Section 5
Trends and Priorities in Vehicle Development in Relation to Road Safety

M.R. Dunn, Chairman, United Kingdom

Trends and Priorities in Vehicle Development in Relation to Road Safety

A. Chenevez
France

As in the first nine ESV conferences, the discussions of this Tenth Conference have largely shown that the manufacturers' research activity is not slowing down toward road safety improvements.

Such research is conducted in close cooperation with the public authorities and independent organizations. Numerous regulations have been developed from the results of that activity; they have had deep consequences on vehicle construction and have played an important role in the continuing reduction of the number of road accident victims in all countries, related to the number of kilometers driven and even in absolute figures.

Further safety progress requires new imaginative efforts. In this field, as in many others, the benefit/cost ratio is decreasing. In the 1970's, we took benefit of the most obvious and profitable measures, such as seatbelt improvements, energy absorption in front and rear ends of cars, etc. But to still improve safety through car design, we need to create much more sophisticated and expensive devices, the efficiency of which will necessarily be lower than for those invented before.

Without slowing down their efforts toward the specific safety of the vehicles, many manufacturers are wondering if the international scientific community should now concentrate on usage problems rather than just on vehicle construction.

To take just one example, I would like to mention how much the manufacturers have taken part in the seatbelt use campaigns throughout the world. Why should we provide customers with better and better restraining devices if they remain unused or can be disconnected in the case of passive restraints?

You know that in many countries more than 40 percent of the fatal accidents are caused by alcoholic drivers, so you will certainly understand why the manufacturers are in favor of more severe and more frequent controls of drunk drivers.

Similar examples could be cited in which the role of the police appears to be as important as that of the engineers. If public authorities accept that way of thinking, this will not mean the manufacturers' task would be reduced but their cooperation with public authorities will be rendered more efficient.

Prof. H.J. Kraft
Federal Republic of Germany

The round number 10 suggests the idea of a retrospect. Therefore, when treating at this Tenth ESV conference the topic of the panel discussion, "Trends and Priorities in Vehicle Development in Relation to Road Safety," the beginnings should be considered also.

The development of experimental safety vehicles originated from specifications that disproportionately emphasized occupant protection. Thus, overheavy tank-like vehicles were designed and built in which the passengers could be better protected indeed, but that

constituted a considerably higher danger for the safety of other road users. In this context, the impairment of other vehicle properties as, for instance, vehicle-handling or low-fuel consumption is mentioned only incidentally.

After construction and testing of a series of such vehicles, it was also realized by the involved governments that this was the wrong way. But before this knowledge had become generally accepted, diverse governmental delegates blamed the industry for having no interest in insuring the safety of its customers in the best possible way. However, just the opposite is the case for two reasons:

- Humanitarian reason: A sense of responsibility stimulates the automobile engineers to continuously do their very best to protect the customers against all avoidable dangers.
- Economical reason: For quite a long time, the industry has recognized that the life and health of its customers must be protected to insure also the existence of the enterprises. Vehicles can be replaced, but not lives.

Because of frank discussions between industry and government, the actual situation has improved considerably. Together we are on the right track. It is only by virtue of a well-balanced concept and special consideration of the compatibility of different vehicles that overall safety can be further improved. In this context, also, the importance of harmonization of regulations must be mentioned. Above all, legal regulations that are expected in the future (e.g., side impact) from the very beginning should specify only internationally valid requirements, and legal activities on a national basis should be avoided.

The most important tendencies toward an improvement of traffic safety can unquestionably be observed in the use of modern electronics for control systems with respect to steering, brakes, and drive. The resulting gain in safety lies in case for the driver and an even better control of the vehicle in critical situations. We are confident we will make further gains toward our common goal, namely, the increase in safety on our roads.

Dr. E. Landsberg
Italy

The automotive industry will continue to cooperate in the promotion of improvements for road safety. In fact, cars have been greatly improved in this respect during the past 30 years. The industry has been particularly concerned to promote active or accident-avoidance features on cars. They include the many improvements to brakes, steering systems and suspensions, and lighting, quite apart from better instruments and warning signals. These advances have been achieved by the automotive industry largely without the introduction of regulations requiring them. Protective devices and features have also been introduced, and the overall safety of cars has been improved almost beyond recognition.

