarding the car from the viewpoint of today, 13 years after its development.

Toyota ESV-1 was designed as a 2,000 lb.-class compact 2-seater touring sedan. It was not a modified version of a production vehicle, but was of a totally new design. In designing this model, the latest technology at that time was adopted, apart from a conventional design concept. Both front and rear windows were designed for full front and rear views. Large, isolator-type energy-absorption bumpers were installed on the front and back. The wide tread and low gravity center balance this car securely. Large rear combination lamps contribute to better visual perception.

Toyota ESV-1, designated as an experimental vehicle in quest of an even broader technological feasibility, was developed to meet the Japanese specifications.

Overall Length: 4300mm
Overall Width: 1800mm
Loaded Height: 1360mm
Wheelbase: 2300mm
Tread (Fr.,Rr.): 1500mm
Curb Weight: 1290kg
Capacity: 2 Persons
Engine: 1588cc, 102HP

Figure 1. Dimensions of TOYOTA ESV-I

The ESV-1 was developed in about 3 years, starting from 1971.

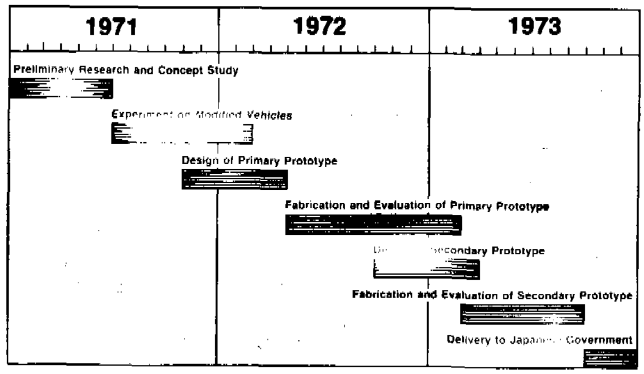


Figure 2. Time schedule for Toyota ESV-I

The new technologies adopted in ESV-1 can be seen in Figures 3-5.

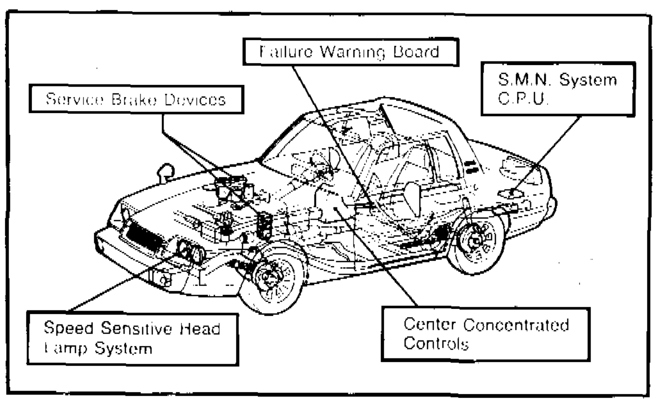


Figure 3. TOYOTA ESV-I main safety devices (accident prevention)

Accident-prevention innovations include service brake devices, a speed-sensitive headlamp system, a failure warning board, a single-wire multiplex network system, and center-concentrated controls.

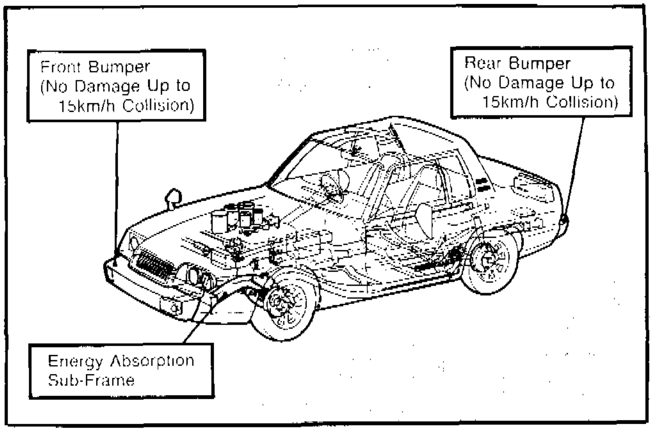


Figure 4. TOYOTA ESV-I main safety devices (crashworthiness)

Among the new technologies related to impact alleviations are the energy-absorption subframe and large, isolator-type energy absorption bumpers. These front and rear bumpers were designed to completely prevent damage in a 15 km/h fixed-barrier collision.

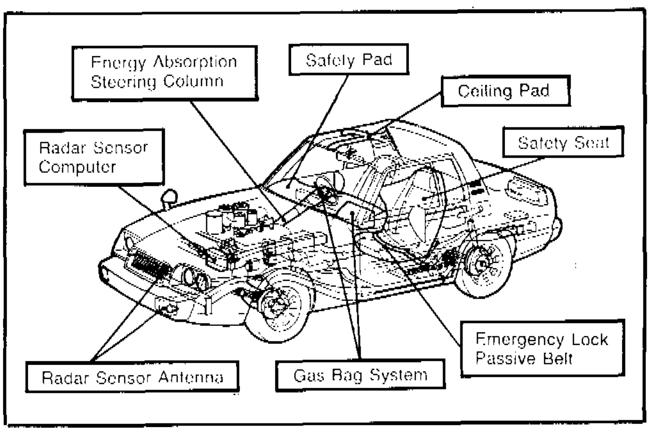


Figure 5. TOYOTA ESV-I main safety devices (occupant protection)

Major new technologies related to occupant protection are a radad sensore gas bag system, passive lap belts, and a new safety seat.

