

REPORT ON THE FIRST INTERNATIONAL TECHNICAL CONFERENCE ON
EXPERIMENTAL SAFETY VEHICLES

PARIS FRANCE: JANUARY 25TH THRU 27TH, 1971



DEPARTMENT OF TRANSPORTATION National Highway Traffic Safety Administration



Report on the First International Technical Conference on Experimental Safety Vehicles



Sponsor: U.S. Department of Transportation
Hosts: The Government of France
The French Automobile Industry

Held at: The Chabra Syndicale,
Construction Automobiles
2 Rue De Presbourg, Paris, France
January 25-27, 1971



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foreword

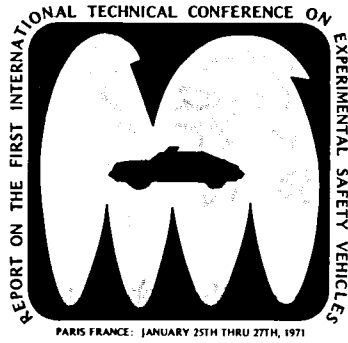
This report of the proceedings of the First International Technical Conference on Experimental Safety Vehicles was prepared by the Office of Experimental Safety Vehicle Programs, National Highway Traffic Safety Administration, United States Department of Transportation.

The report includes the conference opening remarks, the formal technical presentations by the countries participating, reproduction from tape recordings of the three Specification Discussion Sessions, and the concluding remarks by the United States and France.

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.

AGENDA

Monday, January 25	1000-1030	Introductory Remarks: France
	1030-1100	Introductory Remarks: U.S.
	1100-1200	Introductory Remarks: Germany, Japan, Italy, U.K., Netherlands, Sweden
	1200-1300	U.S. Technical Presentation, Part I
	1300-1500	LUNCH
	1500-1600 1600-1700 1700-1800	U.S. Technical Presentation, Part II German Technical Presentation Japanese Technical Presentation
Tuesday, January 26	1000-1100	French Technical Presentation
	1100-1300	First Specification Discussion Session: Vehicle Ride and Handling (Braking, Steering, Suspension, Drive Train)
	1300-1500	LUNCH
	1500-1600 1600-1800	Italian Technical Presentation Second Specification Discussion Session: Crashworthiness (Structures, Restraint Systems, Interior Design)
Wednesday, January 27	1000-1100	U.K. Technical Presentation
	1100-1300	Third Specification Discussion Session: Other Accident Avoidance Factors (Visibility, Lighting, Controls, Displays)
	1300-1500	LUNCH
	1700-1730	Conference Summary & Concluding Remarks: U.S. Concluding Remarks: FRANCE



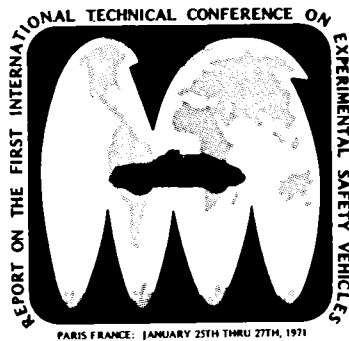
The First International Technical Conference on Experimental Safety Vehicles

Participants

- Allemagne/Germany Ministerialrat Belke
 Regierungsdirektor Jungblut
 Dr von Brunn, V.D.A. - President
 Dr Brenken, V.D.A.
 M. Matthes, V.D.A.
 Dr Sassor, AUDI N.S.U.
 M. Basche, B.M.W.
 M. Elsholz, B.M.W. (observer)
 Dr Reidelbach, Daimler-Benz
 Dr Burghard, Daimler-Benz
 M. Boche, Ford
 M. Brumm, Opel
 M. Kraft, Volkswagen
- Australie/Australia M. Bell, Exec. Engineer, Technical Section,
 Dept. of Shipping and Transportation
- Belgique/Belgium M. de Koster
- France M. Dreyfus, Directeur des Routes,
 Ministère de l'Équipement
 M. Frybourg, Directeur de l'I.R.T.
 M. Osselet, Direction des Routes
 M. Herla, Directeur de l'O.N.S.E.R.
 M. Berlioz, O.N.S.E.R.
 M. Gauvin, Arrondissement minéralogique de Paris I

- France (continued)
- M. Leroy, Directeur du Laboratoire des Chocs, O.N.S.E.R., Lyon Bron
 - M. Dollet, Ministere du Developpement Industriel
 - M. d'Ornhjelm, C.S.C.A. - President
 - M. Aubin - C.S.C.A.
 - M. Martin - M. Behaghel - C.S.C.A.
 - M. Cornell - Chrysler-France
 - M. de Forcrand - Chrysler-France
 - M. Clavel - Citroen
 - M. Bohers - Citroen
 - M. Caroff - Citroen
 - M. Estaque - Citroen
 - M. Palfer-Sollier - Citroen
 - M. Boschetti - Peugeot
 - M. Dangauthier - Peugeot
 - M. Chillon - Peugeot
 - M. de Lavenne - Peugeot
 - M. Ruellan - Peugeot
 - M. Ouin - Renault
 - M. Georges - Renault
 - M. Chenevez - Renault
 - M. Eelsen - Renault
 - M. Maroselli - Renault
 - M. Seznec - Renault
- Italie/Italy
- M. Valerio Agostinone, Ministere des Transports
 - M. Giacomo Pocci, Ministere des Transports
 - M. Castano Danese, Ministere des Transports
 - M. Carlo Tibiletti, A.N.F.I.A.
 - M. Satta Puliga, Alfa Romeo
 - M. Montabone, Fiat
 - M. Montanari, Fiat
 - M. Franchini, Fiat
 - M. Moscarini, ISAM, Experiment Institute for automobiles and motors
 - M. Fogliata, Alfa Romeo
- Japon/Japan
- M. Kondo, Director, JARI
 - M. Yamada, Chairman of JAMA ESV Committee and Toyota Exec.
 - M. Igarashi, Auto Section, MITI
 - M. Watanabe, Chief Safety Research, Isuzu
 - M. Furusho, Chief, RD, Daihatsu Kogyo
 - M. Shoda, Chief, RD, Suzuki Motor Co.
 - M. Onishi, Planning Engineer, Toyota
 - M. Takahashi, Research Engineer, Toyo Kogyo
 - M. Ichinose, Research Engineer, Toyo Kogyo
 - M. Noguchi, Design Engineer, Nissan
 - M. Maeda, ESV Project Mgr, Nissan
 - M. Mori, Chief, Automotive Safety Honda
 - M. Komatsu, Automotive Safety Engineer, Honda
 - M. Mitamura, Project Design, Mitsubishi
 - M. Hayashi, Project Design, Mitsubishi
 - M. Okami, Testing Div. Mgr, Japan Auto. Research Institute
 - M. Taniguchi, Chief Technical Dept. JAMA
 - M. Shizume, JAMA/Paris

Pays-Bas/Netherlands	M. Bastiaanse, Central Organization for Applied Scientific Research M. Bruggen, DAF M. Van Papendrecht, DAF
Suede/Sweden	M. Gustav Ekberg, Chief, Vehicle Bureau M. Gustavsson, Technical Director, SAAB M. Unosson, Chief, Advance Engineering, SAAB M. Nilsson, Liaison Engineer Safety, SAAB M. Salinger, Chief Testing Engineer, VOLVO M. Bohlin, Safety Research Engineer, VOLVO
U.K./Royaume-Uni	M. Lister, department of Environment M. Baxter, department of Environment M. Masset, Ford M. Weighell, Chrysler M. Peck, British Leyland M. Bissell, S.M.M.T. M. Ridgeway, Rolls Royce
U.S./Etats-Unis	M. Brenner, Chief Scientist, NHTSA M. Edwards, Assoc. Director, Research Institute M. Slechter, ESV Project Manager M. Chandler - ESV Engineer M. Di Lorenzo, ESV Engineer M. Lippman, Assistant to Dr Brenner M. Kruse, U.S. NATO M. Roth - AMF M. Larson - General Motors M. Busby - A.I.A.
Communautes Europeennes (Bruxelles)	M. Schlosser
O.C.D.E./O.E.C.D.	M. Orski Mrs Targel
O.T.A.N./N.A.T.O.	M. Randers, Assistant Secretary General M. Yves Laulan



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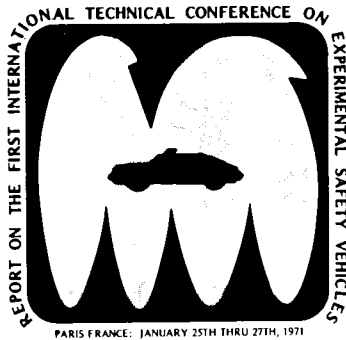
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SECTION 1

Introduction

Chairman Mr. John A. Edwards, Acting Associate Administrator for Research and Development, U.S. Department of Transportation, National Highway Traffic Safety Administration

Host Monsieur G. Dreyfus, Directeur des Routes et de la Circulation, Ministere de l'Equipement, France

REMARKS Monsieur G. Dreyfus, Directeur des Routes et de la Circulation, Ministere de L'Equipement, France

Dr. Robert Brenner, Chief Scientist, U.S. Department of Transportation, National Highway Traffic Safety Administration, United States

Ministerialrat Belke, Regierungs, Director Jungbrut, Federal Republic of Germany

Professor Dr. Kondo, Director, Japan Automobile Research Institute, Incorporated, Japan

Mr. V. Agostinone, Ministere des Transports, Italy

Mr. R.D. Lister, Department of Environment, United Kingdom

Mr. Bastiaane, Central Organization of Applied Scientific Research, The Netherlands

Mr. Ekberg, Chief, Vehicle Bureau, Sweden

Mr. de Koster, Belgium

Mr. Bell, Executive Engineer, Department of Shipping and Transportation, Australia

section 1 part 1

Conference Opening Introductory Remarks

INTRODUCTION

Mr. G. Dreyfus, *Directeur des routes et de la Circulation Routiere*

FRANCE

Gentlemen,

I welcome you to Paris.