The latest accident-avoidance features to be proposed are the supplementary rear stoplights, which are being required in the United States, but it may be worth noting that no advantage was found for such a system when evaluated in trials in the Federal Republic of Germany.

Despite these problems, it is probably true that mechanical safety features on cars do need regulations to enforce their uniform introduction.

Sadao Takeda
Japan

I would like to present a brief summary of recent Japanese research and development in safety-related technology and also to introduce the recent development of internationalization of the Japanese road safety standards and certification system.

In general, there are four factors that influence the level of technical innovation in automobiles. First, the emergence of fundamental technologies, such as new materials and electronics, that will lead to the development of many associated technologies; second, consumer demand and the marketplace; third, social or public demands, as seen in the antipollution movement; and fourth, the desire of automakers to strengthen their competitive powers.

Regarding social or public requirements, safety-related technology has been regarded as an important aspect in this field since the 1960's. Today, safety is not only a social requirement but is necessary for the individual consumer, besides helping to differentiate one automobile product from another.

As a result, many attempts have been made to develop viable safety-related technology. Safety measures concerning vehicles are broadly divided into two categories. One is the provision of adequate protection once a

collision occurs, and another is the prevention of such collisions. Particularly in the field of accident prevention, we believe technological development has been and will be made in many areas as a result of the increasing progress being made in electronics.

The necessity of providing adequate protection for people involved in automobile accidents, including pedestrians, is a well-established fact. In Japan, studies are being carried out on seatbelts, on child-restraining chairs, and on how drivers and passengers can be afforded adequate protection from double-end collisions and side collisions. However, since this conference has focused on these issues at various sessions, I would like to concentrate on the recent technological developments in the field of accident prevention, reflecting the overall improvements made in the electronics field.

Amazing progress has been made in the electronics field in recent years. These achievements point to the possibilities of adding intelligence to machines and of applying more sophisticated control methods to driving. As a result, car electronics technology is spreading from engine control to power train, body control, and other aspects of the overall car structure. Today, many car models incorporate more than 10 chips. Safety-related technology has continually moved forward by using electronics as a major starting point.

The antiskid brake, a widely used safety feature, has been upgraded with the aid of electronics. Also, as already introduced in this ESV conference, an electronic warning system capable of sensing the driver's drowsiness and other fatigue conditions is now in practical use. Electronics technology is also applied for the brake power-maintaining system to make starting on an inclined road smoother as well as to eliminate the creep phenomena encountered in automatic transmission vehicles.

Attempts are underway to use electronics in improving running performance, such as the four-wheel steering system to achieve greater turning stability and improved response speed. Further, research on the use of supersonic waves, laser beams, and millimeter waves for detecting any obstructions located near the automobile has made important strides for future realization.

Further progress will be made in electronics, insuring a more sophisticated control system for automobiles. We anticipate development of a wide variety of systems for traffic safety, especially in the area of accident prevention.

I would like to explain three important points concerning the trouble-free development and diffusion of new technology. First is the importance of an interface between humans and machines. For example, a car provided with an antilock system is still not entirely safe if the driver is overconfident in the system's ability to prevent an accident. Drivers are all too human, and their continuing education and growing awareness in this field are important for increasing safety.

Second is the importance of developing more economical technology. This is indispensable for popularization. For example, more and more people in Japan are beginning to recognize the positive effects of antilock brakes, but their use has been limited to only 2 percent of new cars because each antilock brake system costs more than $500.

Third is the importance of exchanging information about safety technology. Although joint research and development among automakers is difficult to carry out, due to the incorporated safety measures contributing significantly to the competitiveness of each automobile product, as mentioned earlier, it is important nevertheless that information be exchanged to further the development of safety technology. Therefore, I hope the ESV conference will serve as a forum for the exchange of information concerning safety-related technology.

I would like to mention also the recent progress made in Japan concerning certification formalities as part of the overall move toward internationalization. Automobiles are so-called international merchandise, and it is of considerable importance that, as far as is possible, existing nontariff barriers be transformed into more harmonized formalities. Considerable efforts have been undertaken by Japan in this area.