To implement the ESV-1 development project, a team of 40 engineers was organized to stay with the project from beginning to end. During the course of the project, more than 200 engineers were used. Related parts manufacturers also extended generous cooperation.

- Formation of the Project Team
- More Than 200 Persons at Peak Activity Including 40 Fully-Engaged Engineers
- Cooperation with Several Parts Manufacturers

Figure 6. Organization of TOYOTA ESV-I development

Development costs were very high, reaching 2 billion yen, or 7.5 million dollars, calculated at the currency rate at that time. One hundred experimental models were manufactured, of which 10 were delivered to the Japanese Government; some of these 10 were also evaluated by the U.S. Government.

Although the ESV-1 attained almost all of the performance targets created for it, the vehicle was excessively heavy. This meant that its aggressiveness would increase, it could not be produced efficiently, it would be very expensive to buy, even if mass produced. The ambiguity of its performance evaluation for new technology also posed a serious problem.

In restrospect, I must admit that very little safety technology from the ESV-1 was introduced into our production vehicles, in spite of the tremendous amount of resources, such as manpower, money and facilities spent in this project. This result is considered to have been due to the strenuous pursuit of technological feasibility without paying sufficient attention to public acceptance. Without fully considering cost/benefit, harmony with society and primary purpose of automobiles, we placed too much emphasis on the development of a vehicle whose purpose was occupant safety in high-velocity collisions.

- Tremendous Amount of Resources Such as Manpower, Money and Facilities Were Spent in This Project
- Very Little Technology Was Introduced into Production Vehicles due to Lack of Public Acceptance

Figure 7. Conclusion of TOYOTA ESV-I development

Toyota believes that accident prevention and occupant protection technology should be developed in view of the vehicle's role in these three factors: Human, Environmental, and Vehicle. Under this safety policy, Toyota has been committed to improving automotive safety.

Accident Prevention and Occupant Protection Technology Were Developed Steadily in View of the Vehicle's Role in These 3 Factors:

Human

Environmental

Vehicle

Figure 8. TOYOTA's efforts on vehicle safety

Let me here introduce Toyota's efforts in making production vehicles ever safer.

First, improvement of vehicle performance for accident prevention. This includes efforts toward better basic performance, higher reliability, fewer exterior projections, higher controllability and driver fatigue reduction.

Improved Vehicle Performance for Accident Prevention(1)

- Basic Performance (Braking, Handling, Acceleration)
- Reliability
- Removal of Exterior Projections
- Driver Controllability
- Reduction of Driver's Fatigue

Figure 9. Results of TOYOTA's efforts on vehicle safety

Also in this category are prevention of misactuation, vehicle performance compatible with environment, easier access to information and better presentation of information.

Improved Vehicle Performance for Accident Prevention(2)

- Prevention of Misactuation
- Vehicle Performance Compatible with Environment
- Easy Access to Information
- Presentation of Information

Figure 10. Results of TOYOTA's efforts on vehicle safety

Approaches to better vehicle performance for occupant protection include integrity of the passenger compartment in collisions, as well as collision impact alleviation, removal of interior projections, prevention of occupant ejection at collision, prevention of fuel spillage and other secondary damage, and easy rescue and evacuation.

Improved Vehicle Performance for Occupant Protection

- Integrity of Passenger Compartment
- Impact Alleviation
- Removal of Interior Projections
- Prevention of Occupant Ejection
- Prevention of Secondary Damage
- Easy Rescue and Evacuation

Figure 11. Results of TOYOTA's efforts on vehicle safety

Toyota has been doing its utmost toward achieving well-balanced improvements of these aspects step-by-step with careful consideration to developing every new production model. Of course we have fabricated special experimental vehicles as needed for use in assessing new technologies.

These efforts have already been realized in the Toyota vehicles now readily available. For example, you can easily see the 4-wheel Anti-Lock Brake System in the Toyota Supra, the Electronically Controlled Transmission in the Cressida, Camry and so on, the Electronic Instrument Panel in the Supra, Cressida and Camry and the world's first electrically motorized automatic belt system in the Cressida and Camry for the U.S. market.

Toyota has been and will continue to make steady vehicle safety improvement efforts as our responsibility to society. We should continue to make such R&D effort without compromising the primary purpose of the vehicles, apart from an ESV project. We should obtain more information about human tolerance and accidents. This is because of the still insufficient knowledge as to the human tolerance needed to fully evaluate where the largest improvement in vehicle safety can be achieved. Regarding accident data for statistical analysis, it is our desire that automakers should be given more opportunities to participate in discussions. These points were included in the NHTSA conclusions at the 5th ESV Conference. We must review what is going on regarding these points.

We should

- Make Such R&D Efforts Without Compromising the Primary Purpose of the Vehicle.
- Obtain More Information about Human Tolerance and Accident Data.
- Promote Safe Driving and Safety Seat Belt Usage - The Most Effective Measures to Save Lives.

Figure 12. Summary

Furthermore, we should promote safe driving and safety seat belt usage to make the best of the potential which the current production vehicles have to ensure occupant safety - those are the most effective measures to save lives.