The U.S. Administration has expressed the wish that governmental experts of the main manufacturing countries be invited to a meeting where experimental safety vehicles would be discussed, and asked the French manufacturers to take charge of the organization for this meeting in Paris.

Today is the first day of the meeting, summoned with the French Government's full agreement.

The Direction des Routes et de la Circulation routiere (Highways and Traffic Bureau) prepares — together with the other agencies who may be concerned — all regulations concerning automotive vehicles. This is the reason why I have the honour of welcoming you and opening this session. It is a great pleasure for me, as I know the importance of the results of your studies.

I greet the representatives of NATO and O.E.C.D., the representatives of the U.S. Government who invited us, and the representatives of the governments of the Federal Republic of Germany, Italy, Japan, the Netherlands, the United-Kingdom, Belgium, Australia, and Sweden who accepted this invitation.

I greet also the representatives of the motor manufacturers. They are use to holding meetings in these premises every time the members of the Bureau Permanent International des Constructeurs d'Automobiles convene in Paris.

We intend, in the course of this three-day meeting, to put in common our information and our plans related to an object which is of the highest interest to us all, official bodies and manufacturers: I mean Highway Safety and specially the influence of vehicle design upon highway safety.

France, on her own, is making a significant effort to improve safety. Measures have already been taken and others will follow, concerning the road system, as well as users' education and information. I know all of you have displayed great efforts on this subject. What we demonstrate here is our will to reach another milestone in support of research progress.

Thanks to the experiments we are all going to carry out we shall be able to adapt our regulations to the aim we shall specify, and I am convinced that the Governments' and the Manufacturers' common wish is that the standards which must be achieved are concerted between the Governments and enforced in all countries following parallel methods.

This is the right approach and, in this spirit, I assure you that the French Administration wishes to cooperate fully.

Our aim is to promote technical progress, to set common standards when our knowledge is sound enough, to base them on our knowledge, and to develop them, if necessary, when our knowledge improves — of course our studies will be all the more profitable if the results are widely advertised in as many countries as possible. Such is the French Administration — and, I am certain, the French Manufacturers' — standpoint.

Agreements have already been signed for that purpose by various Governments. The French Government is ready to sign, if necessary, similar agreements with countries wishing to do so. But, as a matter of fact, ten countries are represented here. If each of them intends to sign an agreement with every other one, it means a lot of paper.

We must be prompted by a spirit of efficiency and productivity — Would it not be easier to prepare a single document which could be adopted by anyone wishing to sign? This is the first idea I ask you to think about.

I believe that we must now think of the way the

outcome of our research will be exploited, and of the most efficient means of using research workers towards our aim — safety.

The highest level of safety consistent with actual industrial and trading possibilities is the object of any research concerning basic safety data and the E.S.V.

Such research deals — and will deal — with a large number of vehicle parts and equipments, and even with vehicle design. It has to be done with the help of a great many specialists.

We have appreciated the fact that the U.S. agencies, when launching a research program for 4000 pounds vehicles, suggested to other Governments to launch programs for 1000 Kg vehicles, and that several European Governments contemplate — or already have — undertaken studies concerning the range of vehicles usually produced in their country.

Therefore, one would think that all international standards adopted later on will take into account; the different classes of vehicles. A spirit of competition, must be maintained. We must be ready to talk together, to prompt special regulations concerning 700/1200 Kg vehicles, a special feature of European manufacturers.

Even if research workers are trained as quickly as possible, their number is limited, and it is to our interest to concentrate them on major safety problems — Engineers' work today to conform vehicles to regulations which are the result of specific initiatives of various countries.

Wherever such initiatives are taken, they consume specialized engineers' time and energy and at the same time they create problems, some of which may be unsolvable from the industrial view-point. Hence a discomfort, prejudicial to the international cooperation spirit we are seeking; more over it makes it impossible for the specialists to concentrate on useful research.

In the opposite direction, every time an international agreement is achieved, or will be achieved, concerning a given regulation, a general improvement occurs on various grounds: safety, efficiency, productivity.

Even if our ways and means differ, all of us are engaged in a new stage on the road to safety — our

attendance means that we believe in the efficiency of such research towards internationally approved regulations that are adapted to the various types of vehicles.

Let us set 1975 as a deadline for reaching this goal, provided that, whenever answers are found earlier, they will become partial international regulations as soon as they can be enforced.

With this target in view, we must ask the industrialists to concentrate all the possibilities at their disposal, and the best among their research workers, upon this research.

It entails, as I said a minute ago, that their research department not be encumbered with studies originating from special initiatives concerning regulations.

It may happen, and it is likely to happen, that the programs we are going to discuss during this meeting, will lead to a significant progress, even before completion of the studies as a whole.

Would it not be better, then, — and this is every manufacturer's wish — that during this intermediate period we strived to adapt and harmonize international regulations, keeping clear of special initiatives?

Research efficiency, mutual information, concerted and adapted regulations, such are the guidelines I think we must follow. I would be thankful if the ten delegations expressed their feelings on these subjects.

We must thank the United States, who promoted this important meeting, with a spirit of international cooperation.

It seems the most appropriate welcome wish is that this meeting achieves a great success.

A very concrete form of success is that when we part in three days time, we are determined to cooperate closely and to take only concerted initiatives in the future, when regulations are concerned.

OPENING REMARKS

DR. ROBERT BRENNER, *Chief Scientist*,
U.S. Department of Transportation,
National Highway Traffic Safety Administration

UNITED STATES

Mr. Dreyfus, Mr. Frybourg, Mr. Osselet, my friends from other governments, French industry, and the industries of the other countries, Ladies and Gentlemen:

I am very happy to be here with you at this landmark meeting on the important subjects of road safety and the Experimental Safety Vehicle. I want to convey the best wishes of President Nixon for a successful meeting which so sharply reflects his deep personal interest in highway safety and other problems of the world's environment.

I bring you as well the personal greetings of our Secretary of Transportation, John Volpe, whose strong leadership is opening new dimensions of road safety, not only in the United States but throughout the world. And then the Administrator of our agency, and my boss, Mr. Douglas Toms, asked me to convey his very enthusiastic endorsement of the goals of this meeting. Finally I bring you as well the greetings of Mr. Russell Train, newly appointed by President Nixon to head the U.S. Delegation to CCMS, NATO. Mr. Train succeeds the very eminent scientist and colleague, Dr. Daniel P. Moynihan, who was the Counsellor to President Nixon.

From the inception of CCMS, Dr. Moynihan has had a key role in enunciating and implementing the principles and purposes of this newest subsidiary body of NATO. To quote from one of his addresses on the subject (October, 1969):

“ . . . Just as advancing technology has given rise to the central social vision of our age, so also has it become the central problem of the age. In massive and dominant proportion the things that threaten modern society are the first, second or whatever-order effects of new technology . . . ”

What are some of the degradations to the environment, health and safety that technology is causing? The examples unfortunately are many:

- air pollution
- ocean pollution
- inland water pollution
- compelling issues of nutrition such as cancer produced in animals by chemical food addi-

- tives as preservatives or diet fads
- the indiscriminate use of space in our cities
- the irreversible destruction of natural resources
- the color TV set that floods unsuspecting children with damaging x-rays as a concomitant to their seeing the Rose Bowl Parade in glorious living color

And then there are the 55,000 or more who die every year in the United States in traffic crashes and the millions who are seriously injured and the billions of dollars lost in the destruction of property.