As far as certification formalities are concerned, wide-ranging simplification of the Automobile Type Designation System was introduced in August 1983 with a view to increased internationalization so the system could be more accessible as far as the import of foreign automobiles is concerned. Based on the new system, the type designation was approved in 1984 for seven models and eight types of imported automobiles.

Much effort has been made to coordinate fundamental safety requirements in Europe and the United States. In October 1983, 12 items in the safety standards were amended to conform with those in Europe and the United States. Regarding 14 items of safety-related requirements, the safety standards in Europe and the United States have been treated as being at the same technological level as those in Japan. As in the past, we still feel we would like to participate wholeheartedly in ECE WP29 as one of our activities for setting up the International Uniform Safety Standard for Automobiles, which will contribute to the harmonization of standards between countries.

I had mentioned the recent developments in safety-related technology, especially the progress in electronics technology and internationalization of the safety standards and certification formalities in Japan.

I.D. Neilson
United Kingdom

Starting on a general point as a contribution to this discussion, it may be worth drawing a distinction between safety developments that are highly desirable on grounds of safety effectiveness and those that are possible. The need is to make progress, and this must clearly be done where it is readily possible. On a longer time scale, things that are highly desirable may have to wait until they can be engineered satisfactorily, but this should not delay the possible items being done first.

To balance these introductions, I have been asked to refer to trends and priorities for the improved safety of trucks, buses, and motorcycles.

For trucks, it is known that about 9 out of every 10 fatal injuries in accidents involving trucks are to road users outside the trucks—car occupants, pedestrians, and riders of two-wheelers. Only 1 in 10 are drivers and occupants of the trucks. There is a clear trend toward antilock braking systems to maintain braking stability, and these systems become even more highly desirable as the number of axles increases. There is scope for improved protection for other road users. Side guards can be designed to stop pedestrians and cyclists from being dragged under the rear wheels of trailers. There is a clear need for front underrun bumpers for trucks as a means of protecting car occupants from being killed in the many accidents where this can be avoided.

Improvements in the structural design of coaches may be anticipated, and it is to be hoped that regulations for improving structural resistance to collapse in overturning accidents will be universally adopted. Seatbelts can be fitted in coaches but, apart from some consumer resistance to using them, there are technical difficulties in designing satisfactory installations and so they may be fitted only to seats "at risk."

The largest scope for improvements in safety is in the field of motorcycle design. In particular, antilock braking should become essential equipment in the near future and in years to come even on small machines. Leg protection for riders of motorcycles is at an interesting stage of development. Progress appears to be at the point of a breakthrough in providing this much-needed item. Doubts should be resolved quickly. It seems protective wear can now be designed that gives some useful protection for the enthusiast who may choose to wear such clothing.

Ralph J. Hitchcock
United States

Several months ago, I attended a conference in the United States of various experts involved in different aspects of highway safety. Included were experts in vehicle design, human factors, driver licensing, enforcement, emergency medical services, highway design, and highway operations and maintenance. The reason I mention this conference is that a couple of suggestions were made by the emergency medical services experts on vehicle improvements that rather surprised me. The emergency medical services people are on the scene of the accident after it occurs. They said the big problem they see every day is head lacerations and head injuries caused by inside rear view mirrors and by sun visors and their mounting systems. I think it is clear to everyone at this conference that those items –the rear view mirror and sun visor –can clearly be designed so they don't cause head injury and lacerations. The fact that they do cause these kinds of injuries should tell us we need to do more in the component design areas of the car.

There were many things discussed at this conference that involved major changes and additional cost items on the car to improve safety. Such things as airbags, truck underride guards, truck side guards, antilock braking systems for motorcycles, center high-mounted stop lamps, daytime running lights, and Securi-flex windshields have been discussed and will continue to be discussed at other conferences such as this for many years. Various countries and car manufacturers will employ them as major changes in coming models to improve the safety of the vehicles. Other major potential safety improvements discussed at this conference included side impact and pedestrian impact protection. Again, these are major vehicle safety areas that will be discussed for many years. Performance criteria will be developed, and safety benefits will be weighed against costs. There is little I can add to the debate on these major safety projects. Rather, what I would like to stress are the smaller improvements that can be made, many at no additional cost, when incorporated into the basic vehicle design.

The General Motors presentation on built-in safety systems that were linked to detailed accident data and several of the papers by the British and others on smaller safety improvements in the car are notable. For example, the hood or bonnet of the car should be designed with an overlap at the fenders to provide 50 to 100mm of crush space for mitigation of pedestrian impact in injuries. As I

walked back from lunch today, I noticed that many of the European cars parked outside had hoods that overlapped while others did not. Clearly, some of them—the ones that overlapped—are probably going to be much better for pedestrian impact than the ones that do not. While it may be many years before we have a complete pedestrian impact protection requirement, new vehicle designs should have this hood overlap as a part of their basic design.

Similarly, in the United States, recessed windshield wipers were quite popular as a styling feature for several years. Again, these offer major benefits when impacted by a pedestrian. Our current stylists should try again to incorporate recessed windshield wipers into new designs.

In the interior of the car, some of the presentations at this conference have shown that steering wheel vertical displacement in a crash can be dangerous. While our national and international regulations limit the rearward displacement of the steering wheel, manufacturers certainly have the capability to limit vertical displacement as well. Similarly, padded steering wheels and steering wheel hubs are well within current technology and can prevent many serious head and facial injuries to drivers, particularly those who are wearing their safety belts. Last, soft plastic urethane bumpers have been put on many cars as a style feature. If they were designed with a foam support structure, with pedestrian protection in mind, they would do a lot to prevent pedestrian knee and leg injuries.

To summarize, I would like to encourage everyone at this conference, particularly the vehicle manufacturers, to take back to their companies or to their jobs the message that accidents result in many injuries by parts of the car that could be redesigned with little or no additional cost. I would encourage manufacturers and others at this conference to talk to the emergency medical services personnel and accident investigators in their countries to find out which little things might be done to make cars safer for people involved in accidents. If each of us does one or two small things to make cars safer, we can rest assured that many people involved in accidents will suffer fewer injuries and perhaps be alive after an accident because of our work.

Section 6
Conference Summary

C. Ashley, Motor Industry Research Association, United Kingdom

Conference Summary

Dr. C. Ashley
Motor Industry Research Association, United Kingdom

In reviewing this conference, it soon became apparent that the wealth of information cannot be summarised in any detail in 30 minutes. My comments will attempt to pick out the highlights and assess the principal trends. First, we know the conference as a whole is a considerable success. With 475 delegates and 127 papers, it has exceeded all expectations. It must now be regarded as the centre of excellence for communicating knowledge on experimental safety research in relation to vehicles.

Let us look at the value of the conference in simple monetary terms. If each paper represents $100,000 of work, then the total value of the conference is $12.7 million as a minimum. I would estimate that safety research worldwide by government and industry exceeds $100 million. That figure could be compared with the broad-band vehicle development costs of an annual $6 billion per annum, based on 40 million vehicles, $5,000 per vehicle, and 3 percent R&D costs.

Even the $6 billion on R&D is dwarfed by the $120+ billion cost of car fuel and the $12 billion cost per year if pollution measures increase fuel consumption by 10 percent. Perhaps road safety could be given a little more financial priority than less than 1 percent of the final annual cost of emission control.

Now let us return to the conference and the status reports. These are not a formality but represent a most important statement on "where we are" for each individual government agency. The United States shows a situation with a significant fall in fatalities of 11 percent 3 years ago, and this situation has been broadly maintained. There are signs of car occupant fatalities increasing, and it is to be hoped the courage of the first 13 States in bringing in mandatory seatbelt laws will be rewarded by the appropriate reduction in fatalities and injury and hence encourage the others. It would appear essential that research is carried out to show how Britain's and Germany's success in getting better than 90 percent seatbelt usage can be carried over to the United States where usage can be as low as 30 percent in mandated States. The United States gives major support of over $30 million to research and data collection. Their whole comprehensive programme in airbag development and demonstrations, crash avoidance, lighting, handling heavy vehicles, alcohol, and crashworthiness is commendable. Need I add the importance of harmonisation in this work?