All of these degradations are the results of technology, pure and simple, and will be mitigated if not cured only by this same technology that created them. And with the degradations emanating largely from technological activity in the industrialized nations of the world, it will have to be these same nations that will have to start the corrective forces in motion.

NATO is, of course, an important quorum (although certainly not the only one) of the industrialized world, with major experience and success in intergovernmental transfer of technology for mutual problems of defense and related political consultation. It is therefore well qualified to spearhead or at least assume a very active role in this needed intergovernment transfer of technology for mutual problems in the defense of the world environment.

The thrust of our effort is to command attention and response at the very highest levels of government. Toward this end a somewhat unique approach, suggested originally by the United Kingdom, is now being implemented under the strong leadership of Dr. Gunnar Randers, the Assistant Secretary of NATO. In this approach, a single nation or pilot country assumes the primary responsibility for a given area of activity, conducts the effort with its own resources, stimulates cooperation with participating countries and prepares the necessary reports to the CCMS. This pilot country approach provides for single country responsibility and leadership for one and only one dominant purpose; this is to promote more rapid action than usually is possible through multilateral responsibility.

In some cases two countries share the leadership but I would emphasize that there is no major CCMS secretariat in NATO since most of the operational detail and expenses are met by the pilot countries. In effect, the NATO allies have divided leadership responsibility, and each member nation cooperates with studies led by others even while it might itself be the leader of one or more efforts.

It is interesting to note the wide range of studies that are now in progress: open water pollution being led by Belgium in cooperation with Portugal, Canada and France; inland water pollution, Canada with France, the U.S. and Belgium assisting; environment in the strategy of regional development, France the leader; scientific knowledge and decision-making, the Federal Republic of Germany; work satisfaction in a technological era, the United Kingdom.

The studies that the U.S. proposed and which have been approved include air pollution, with the assistance of Turkey and the Federal Republic of Germany; disaster response or disaster assistance, with the assistance of Italy; and, finally, our subject of the day, Road Safety, and we are nominally alone in this area of activity.

I say that we are only nominally alone in the road safety activity because a number of nations have assumed leadership roles in various project areas:

- alcohol driving countermeasures, Canada;
- advanced vehicle inspection, the Federal Republic of Germany;
- road hazard identification and treatment, the Republic of France;
- emergency medical services, Italy;
- accident investigation, The Netherlands.

We are now negotiating with other countries for possible leadership roles in pedestrian safety as well as the whole of driver performance.

The pilot study thus is comprised of a series of projects largely selected from topics discussed in a series of meetings with different countries throughout the world. The United States as the pilot country is leading some of the projects in addition to the overall study; other countries are leading other projects. Apart from project leadership per se, all of the governments contacted, NATO as well as non-

NATO, are ready to participate in varying degrees on this exchange of information called for in the various projects.

All of the projects are directed toward government action, not research per se. The reason is that while much safety research is still urgently needed, much is already known that can be placed into operating practice and start saving lives immediately. Thus, the pilot study is oriented to government decision-making and action, based upon a full and open exchange of technology and operational experience. To be successful, the exchange must be two way, and having accepted the responsibility for the pilot study effort, the United States is most encouraged by the number of countries that have accepted leadership roles in the various projects that comprise the study. And, of course, within this context we are most delighted that the Government of France, with the assistance of the French automobile industry, so kindly offered to conduct this meeting.

We anticipate that much of the road safety practices of member nations will aid the United States in planning and implementing its safety programs, even as the new United States safety technology, with the full and active support of President Nixon, Secretary Volpe, and Mr. Toms, is helping member nations and non-member nations in planning and implementing their efforts. The road safety pilot study is not conceived of, nor intended to be an effort continuing indefinitely into the future. It is to end with the submission of a final report by the United States to the CCMS in December of 1972. This report will contain recommendations which NATO can adopt or reject on government or industry activities in each of the various program areas that can continue on a permanent or sustained basis after the pilot study is ended.

Thus the heart of our program is to stimulate a significant exchange of technology among a major group of industrialized nations of the world. What might prove to be the severest test of this fundamental hypothesis is the subject of this meeting, the Experimental Safety Vehicle Program. I would, therefore, like to elaborate very briefly on the international aspects of this program. A more detailed treatment

is contained in a paper which I presented in London several months ago, copies of which are available.

Briefly, the concept of government sponsoring the development of experimental vehicles in which safety is the overriding design goal is part of the landmark vehicle and highway safety legislation enacted by the U.S. Congress in 1966. Under this particular legal requirement that we build ESV's, we have let three contracts to each of three private companies: Fairchild-Hiller; American Machine and Foundry Company, and General Motors Corporation, for each to design and build a prototype vehicle to meet specified levels of safety performance.

For example, one of the specifications calls for full survivability of vehicle occupants without serious injury in a 50-mile-per-hour barrier impact. Details of the design are left to these contractors who are to deliver to the Secretary of Transportation a prototype and a back-up vehicle that meet the specifications.

Upon receipt of the two vehicles from AMF and Fairchild-Hiller, the Secretary will initiate a testing program to test the safety performance of each design. Based upon the results of the comparative tests, the Secretary will select one or the other of these designs and contract for the construction of 12 additional vehicles which in turn will be tested against the product which General Motors Corporation will later be delivering to the Secretary.

The results of these tests and evaluations of the safety prototype vehicles will then comprise the technical foundation for issuing new federal safety standards for all vehicles sold in the United States.

The basic goal of the ESV program is to stimulate through safety design of the vehicle as a complete system a quantum jump in vehicle safety performance as compared to the incremental improvements which industry has always made in varying degrees in production vehicles from one model change to the next. We are quite conscious of the progress which industry has made and is making in improving vehicle safety performance. But we also recognize that successive improvements can be introduced only at rates compatible with such factors as sunk cost in tooling or the competitive position in the marketplace. The introduction by industry into the market

of a vehicle that is completely new from the safety standpoint is in fact comparatively rare. And it is precisely because the marketplace and other factors prevent industry on its own from producing this quantum jump in vehicle safety design that government sponsorship of ESV's becomes important.

In addition to producing the quantum jump in safety performance, the ESV program has other major purposes. For example, it can mean a reduction in the price the consumer pays for cars having higher levels of safety performance. We strongly believe that the combined effect of a group of safety improvements upon the price the consumer pays for the final product will be substantially lower if most of the improvements are designed into the vehicle as a total integrated system from the start rather than as a sequence of add-ons to a basically unchanged vehicle design.

In ESV developments, automotive designers have unique opportunities to develop innovative low cost solutions that incorporate all safety requirements into the vehicle at once and yield high levels of safety performance in the end product. They can optimize and sub-optimize the performance and cost of various subsystems of the vehicle as they deem appropriate to meet or exceed performance specifications. They can establish priorities, and, I might add parenthetically, all candidate safety improvements need not have the same priorities. Moreover, priorities which might be the same for large vehicles might not be the same for small vehicles.

In short, within the disciplinary constraint of having to design and construct a complete vehicle, designers are afforded the opportunity, in fact are forced to make the trade-off analysis between candidate-safety improvements and I might say exhaust emissions as well.

Still another underlying objective of the ESV program is to examine how a comparatively large number of safety requirements for vehicle subsystems can be consolidated into a smaller number of standards dealing more with the vehicle as a complete system. For some time we have been extremely concerned about the increasing number of individual standards that collectively define the safety perform-

ance of the total car. In the United States we now have in effect some 31 vehicle safety standards with upward of 170 new standard changes or additions to existing standards under development. We strongly believe that increasing the number of standards is not a good approach, either from the engineering standpoint or the effect upon vehicle price. We much prefer to move over the next several years in precisely the opposite direction, that is toward a fewer number of standards that treat the safety performance of the complete vehicle. This is a new, and as yet untested principle of government regulation of vehicle safety performance on the basis of a total system requirements rather than on a subsystem basis. The ESV program is a fundamental and mandatory first step toward validating this principle, and as this program progresses we will be studying the degree to which total system performance standards can overtake and supplant standards on subsystem performance.

The initial U.S. ESV effort has been limited to the 4,000 pound family sedan for several reasons, several of which are: first, this class of vehicle does predominate on U.S. roads; second, the incorporation of new safety improvements, particularly in occupant protection, is less difficult in the larger cars than in smaller cars; third, ESV programs are inherently expensive from all standpoints, dollars, engineering manpower and time.

The U.S. is nevertheless most interested in the development of prototype safety vehicles in the smaller size and weight classifications. In the United States small vehicles represent approximately 6 percent of the vehicle population, but account for more than ten percent of the crashes producing serious or fatal injuries. Our projections indicate that the percentage of smaller cars on our highways is rising rapidly, both with more compacts as well as the introduction of domestically produced small cars into U.S. markets. This is the safety increment that underlies our interest in the small car development.