The initiative of the European Experimental Vehicle Committee is well demonstrated by the work presented at the conference on the side impact dummy Eurosid, the mobile barrier, and studies on cycles and pedestrians. This work is, of course, supported by a number of countries including Germany, Italy, the United Kingdom, Holland, and Sweden.

Japan has a remarkable safety record, showing significantly lower accident rates, however measured, than other major countries. They have a slight negative trend, due to an increasing vehicle population, and it is reflected by increased motorcycle casualties. They hope to control this by increased application of existing legislation.

The accident situation in Italy, France, The Netherlands, and Germany still leaves room for improvement compared with the United States and Japan. Not that matters are static: in France, fatalities are down to the level of 20 years ago, in spite of the traffic increase. Their programme of assessment of accident Reagir, in which 10,000 injury accidents per year will be analysed, should play a major part in directing their efforts. The incentive scheme linking general subsidies of local authorities to accident reduction is novel, and we look forward to hearing of their experience in 2 years time. Like many countries, France is directing particular attention to motorcycles, heavy goods vehicles, and coaches. They are also, somewhat belatedly, introducing a road-worthiness fitness test for second-hand cars. Another logical step is the introduction of lower speed limits for wet conditions, and, again, we look forward to hearing of their experience.

An interesting proposal from Italy is for an international accident data bank. Perhaps this can be pursued in Europe as part of 1986 Road Safety Year. Italy also raised the contentious question of replacement part quality in safety-related matters and how this could be controlled– a very big question, which we expect will be looked at in many countries.

Germany outlined many interesting trends in driver education and training. We note that seatbelt usage in the rear has been made mandatory, but with no fines for the time being. This initiative will give useful evidence for other countries. Another interesting initiative will be the new Canadian legislation on running lights; this will be a valuable experience for comparison with Sweden.

Now let us turn to the conference proper, with the plenary technical session on progress with safety developments for road vehicles chaired by Mike Finkelstein. I mention the chairman because he has the important responsibility of inviting the papers and structuring his session. This particular session opened with two presentations by TRRL on modified safety vehicles. Hobbs discussed a series of modifications to an Austin Metro, making it more pedestrian-friendly through a more compliant front and bonnet or hood. Theirs was an interesting solution to the problem of reconciling standard bumper heights with reduced leg injuries. Watson's paper described the latest advances in motorcycle safety with antilock braking, leg guards, nonspill fuel tank, and an airbag. This is important because many observers are feeling that antilock braking should be available on motorcycles, perhaps starting on the big bikes of over 500cc.

The airbag panel of Breed, Maugh, Reidelbach, and Romeo discussed optimisation of airbag design for performance and cost. The experience of Ford and Daimler-Benz unit production systems will be invaluable, and the low-cost approach of Breed is exciting. I feel the use of mandatory 3-point belts, with an optional auxiliary airbag system for additional protection, is the logical route to take.

Finally, the panel of Detloff, Johanssen, Haenchen, and Sano described the wide range of automatic seatbelt designs available. The panel was convinced of the necessity to evaluate carefully automatic belt performance over a wide range of conditions. The usage rate of 98 percent in the Toyota Cressida was commendable but explicable in that people bought the car to use that feature. Perhaps increasing application of seatbelt usage laws will reduce the emphasis on automatic operation but place increased pressure on comfort, fit, and convenience.

The technical session on biomechanics and dummy development was chaired by M. Leroy. Ten papers were presented, of commendable quality. The work from the University of Pennsylvania on brain injury will be a great help in this field, as will the three papers on thorax tolerance and injury mechanism by Eppinger, Lan, and Vernir. Hoffner dealt with pelvic tolerance in side impact, and this was both a synthesis of available data and a proposed criterion based on energy. The paper by Langdon on modelling lateral impact of the thorax leads naturally to the important session on dummy development and, in particular, to the Eurosid side impact dummy, which is the result of collaboration between TRRL, ONSER, TNO, and PSA. One might expect a dummy that combines the best attributes of four groups to need careful development to produce an effective device. With the major emphasis on side impact, Eurosid is clearly designed for a need, and we will look forward with close interest to major participation in the next phase.

John Melvin described a major analytical study leading to new concepts in anthropomorphic test devices with a bold approach to a realistic dummy capable of coping with a range of impact directions. Finally, Aldman described the Chalmers/ONSER approach to an omnidirectional one-legged rationised dummy, intended to give human-like and repeatable impact response in pedestrian tests. We look forward to further reports on all three projects at the next ESV meeting.

Session three was chaired by R.M. Nicholson from the United States and was concerned with crash avoidance. It was notable for papers on three electronic devices originating from Japan: laser radar for obstacle distance measurements, a drowsiness warning device, and a tyre pressure warning system. Microwave radar devices have been demonstrated for some time but have been unable to meet size and cost targets. The lower cost 100m-range laser diode is encouraging, and I expect it to be available as an optional warning device within this decade. Quantifying fatigue or drowsiness is an almost insoluble biomedical problem, but indirect detection through steering behaviour does appear to have possibilities.

Handling was covered by aerodynamic stability computer modelling, a run fairly flat tyre bead design, practical and theoretical optimisation of four-wheel-drive vehicle handling, and further development of the Honda four-wheel steering system. The handling papers deserve close study by vehicle designers. There is still room to increase safety margins in this area, particularly under slippery conditions.

Other papers dealt with visibility, considering beam pattern and windshield condition. There were two major survey papers on statistical analysis of vehicle size involved in accidents, and on car controls for physically handicapped people.

As an incidental on accident avoidance, I asked K. Digges to reconcile the difference between the United States and German experience on high-mounted brake lights where the United States found improvement but Germany did not. He said the improvement in the United States was linked to centre-positioned high brake lights, and their experience with paired high lights mirrored that of Germany.

Although not specifically mentioned, antilock must be the most important development in crash avoidance. It is now available on a range of cars, the latest application being standard fitment to the Ford Scorpio-Granada. We look forward to lower cost mechanical systems for application to smaller cars, as promised by Lucas-Girling.

Session four on occupant protection for frontal impact was chaired by K. Digges. The key element of the presentations was growth in the use of modelling for both structures and occupants. Associated with growth was the reported accuracy and the cost-effectiveness of these techniques. Indicative of this growth is the decision of Ford Europe to invest $6 million in a Cray computer, which will give them an expanded scope in nonlinear modelling by finite elements. The exchange of information in this area between different countries was of particular value.

The principal problem addressed is that of mitigating the effect of head contact on the steering wheel for belted drivers. A test method for evaluating the severity of this impact was proposed by TRRL. Two solutions to prevent the contact were the use of airbags by Mercedes-Benz and steering wheels developed to meet the new TRRL test procedure.

The question of global, compared with subsystem, test was not addressed specifically, but it is clear that each plays its part in developing and signing off the vehicle. The actual angle and speed of a frontal impact test is still an outstanding question.

The Wilson paper, which calculates the benefits of individual treatments of parts of the vehicle, opens new perspectives in design tradeoff. His paper touches upon the friendly interior concept, which has raised so much interest.

The fifth session was organised by R. Stamm and covered accident investigation and its relevance to legislation. A significant paper by Dr. Mackay looked in detail at the effects of mandatory seatbelt use in the United Kingdom. They found a 25 percent reduction in serious injuries and deaths for car and light van occupants. They also concluded that the increase in pedestrian and pedal-cycle injuries and fatalities were statistically insignificant and did not support the hypothesis of risk compensation. They also found gross intrusion in the majority of accidents in which restrained occupants are killed and suggest that seatbelt design improvement is not a major priority. They do point out the significant reduction in fatalities and injuries that would follow fitment and use of rear seatbelts, which were also the subject of the Dutch study on seatbelts. This latter also supports the general United Kingdom experience.

Other investigation papers included the Japanese experience with a 50 percent fatality reduction from 1970 to 1980. The well-known car size effect was well detailed from the invaluable NHTSA Fatal Accident Reporting System (FARS). I have already mentioned the Italian proposals for a European data bank. Such data banks need major investment if the information is to be sufficient for valid correlations to be derived.