But in addition to safety considerations, our interest in small-sized ESV's bears heavily on the economics of providing safe personal transportation for low-income groups. We do not believe that safety

should be a luxury item available only for the rich; low-income people must have safety in the cars they can afford.

One analysis shows that the cost of small cars now priced around \$1800 in the United States, will increase by more than 40 percent in 1975 over 1969 levels, because of U.S. safety and anti-pollution standards. This would mean that an \$1800 Renault, Volkswagen, Gremlin, Pinto, Toyota, Datsun, or a car in this price range would cost about \$2400, and this 40 percent estimate probably does not affect all of the rule-making actions that we now have underway.

It is unmistakably clear to us that if these cost data are correct, we, in the United States, might be on a course that will ultimately drive the low-cost, economical, safe car, out of the U.S. market. I can assure you that this is an end result that my government considers undesirable from every standpoint, transportation cost, fuel consumption, highway capacity, parking space, air pollution and the provision of personal transportation for low-income groups.

We note, however, that these cost increment estimates result from adding the cost for each improvement to the price of the car sequentially; they would not be as high if the improvements were introduced as an integrated single package. Thus the need for an ESV approach in the small car is quite clear, particularly in the very difficult area of safety and economic tradeoffs. Do we spend \$400 on anti-skid braking in the small car, or is the same \$400 better spent in improved structural crash-worthiness? How do we choose between these if we can only have one and still have the price of the final product within the purchasing capability of low income groups?

As difficult as such cost safety tradeoff analyses might be in an ESV development program, they are more difficult, but nonetheless inexorable later in designing for production vehicles. The discipline of making systematic safety tradeoff decisions might just as well start in ESV programs as the forerunners of similar decisions later for production vehicles. And with such decisions being made in parallel

between small and large car ESV developments, we would be laying the foundation for this possible new dimension in vehicle safety regulation which would recognize that priorities for safety requirements might vary between large and small vehicles, or between expensive and low price vehicles.

To bring to the attention of foreign governments the need for lightweight ESV developments in the 3000, 2000, or even 1500-pound weight classes, we proposed at the first technical meeting of our pilot study for NATO in February of this year, that the U.S. 4000-pound ESV's become the foundation for a broad program of international cooperation among nations. Each would sponsor ESV developments in parallel with the U.S. effort. Since then, it has been my distinct privilege, as well as a most exciting personal experience, to discuss this program separately with government and industry officials of every country having a major automotive industry, not only with NATO countries, but also with Sweden and Japan. Throughout, the importance of comparatively quick action has been emphasized; with delivery of the U.S. prototype and backup vehicles to the Secretary of Transportation to start in December of 1971, we want to move rapidly on getting the safety improvements into production vehicles and on testing the feasibility of changing our regulatory approach toward total system performance.

On November the 5th of this year, our Secretary of Transportation John Volpe and Minister of Transport George Leber of the Federal Republic of Germany signed a bilateral agreement under which the German government, supported by its industry, will develop a 2000-pound ESV and begin to exchange information and technology with us in our program.

On November 18th of this year, Secretary Volpe and Minister of International Trade and Industry Myzawa and Minister of Transport Hashimoto of Japan, signed a similar agreement.

Intensive discussions are now in progress on bilateral agreements between the United States and other countries, many of which are represented here today.

In initiating this international cooperative pro-

gram of ESV developments, we fully recognize the formidable obstacles to completely free and timely flow of new automotive technology across the boundaries of the industrial world. We are completely cognizant of the proprietary rights of private manufacturers who discover new technology of vehicle safety performance, and we obviously recognize the stimulus to discovery provided as a consequence of protecting legitimate self interests.

And we are no less cognizant of the problems of achieving the favorable trade balances that all countries seek.

But we also recognize the extreme urgency of pooling world technology in vehicle safety. Too many men, women, and children are being killed every day because safety technology known to work in one country is not available in another. Our challenge is to find ways to stimulate an equally rapid flow of automotive safety breakthroughs across automotive corporate and international boundaries. If, miraculously, an absolute cure for cancer were to be discovered somewhere in the world, I am sure that it would move most rapidly across corporate and international boundaries. For example, I do not believe that if a French pharmaceutical firm discovered a cure for cancer, that we would prohibit this cure from coming into the United States while waiting for a similar discovery to be made by a U.S. firm. Why should analogous cures for the vehicle traffic death not become available for all as soon as it is discovered.

I would conclude by emphasizing that the technology of road safety, especially in vehicle design for safety, is changing extremely rapidly. In fact, it is changing so rapidly that some of us are now cautiously speculating that spearheaded by the ESV program, a generation of vehicles might be at hand in which the chances of a vehicle occupant being killed or seriously injured in the 50 to 60-mile-per-hour crash will be virtually nil.

Thus technology might be producing what, for a substantial part of the traffic death and injury problem, would be the analogue of what the Salk vaccine was to polio. I might add that the vehicle crash as the number one killer of children and young

people in America has been producing more than twenty times the number of deaths that polio ever produced in the worst epidemic years. This brings to mind that it was not very many years ago that there was no solution in sight for polio.

We know that we are on the verge of breakthroughs that will eliminate the traffic crash as the number one public health problem of our young people in the United States. And with these solutions in sight, what we are striving to accomplish, in effect, is what the medical profession and health scientists have been doing for years; this is to expedite the flow of effective countermeasures to this public health problem across international boundaries. We do not know precisely how this is best done, but we have ideas, and are willing to test them. This is our mission.

We are confident that by bringing the collective strength, intelligence and judgment of NATO, this very important quorum of nations, to bear on the traffic problem of the world with the cooperation of non-NATO nations as well, this transfer of technology will occur more rapidly.

And as a result, we know that the day will come much sooner when mankind looks back upon traffic deaths as memories of irresponsible technology in uncivilized societies of the past.

Thank you very much.

OPENING REMARKS

MINISTERIALRAT BELKE,
Regierungs Direktor Jungblut

FEDERAL REPUBLIC OF GERMANY

Ladies and gentlemen, Mr. Chairman, the meeting that is beginning today concerning the ESV is specifically of a technical character.

Nevertheless, I think it would be a good idea if I give you an idea of general developments in Germany as to the ESV.

In March of last year, the majority of you were present at the first technical meeting, which dealt with the United States' studies in this field. We met in Brussels, and we were informed of the American work that is underway in this field.

We were also informed of the interest the United States has in the development of an ESV near 2000 pounds to be carried out by the German industry. We had the assurance of the United States that this effort would be supported by them.

I am not informing you of any secret when I say that we expressed reservations, to begin with, as to this idea, because, in past years, a lot of spectacular safety cars have been produced, which have had no effect on the actual safety of the occupants of the cars.

Hence, it is natural that in the Federal Republic, over the past two years, we have wanted to come to international agreement as to legislation on the safety of cars, and we have been keen to see the improvement of the various subsystems and components, even if this were a very difficult task, because of the various opinions that existed.

Now you might understand this standpoint when you remember that the Federal Republic is in the middle of Europe, and hence receives a number of international cars and a lot of international traffic. In 1970 in the Federal Republic, more than half the cars produced in Germany were exported.

In the Federal Republic, contrary to the U.S.A. we have no legislative agreement vis-a-vis the government, that is vis-a-vis the Transport Minister. We have no approved undertaking to build an ESV, and hence, without such a commitment, the Financial Minister is hardly willing to finance such an expensive project as is the case with an ESV project.

Despite such difficulties, the Transport Minister was nevertheless very interested in an ESV project as was seen when we had discussions with the people

concerned. We also found that the German manufacturers were also very open to this idea, the idea of producing an ESV.

The German automobile industry, therefore, in August 1970, vis-a-vis the Transport Minister, declared that they were ready to study the technical requirements of an ESV at the European level. This would be examined by 1970, and the technical specification then would be fixed. This step was necessary because the requirements stipulated by the U.S. for a 4000 car could not automatically be transferred to a car of a different weight.

Dr. Brenken, the main person responsible for the German Automobile Industry Federation, is going to discuss this work this afternoon and is going to give you the results of the work.

Before these technical requirements were fixed, the Volkswagen factory, on the 12th of October 1970, publicly declared their decision to produce in cooperation with the VDA and NHTSA an ESV of approximately 1000 kilos.

Cooperation on the part of the German automobile industry contributed to the fact that on the fifth of November last year, Germany signed a Memorandum of Understanding with the United States, for the development of an ESV.

This memorandum provides for the Federal Republic, apart from its efforts within the framework of Europe and apart from its efforts in the ECE and CCMS, to insure that improvements be brought about in the safety of components. It proves that the Germans are willing to cooperate as much as possible in order to obtain new knowledge, knowledge that will be useful for the development of added safety of the automobile.