Finally, in the detailed trauma area, a German paper suggests a method of dealing with high scatter and uncertain limit values for crashworthiness criteria, such as HIC. This matter is important to resolve, if realistic targets are to be set for the so-called global test.

The side impact session was chaired by Ian Neilson of TRRL. This was a most significant area with nearly 20 papers, the largest section of the conference. The essential outcome of the work presented must be a harmonised side impact test procedure. Standardisation will be needed for dummy, injury criteria, barrier characteristics, and test speed, angle, and position.

Standardisation of the moving barrier is a first priority, and I feel that sufficient information and will is available to make decisions on this as soon as possible. May I suggest that the stiffness of the final model should tend to be in line with good design practice for minimising pedestrian injury and side impact aggressivity, rather than represent the current average vehicle norm, which will be a moving target. This harmonisation could be a most important consequence of the conference. It should be followed by dummy harmonisation.

There remains the discussion about whether legislative subsystem tests can be devised, instead of a full-scale test with a dummy. Conflicting ideas are still being put forward but, finally, a combination of both may be appropriate. The time for decision has arrived.

The other papers in the session significantly moved forward our modelling techniques and the study of the impact of vehicles into pedestrians.

The seventh session on safety development of goods vehicles and buses was chaired by L. Strandberg from Sweden.

A major programme on development of the tractor semitrailer unit for the future was given by M. Soret of Renault. In the VIRAGES concept vehicle, they showed development in ride, handling, stability, antilock braking, visibility, conspicuity, spray reduction, and side underrun and shielding. Spray reduction was also featured in the MVMA work (where the laser method of measurement they developed has advanced), as well as techniques for making objective comparisons.

Other papers dealt in detail with commercial vehicle-handling quantification, obstacle avoidance, front underrun, and conspicuity. A paper from my own organisation dealt with load restraint in light vans where a recommended practice has benefited both manufacturer and user.

There has been increased emphasis on PSV and coach safety, and this was reflected by papers concerned with accident analysis and the soon-to-be-legislated rollover test procedure. The discussion showed concern with the need for belts in coaches. The minimum must be belts in

the front and safety seats to absorb impact and retain the other passengers.

Much is known and agreed on how to improve safety in these vehicles, and has been clearly shown by the known concept trucks by Renault and TRRL/MIRA. Let us hope that at the next ESV conference there will be more representation by truck and coach manufacturers.

The study of severe coach accidents in France has emphasised the important hazard of fire and the need to provide easy evacuation of the vehicle. One must always remember that a significant proportion of the passengers are elderly, and experimental work must be realistically based.

Signor Rossi from Italy chaired the session on pedestrian safety and protection, a subject designated as a target area for improvement by several of the national position papers.

Thirteen papers were presented, covering a range of approaches. The problem is a complex one, with interactions between many different design aspects including frontal dimensions. This makes it difficult to specify component tests, but there are difficulties with a whole vehicle approach also in the wide range of speeds and points of impact possible.

For cars, three principal areas are important—the bumper, the bonnet leading edge, and the bonnet top. Secondary areas are the wing and windscreen. Many of the papers were concerned with optimisation, whether by experiment or analysis of these areas.

Progress on defining standards for the car-pedestrian interface must move forward with the work on side intrusion to insure engineering compatibility.

One of the techniques used by Maestripieri and others is a mobile barrier with adjustable characteristic simulating a range of vehicle front end possibilities. This enables the interaction between the frontal dimensions to be explored and quantified. The computer-based study of Harris and Grew opens up new approaches to defining these interactions.

The chairman for the final parallel session was Nakamura, and this session dealt with motorcycle safety.

Clearly five aspects are important:

1. Antilock braking
2. Leg protection for rider and passenger
3. Airbag use to control side movement in frontal impact
4. Conspicuity
5. Protective clothing and helmets

The importance of rider training has also been stressed in this status report.

All these aspects were brought out and demonstrated in the exhibition, particularly in the TRRL safety motorcycle.

The time now seems ready to move forward, and I would particularly like to encourage application of antilock braking and leg guards to motorcycles, perhaps starting with the larger machines where cost is not such a major factor.

Conclusion

I will conclude by making general comments on the conference. Some people have asked whether the scope should be enlarged to include driver behaviour and road design. Even emissions and noise have been mentioned. This will be reviewed by the committee, but I believe the tendency must be resisted so we can concentrate on the key area of safety and the vehicle.

I would like to congratulate Diane Steed on her dramatic statement that she is establishing an office of international harmonisation, reporting directly to herself. Even more encouraging is her specific reference to braking standards and side impact test methods and standards.

The final message is to ask each one of you to do your utmost within your area of professional responsibility to take advantage of the wealth of information given at this conference. When this is done, there will be a significant positive effect on vehicle safety and accidents worldwide.

Section 7
Closing Remarks

Michael M. Finkelstein, United States
John W. Furness, United Kingdom

Closing Remarks

Michael M. Finkelstein
National Highway Traffic Safety Administration

As the Tenth International Technical Conference on Experimental Safety Vehicles comes to a close, we in the auto safety community again have tangible evidence of the benefit gained from our effort to seek solutions to our common problems. As we progress beyond the development of experimental safety vehicles to the examination of the full range of vehicle safety problems facing us all, it is clear that our success to date in the ESV program must serve as a model for future cooperation.

Here in Oxford, we have had 4 days of wide-ranging discussions of vehicle safety. We have heard and discussed papers of the highest quality, papers whose importance will grow as we have time to study them and incorporate these new findings into our own future research.

We would be remiss if we did not take this opportunity on behalf of Administrator Steed and the entire U.S. delegation—I am sure I can say without fear of contradiction, on behalf of all of the conference participants—to express our gratitude for the generosity, hospitality, and remarkable efficiency of our British hosts: Her Majesty's Government and the Institution of Mechanical Engineers. Thank you all.

John W. Furness
United Kingdom

Ladies and gentlemen, it is now my task as your conference chairman to formally close this Tenth ESV Conference. In doing so, I would like to make some comments on the proceedings. First, I am sure you will agree that the conference itself and the associated social events have been both interesting and enjoyable. We have had a considerable number of reports and papers presented on a variety of topics concerning the safety design of road vehicles. Many were of high quality and have shown us some new and promising aspects of vehicle safety design to exploit. In addition, we were able to see the practical application of several of these ideas on vehicles and components exhibited here this week. The result seems to me to have fully justified the decision of the organisers to extend the scope of the conference to include motorcycles, trucks, and buses, as well as passenger cars.

On behalf of my co-chairman Michael Finkelstein and myself, I would like to thank everyone for their contribution to the success of the conference: to the U.K. Department of Transport for hosting the conference, the Planning Panel and staff of the Institution of Mechanical Engineers, and the U.S. National Highway Traffic Safety Administration for organising the event; to all who contributed papers, took part in panel discussions, chaired technical sessions, presented status reports, or made exhibits available; for the cooperation of the Society of Motor Manufacturers and Traders, the University and Colleges of Oxford, our interpreters, the catering staff, projectionists, and the secretarial and other workers behind the scenes. Even the weather was unusually kind to us, which helped the outdoor events!

I would also like to make special reference to James

Shively of NHTSA who has acted as U.S. coordinator for all ten ESV conferences and is, I understand, due to retire shortly; to Ian Neilson of the Transport and Road Research Laboratory for helping to organise the exhibition and acting as the focal point for the receipt of all the European papers, and to Dr. Cedric Ashley for his able summary of the technical highlights of the conference papers and exhibits.

In conclusion, I am most grateful to Sir Peter Lazarus, Permanent Secretary, U.K. Department of Transport, for opening the Conference, and to Miss Diane Steed, Administrator, NHTSA, U.S. Department of Transportation, for her stimulating keynote address, for presenting the NHTSA awards, and for giving us so much of her valuable time.

It only remains for me to thank you once again, to wish you all a safe journey home, and to declare the Tenth ESV Conference closed.

*U.S. GOVERNMENT PRINTING OFFICE: 1986-499-027