Now one of the important aspects of this agreement is the underscoring of the willingness to exchange information on ESV work. Work to date has been characterized by the fact that the German automobile industry has always cooperated in ESV projects, whether it be in stipulating specifications and I would stress that up to now we haven't received financial support from the state.

The Transport Minister is supporting our efforts wholeheartedly. We are at the beginning of a new

worldwide development, and I think that it holds great promise. This is why we welcome this meeting today, and we hope that we will have an interesting exchange of views and opinions.

The preparation of such meetings is so important, and requires a great deal of effort. Therefore to all the people who are participating today, all you ladies and gentlemen, I would like to thank you all; first and foremost, of course, the hosts. I would like to thank the French government for organizing and supporting the meeting. The French Automobile Industry for hosting the meeting. I would also like to include, last but not least, the delegation from the United States who are, after all, the initiators of this meeting.

And for all the people who have organized the meeting, I would like to say, thank you very much. And I do hope that we will all be successful in our meeting here today.

Thank you very much.

OPENING REMARKS

PROFESSOR DR. KONDO, *Director*,
JAPAN AUTOMOBILE
RESEARCH INSTITUTE

JAPAN

Mr. Chairman, Ladies and Gentlemen. I feel greatly honored to have the opportunity to make the introductory remarks explaining the situation in Japan concerning cooperation in the development of Experimental Safety Vehicles.

The improvement in safety performance of the vehicles and the development of countermeasures for the programs of exhaustive gas and the vehicle noise, are most important developments which will define the destiny of the automobile in the future.

Especially in such a densely populated country like Japan, this problem will become more and more important. Therefore, when the international project concerning ESV was proposed by the United States, we regarded it as very significant, and immediately decided to participate in this project.

The memorandum of the mutual cooperation between the United States and Japan was signed last November in Tokyo by Mr. Volpe, Secretary of Transportation of the American government, and Minister Miyazawa and Minister Hashimoto of the Japanese government.

Upon this signature, Japan started officially her ESV project. The process of development of this project in Japan will include three steps.

First, the step for setting up the specification of ESV, which is scheduled to be finished by the end of February 1971.

The Japan Automobile Manufacturers Association and the Japan Automobile Research Institute are now cooperating to set up various specifications needed for the Japanese ESV. The result of this work will be approved by our government.

The second stage of our ESV project will be for the fabrication, which is scheduled to end by the fall of 1973.

Automobile manufacturers who intend to fabricate the experimental vehicle using the authorized specifications will have to apply to the government. The government will then select several manufacturers considering many points of view, including technical and financial viewpoints.

These selected manufacturers will get financial support from the government for their experimental fabrications.

The third step, which is planned to be finished by the end of 1973 will consist of ESV tests. The Japan Automobile Research Institute, a neutral organization, will gather and arrange definitive data on the performance of each ESV. The government will support some subsidy for this testing. This is the final step we are planning for the development of ESV.

Now, then, I would like to explain some safety regulations in Japan.

In Japan the new safety regulation for vehicle road transportation was legislated 1951. It regulates fully and minutely braking systems, lighting equipment, running system, control devices, meters and others. It has been revised several times to adopt to changing conditions of traffic and drivers, and especially in this connection much effort has been made for the safety of pedestrians.

Despite our effort, however, the number of traffic accidents is rapidly increasing each year. To overcome this situation, we are now studying a long-range plan for the improvement of motor vehicle safety.

In our effort concerning the long-range plan, we hope to be able to make maximum possible use of expected achievement of this ESV program.

The ESV development program has started, but this international cooperation should not be limited to the ESV. It should be the first step for the broader cooperation where we will tackle all the other problems concerning the improvement of the motor vehicle in the future.

Thank you.

OPENING REMARKS

MR. AGOSTINONE
Minister of Transportation

ITALY

The initiative International Forum for Road Safety. As we know, these problems are very complex, and they include not only technical and industrial aspects, but also social aspects, which are very important.

Road traffic in Italy has increased considerably over recent years, and indeed over a very short period of time. We have had to come to grips with many safety problems.

From the point of view of safety of cars, we have initiated many efforts. The Italian Automobile Industry has done a lot and indeed we have made considerable progress.

Nevertheless, we are fully aware of the fact that from now on we have to implement in practice the results of our studies, with a view to improving the safety of cars. We must expand our efforts at the international levels, through the World and European organizations in which the Italian government participates.

At the very beginning Italy was willing to participate in the development of an ESV, and it was for this specific reason that we have worked on the more common type of car that exists in Italy. I will talk of the problems that we have had to deal with, more specifically where small cars are concerned, because these are very common in Italy.

We wish to cooperate very closely with all the European countries which produce cars, and with the United States. The Italian Government has entered into an agreement with the United States, and in the very near future, such a memorandum of understanding with the United States will be signed.

We hope that this cooperation will be more and more profound within the framework of the committee that was set up in London last October. The first working meeting is going to take place on the 4th and 5th of February in Rome. We have been informed, and we are sure that we will be able to start a dialogue with many European countries, thanks to the work of this committee, and we will be able to deal with many research problems which are absolutely indispensable. We must deal with these problems if we are to prepare an ESV that is truly valid.

We are really aware of the practically inseparable

difficulties that we will have to come to grips with. This is a true challenge, and we are determined, if you like, to pick up the gauntlet, and we intend to do all we can. We are sure that this meeting will enable us to progress in our work, which concerns road safety, and more specifically the Experimental Safety Vehicle. We support the cooperation which will undoubtedly be necessary between the various governments and the various automobile industrialists, research institutes, consumer organizations, et cetera. I am sure that thanks to this cooperation, we will find satisfactory solutions to our safety problems, and, hopefully, in the very near future.

On behalf of the Italian government, I would like to thank the French government and the administration who invited us to Paris. The French government indeed is cooperating actively with a view to having a successful meeting.

I would also like to thank the United States government. After all they did initiate this idea, and we do hope that the meeting is going to be crowned with success. We hope that it won't just be an isolated initiative but that it will establish a precedent so that in the future we will have many meetings to deal with the gigantic task that we are confronted with.

We hope that the problems will be solved in unison, and not in isolation, that we will all come together because, after all, this is a problem which concerns humanity.

OPENING REMARKS

MR. LISTER,
Department of Environment

UNITED KINGDOM

The United Kingdom representatives appreciate the opportunity to attend this meeting on the Experimental Safety Vehicle, and to discuss problems on vehicles' safety with those working in this field.

Roads to safety in all its aspects has long been given consideration in the United Kingdom, and over the years has resulted in many important regulations, not only controlling vehicles, but affecting traffic and all the environment.

Pedestrian crossings and speed limits in towns were introduced as long ago as the 1930s. However, we believe that road safety measures should be applied over a wide front. That is not only the vehicle aspect, and that priority should be given to those fields likely to give the best results on a cost effectiveness basis.

This particular tool, you might say, as well as being a valuable method of determining the division of effort and expenditure between the different kinds of safety measures that can be adopted, cost effectiveness can be used to assess the relative value of the various car design safety features.

Diminishing returns when several design changes are introduced, may show that some changes are not really justified.

The pattern of road casualties in the United Kingdom which we believe is comparable with other European countries, is different somewhat from the American pattern in that a much higher proportion of casualties in the United States occur to car occupants.

Because of these differences, we can understand the greater emphasis that the United States places on the protection of car occupants. Nevertheless, the importance of vehicle design and construction is recognized, and certain features of vehicle design which affects the safety have been controlled by our construction/use regulations for a very long time.

The added emphasis given to this side of vehicle safety work by the American initiative in the Experimental Safety Vehicle is therefore very welcome.

The United Kingdom considers that an alternative to building Experimental Safety Vehicles incorporat-

ing many new ideas together is to develop car features separately in practical engineering terms, and to carry out assessment of these features in isolation.

The interaction of the individual features would, of course, have to be considered.

We are adopting this method in developing a safer vehicle, and in our exchanges with the United States. We believe that it is important for the motor industry itself to participate in the development of safety features in order to develop the expertise and to facilitate the introduction of safe designs into production vehicles.

We also have in mind that in the development of vehicle features it is very important not to restrict design innovation. However, uniformity of regulations on an international basis is vital to keep down the costs.

It is hoped that this uniformity will be facilitated by arrangements that are already in existence, and by the intergovernmental exchange that has been agreed to in this safety program.

Thank you.

OPENING REMARKS

MR. BASTIAANSE, *Director*
CENTRAL ORGANIZATION FOR
APPLIED SCIENTIFIC RESEARCH

THE NETHERLANDS

Thank you very much for the opportunity to discuss safety problems. We have the facilities to carry out tests intended to investigate crash helmets, seatbelts, wind screens, instrument panels and, if necessary, air bags.

Furthermore, we investigate with other institutes, accidents from the technical and the bio-mechanical points of view.

I believe we experience about 10,000 crashes a year. In our opinion, it is not possible to create a new safety car development without the information derived from accident analysis studies. We can study all kinds of mathematical collisions but only the real accident will and can give the necessary information, especially from the bio-mechanical points of view.

If you would like to know more about our activities, this information is available. Probably we will have the opportunity later during the discussions.

We thank the French delegation for their hospitality.

Thank you very much.

OPENING REMARKS

MR. GUSTAV EKBERG,
Chief of the Vehicle Bureau

SWEDEN

Mr. Chairman, ladies and gentlemen. We welcome the opportunity to participate in these discussions. We are convinced that it will be of very great help to us to create a better vehicle which will have a great influence on the safety standards to reduce traffic accidents.

You may know that Sweden has followed the American standards with great interest, and I may say that Sweden was one of the first countries in Europe to introduce a great deal of the American standards. However, for a small country it is rather difficult to make special rules, and therefore, I think it is extremely important to bring such questions to an international level.

We have therefore taken a very active part in the work being done within the United Nations, namely WP-29 in Geneva, the work of which we think is extremely important.

The question of an Experimental Safety Vehicle is nevertheless of other dimensions, and it is necessary to join the effort of different countries if we are to achieve the goals of this program.

There may be some difficulties for Sweden to join this work, because we are not a member of the NATO organization. But nevertheless, I think it will be possible, and I hope it will be possible to find a way to take an active part in this very important work.

Thank you, Mr. Chairman.

OPENING REMARKS

MR. DE KOSTER

BELGIUM

Mr. Chairman, gentlemen, I don't intend to speak at great length. I am just an observer here today.

My country, after all, does not produce automobiles. It is more specialized in the assembly of cars. Nevertheless, it was with very great interest that I heard the proposal made by the United Kingdom. That is to say that we should deal with a number of components of a car, because after all as we are not car producers, we cannot deal with the overall problem. But nevertheless, we could participate in the production and the examination of specific parts.

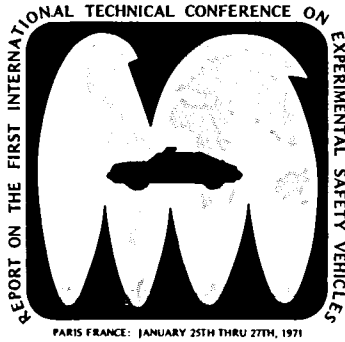
Thank you very much.

OPENING REMARKS

MR. BELL, *Executive Engineer*,
DEPT. OF SHIPPING
AND TRANSPORTATION

AUSTRALIA

Thank you for the welcome, Mr. Chairman. I do not intend to say many words. I am here to observe, and again, I thank you.



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section 2 part 1

The United States Technical Presentations

THE UNITED STATES ESV PROGRAM- OVERVIEW

JOHN A. EDWARDS, *Acting Associate
Administrator for Research and Development,*
U.S. Department of Transportation,
National Highway Traffic Safety Administration

UNITED STATES

Fellow conferees:

I and my staff welcome this opportunity to discuss with you the Experimental Safety Vehicle Program now underway in the United States. We also welcome this opportunity to begin the establishment of those working relationships which are so necessary for success in the months and years ahead. We are indeed delighted with the interest shown in this important exchange of technology to improve worldwide automotive and highway safety and recognize that to be successful, an international effort of this nature must start within a framework of full, mutual understanding. Today, I will briefly discuss the U.S. Experimental Safety Vehicle program as presently structured and then introduce members of my staff for more detailed discussions.

The U.S. Experimental Safety Vehicle Program

The purpose of the ESV Program is to test, on an experimental basis, new ideas of automotive safety incorporated in a vehicle which has been designed, fabricated, and tested as a total system. The basic objectives of this program are to determine the technical feasibility of making significant safety performance improvements in motor vehicles, to stimulate public awareness of the long-term social and economic advantages to be gained from the savings of lives and injuries resulting from advanced auto safety design, to encourage the industry to

increase its efforts in auto safety design and, finally, to establish the technical base for the development of improved motor vehicle safety standards.

The ESV passenger car program which we envision is designed to bring about the development of a number of vehicle classes which together span the spectrum of passenger cars on the road today. These vehicles will be designed to weight and passenger space configurations similar to today's production vehicles so that the unique problems associated with each may be solved. The first vehicle class, the 4000-pound, 5-passenger sedan, is a project in full operation. This maiden project under sponsorship of the U.S. Government is progressing well toward its goal of prototype delivery in December 1971. Detailed progress and specifications for this project will be discussed by Mr. Slechter in a few moments.

In addition to this project, three others are believed necessary to cover the full range of popular passenger cars. These are: the Intermediate Sedan - 3000-pound class, the Compact - 2000-pound class, and the Subcompact - 1500-pound class.

Each of these vehicle classes pose unique problems that must be investigated to assure the ultimate establishment of reasonable safety performance standards for all passenger vehicles. For each project, we would hope that the design concept employ a total systems approach and thus provide the optimum trade-offs between accident avoidance, crash-injury reduction, and post-crash factors.

Obviously, however, the development of safe automobiles in these various vehicle weight classes cannot be accomplished without consideration of the inter-relationships between the classes themselves. On the other hand development cannot wait for the completion of a long series of highly complex "studies" before proceeding. The process is interactive, the technology is largely at hand, and the simple awareness and reasonable consideration of other weight class vehicles is sufficient for us to proceed.

We have, as will be brought out later, given the "big car-little car" crash consideration in the development of our 4000-pound sedan specifications.

We have planned the passenger car ESV program to meet the previously stated objectives through a series of steps which demonstrate significant progress at the earliest possible date. Accordingly, near-term goals have been selected that we believe are reasonable to achieve, yet represent potential substantial savings in highway losses based on our present accident experience.

We believe that crashworthiness must now receive the highest priority in all passenger type safety

vehicles because of the overriding cost effectiveness advantage that is available from initial improvements in this area. As those of you who have reviewed our current specifications are aware, the emphasis in our 4000-pound program is on crashworthiness. Accordingly, near-term goal of crashworthiness in front barrier collisions at 40-50 mph has been selected because a significant portion of frontal injury producing accidents occur at or below this velocity range. In addition, this velocity range provides a logical intermediate milestone on the way to an ultimate examination of feasibility for safety in crashes in the 60-70 mph range.

For the U.S. 4000-pound project, current state-of-the-art vehicle handling characteristics have been selected as the immediate goal because the potential for substantial savings in lives and injuries in this area has not been quantified to a sufficient degree. In addition, the lead time required for exploration of significant improvements in safe handling could compromise the short-term crashworthiness improvement program. Long-term goals do without question require improvements in this area.

Vehicle weight and body style were also a major consideration in the selection of near-term and long-term goals. The family or standard sedan was chosen for initial investigation by the U.S. because of its high usage rate in our country and because conceptual studies indicated that a higher degree of safety could be demonstrated in the shortest design and development time (as I indicated a moment ago we will take initial delivery of 2 competing prototypes at the end of this year).

The development and demonstration of the 40-50 mph family sedan will be followed as soon as possible by development of an intermediate vehicle of the 3000-pound weight class with crashworthiness capability for 40 to 50 mph. This vehicle will not be limited to a front-engine design. Indeed, it may be necessary to go to a mid-engine design to allow space in front for the required crashworthiness hardware. We anticipate starting initial design efforts in the immediate future.

The second major step in the passenger car program is now being initiated with your efforts in the lighter weight vehicle class. These vehicles, while representing less than ten percent of the vehicles on U.S. roads, account for a disproportionately high number of traffic deaths in our country. In addition, the number of small vehicles in the 1500-2500-pound weight class on American roads is rapidly increasing, and approximately 15% of our present market is of foreign manufacture. Competitive automobiles in this category are being introduced by American manufacturers, and this will further increase the percentage of small vehicles on our highways. For these reasons, the special problems associated with providing safety protection for small car occupants will be prominent in our research activities and rulemaking deliberations in the seventies.

The trade-offs associated with the probable introduction of increasingly large numbers of small cars into the U.S. transportation system are being considered. We are all aware of some of the economic and ecological advantages of the small car from both the individual consumer and the general public's standpoint. However, these advantages must be weighted carefully against the inherent penalty that the small car occupant pays in reduced safety when he is involved in a collision with a larger vehicle. We are approaching the problems associated with the larger vehicles in our Family Sedan Project and are hopeful that the design solutions resulting from that project will partially alleviate the small car's disadvantage in a big car to small car collision. This is being achieved through the incorporation of velocity sensitive front-end crash systems that reduce crash forces in the small car when struck by the larger car.

The U.S. Government is obviously delighted with the interest shown by the countries represented here today, and particularly with the Federal Republic of Germany and the Government of Japan who have formally entered into cooperative agreements with the U.S. The expertise of your Governments and industry lends a new dimension to the ultimate

optimization of safety design in the small car.

I would like to interject that our programmatic goals include safety research which will develop and demonstrate increased safety performance in trucks, buses and other specialized vehicles, thereby providing valuable performance data for the total vehicle population. Our research activity is not limited to passenger class automobiles.

I would like to conclude my remarks today by repeating my welcome to all of you to join with us in the design and development of safer automobiles. Certainly the challenge is a worthy one which warrants the very best effort from each of us. Technology has given us the necessary tools. We must put these tools to work to accomplish the design breakthroughs which will reduce the numbers of accidents and injuries, and help eliminate vehicle occupant deaths even in crashes at high speeds. We welcome your participation and the clearly demonstrated expertise which you bring to the task at hand.

Mr. Albert Slechter will now discuss the major specification requirements and progress to date of the 4000-pound family sedan.

**THE UNITED STATES 4000 LB.
EXPERIMENTAL SAFETY VEHICLE-
PERFORMANCE SPECIFICATION**

ALBERT SLECHTER,
*Acting Assistant Director, Office of
Experimental Safety Vehicle Programs,*

U. S. Department of Transportation
National Highway Traffic Safety
Administration

UNITED STATES (Morning Session)

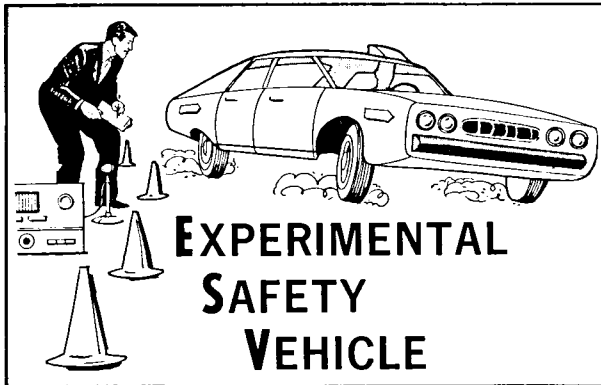
Good Morning Gentlemen. I would like to take this opportunity to say how delighted I am that events of the past six months have led to our being here in Paris for this particular meeting. Speaking for the members of the project office of the U.S. ESV, we have been anxious to participate in detailed technical discussions for the subcompact ESV and to elaborate on some of the basic foundations underlying our specifications for the 5 passenger sedan ESV. It is hoped that through my presentation today, and through panel discussions in the next two days, we may successfully communicate the intent of our specifications, participate in a free technical dialogue, and thereby assist in providing a foundation for the development of a final Subcompact ESV specification.

Before I begin, may I introduce several members of the U.S. delegation who are present for this meeting. First, Mr. Edward Chandler of the U.S. DOT project office who will represent the U.S. in the panel on crashworthiness tomorrow. Second, Mr. Fran DiLorenzo, also of the U.S. DOT project office, who will participate in the panel for vehicle ride and handling and other accident avoidance systems. Both of these gentlemen have been associated with the U.S. ESV project since its beginning. Also in attendance are several U.S. ESV contractor representatives who have been invited to attend this meeting as observers. First, Mr. William Larson, the Program Manager for Experimental Safety Vehicles

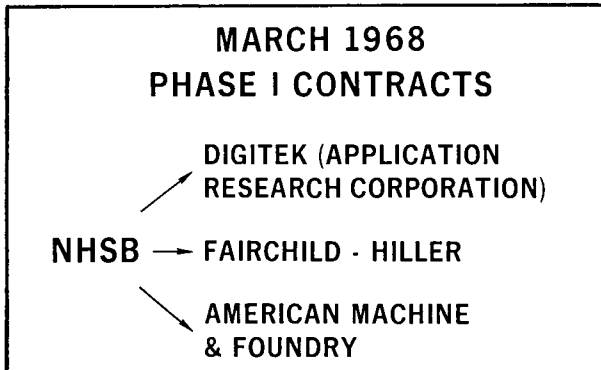
from the General Motors Corporation. Second, Mr. Alan Roth, Director of the Advanced Systems Laboratory and ESV Program Manager for AMF, Incorporated.

My presentation today will consist of two basic parts. First, I will give a brief overview of the U.S. ESV project including key milestones in its planning and our status at this time. Then I will discuss each of the major U.S. ESV specifications including the rationale behind the specification and any other information I believe important to the proper understanding of the specification intent. Where possible, I will give an opinion concerning applicability of each specification to the subcompact ESV. (SLIDE 1)

Slide 1



Slide 2



¹Estimating the Effects of Crash Phase Injury Countermeasures, H. C. Joksch and H. Wuerdemann, The Travelers Research Corp., Final Report on NHTSA Contract FH-11-7228, March 1970.

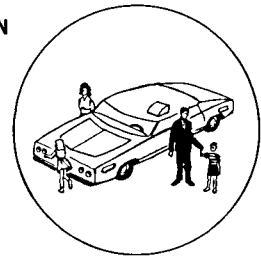
²Final Report on NHTSA Contract FH-11-7228. March 1970

Overview of U.S. Family Sedan ESV

(SLIDE 2) Extensive conceptual and design trade-off studies were conducted for the DOT in the 1968-69 period by three independent contractors. The results of these studies were analyzed by the U.S. ESV Project Office, and an independent evaluation was further provided by another research contractor, the Battelle Memorial Institute. The primary conclusions were (SLIDE 3) (1) that the U.S. should embark first on a typical family sedan ESV project, recognizing the overwhelming popularity of this model in the U.S., and (2) that crashworthiness, the minimization of injury to occupants in crashes, should be given top priority. (SLIDE 4) In mid 1970, after an extensive review of proposals to design the safety car, contracts were awarded to Fairchild Hiller, AMF Incorporated, and the General Motors Corporation for the development of prototype experimental safety vehicles of the family sedan weight class. All of the contractors are designing to the same system performance specification which requires the application of total systems engineering (SLIDE 5) to provide the optimum trade-offs between accident avoidance, crash-injury reduction, post-crash factors, and pedestrian safety. The principal contractors, plus their subcontractors, have a balance of experience which we believe will assure the development of vehicles that will meet the requirements of our specification and the overall goals of our program.

PHASE I - KEY CONCLUSIONS

- FULL SIZE FAMILY SEDAN
 - VEHICLE POPULATION AND USAGE
 - ENERGY MANAGEMENT ADAPTABILITY
 - LIMITED RESOURCES
- TOP PRIORITY TO CRASHWORTHINESS



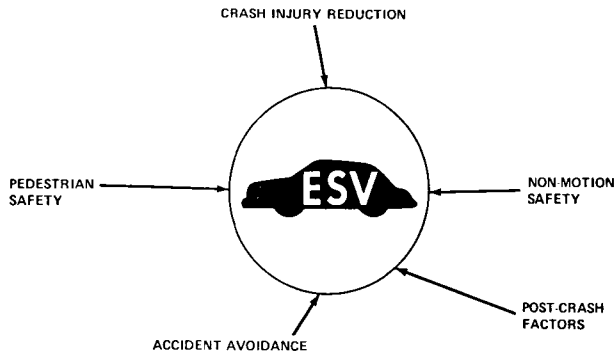
Slide 3

SELECTED PRIME CONTRACTORS

- FAIRCHILD HILLER
- AMERICAN MACHINE & FOUNDRY
- GENERAL MOTORS

Slide 4

Slide 5



Slide 6



Slide 7

FAIRCHILD HILLER TEAM	
CHRYSLER CORPORATION	<ul style="list-style-type: none"> • PARTS SUPPLY (POWER TRAIN/RUNNING GEAR) AND DESIGN ASSISTANCE
DIGITEK CORPORATION	<ul style="list-style-type: none"> • ANALYSES AND MODIFICATION OF BRAKING AND RUNNING GEAR
RAYMOND LOEWY/WILLIAM SNAITH, INC.	<ul style="list-style-type: none"> • EXTERIOR AND INTERIOR DESIGN

(SLIDE 6) General Motors Corporation, is participating under Government contract for the token sum of one dollar, while contracts for Fairchild Hiller and AMF, Incorporated total about 8 million dollars. (SLIDE 7) Fairchild Hiller is one of America's major aerospace contractors and is applying the latest aerospace technical knowledge and engineering skill to their design. Principal subcontractors to Fairchild Hiller are the Chrysler Corporation, Digitek Corporation, and Loewy/Snaith, Inc.) (SLIDE 8) AMF Incorporated has extensive commercial and defense business experience and has as major subcontractors Mini-Car, Inc., Bendix Research Laboratories, Pioneer Engineering and Manufacturing Company and Cornell Aeronautical Laboratories.

(SLIDE 9) Four major objectives have been assigned to the U.S. ESV Program which, as Mr. Edwards has discussed, includes the complete range of passenger car weight classes, as well as one or more special purpose vehicles. The objectives are:

1. Demonstrate the feasibility of advanced automobile safety performance features through design, fabrication and testing of experimental vehicles.
2. Stimulate public awareness of the injury reduction potential and associated economic advantages of advanced auto safety design.
3. Encourage automobile industry to increase efforts in auto safety design.
4. Apply program results to development of new, improved motor vehicle safety standards.

From these overall objectives, more specific objectives were assigned to the 4000-pound class family sedan. These objectives are: (SLIDE 10)

1. To demonstrate crashworthiness for front collision into a fixed barrier at 40-50 mph velocities.
2. To minimize injurious forces in side, rear, and rollover collisions.
3. To provide riding and handling equal to or better than the best of today's sedans, and
4. To demonstrate advanced state-of-the-art braking, lighting, visibility, controls and display systems.

Design/Fabrication Plan and Progress

(SLIDE 11) The Schedule for the U.S. ESV Family Sedan project allows one year to produce the final design which is due to be complete in June 1971. Preliminary designs scheduled for March 1971 are nearing completion. Prototypes from Fairchild Hiller and AMF will be delivered in December 1971, or eighteen months from the award of contract.

(SLIDE 12) Upon delivery to the DOT of the AMF and Fairchild Hiller prototype vehicles, a competitive "drive-off" test and evaluation will be conducted. A follow-on contract for 12 additional test vehicles will be awarded to that contractor whose ESV prototype demonstrates the best overall safety performance. Follow-on vehicle deliveries will begin in September 1972.

General Motors requested that they be allowed more time to conduct necessary design evaluations and development testing. Therefore, GM will complete their design in October 1971, and deliver their prototypes to DOT in September 1972. The duration of the GM program is therefore 28 months. General Motors' prototypes, when delivered in October 1972, will undergo a similar extensive testing program.

Slide 8

AMERICAN MACHINE AND FOUNDRY TEAM

MINICARS, INC

- STYLING AND ENGINEERING SERVICES

BENDIX RESEARCH LABORATORIES

- BRAKING AND STEERING ASSEMBLIES
- SERVICES FOR INTEGRATION AND PERFORMANCE CHECKOUT OF PROTOTYPES

PIONEER ENGINEERING AND MANUFACTURING CO.

- FABRICATION OF PROTOTYPE VEHICLES
- FABRICATION OF STRUCTURAL TEST BEDS

CORNELL AERONAUTICAL LABORATORIES

- TESTING OF THE STRUCTURAL TEST BED

Slide 9

EXPERIMENTAL SAFETY VEHICLE PROGRAM OBJECTIVES

- DEMONSTRATE THE FEASIBILITY OF ADVANCEMENTS IN AUTOMOTIVE SAFETY PERFORMANCE
- STIMULATE PUBLIC AWARENESS OF THE INJURY REDUCTION POTENTIAL AND ASSOCIATED ECONOMIC ADVANTAGES OF ADVANCED SAFETY DESIGN
- ENCOURAGE THE AUTOMOTIVE INDUSTRY TO INCREASE ITS LEVEL OF EFFORT IN SAFETY RESEARCH TO ACCELERATE THE INTEGRATION OF ADVANCED SAFETY SYSTEMS
- APPLY DATA FROM THE TESTING OF EXPERIMENTAL VEHICLES TO THE DEVELOPMENT OF NEW MOTOR VEHICLE SAFETY STANDARDS

Slide 10

4000-POUND SEDAN

MAJOR OBJECTIVES

- DEMONSTRATE CRASHWORTHINESS FOR FRONT COLLISION AT 40-50 MPH
- MINIMIZE INJURIOUS FORCES IN SIDE, REAR, ROLLOVER COLLISIONS
- PROVIDE HANDLING ON PAR WITH EXISTING SEDANS
- DEMONSTRATE ADVANCED BRAKING, LIGHTING, VISIBILITY, CONTROLS, AND DISPLAY SYSTEMS

Slide 11

4000-POUND SEDAN

DESIGN/FABRICATION PLAN

- CONTRACTS AWARDED 1 JULY 1970 FOR COMPETING PROTOTYPES
- FINAL DESIGN COMPLETE—JUNE 1971
- PROTOTYPE DELIVERY—DECEMBER 1971

Slide 12

4000-POUND SEDAN

DESIGN/FABRICATION PLAN

- AWARD DECISION FOR FOLLOW-ON VEHICLES—MAY 1972
- FOLLOW-ON (12) VEHICLES DELIVERED ON 2 WEEK CENTERS STARTING SEPTEMBER 30, 1972
- GM PROTOTYPE DELIVERY—OCTOBER 1972
- GM FOLLOW-ON VEHICLES—DECISION TO BE MADE

Test Plan

(SLIDE 13) The ESV contract requires that all three contractors submit recommended test plans for prototype evaluations and for follow-on vehicle testing. These recommended test plans were received as scheduled during December 1970. In conjunction with this effort by the prime contractors, we have, as part of our Supporting Research Program, contracted for independent work in devising a crash test plan. A report of this independent research was also received in December 1970. With these four major test recommendation inputs, DOT is now in the process of developing the test plan which will serve as a basis for testing of the prototypes by an independent test contractor. To complete our scheduling, DOT will award a testing contract to an independent test firm in June 1971. (SLIDE 14) This test contractor will have six months from June to December 1971 to prepare facilities and conduct the necessary baseline tests in preparation for prototype testing. Testing of the 12 additional vehicles and the General Motors prototypes will carry over into late 1973. However, during the testing period, DOT will continuously assess the test results as they become available to determine what rulemaking recommendations are appropriate. It is hoped that the programs of Germany and Japan can be structured to provide major test results in the same time frame.

Crashworthiness Specifications

(SLIDE 15) The development of enhanced crashworthiness has been given first priority on the Family Sedan Project. This priority designation, was based on a number of considerations. (SLIDE 16) From a cost effectiveness standpoint, we believe the expenditure of resources on crashworthiness will provide a larger return in lives saved at an early date, since much of the structural design technology required had been developed in other fields prior to 1968. Therefore, much of the required development effort can be devoted to adaptation of existing concepts to automotive applications. Designing the total vehicle structure for increased crashworthiness led us naturally to the concept of a total systems approach for our program.

Slide 13

4000-POUND SEDAN

TEST PROGRAM PLAN

- TEST FACILITIES PREPARATION AND BASELINE TESTS COMPLETE – DECEMBER 1971
- PROTOTYPE TESTING COMPLETE – MARCH 1972
- FOLLOW-ON VEHICLE TEST PROGRAM – OCTOBER 1972 – SEPTEMBER 1973
- GM PROTOTYPE TESTS – NOVEMBER 1972 – FEBRUARY 1973

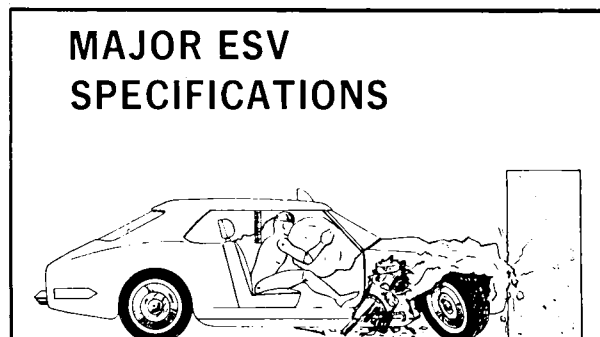
Slide 14

4000-POUND SEDAN

TEST PROGRAM PLAN

- CONTRACTOR RECOMMENDED TEST PLANS – DECEMBER 1970
- TEST METHODOLOGY RESEARCH REPORT – DECEMBER 1970
- NHSB SYNTHESIS AND DEVELOPMENT OF TEST PLAN FOR PROTOTYPES – MARCH 1971
- TEST CONTRACT(S) AWARD – JUNE 1971

Slide 15



The Phase I concept formulation studies discussed earlier were unanimous in showing the feasibility of designing and fabricating vehicles with capabilities in, or beyond, the crash injury reduction performance range that has been specified for the family sedan ESV. Our problem in specifying performance resolved itself, then, to choosing those performance characteristics that appeared most promising within the budget and schedule constraints that exist on the program. Within this framework, we applied the primary criterion of near-term potential for saving lives, supplemented by the secondary criterion of developing a performance data base for making longer term decisions with broader applications to our total traffic system. In other words, the Family Sedan specifications are aimed toward, first, developing a car that will provide greatly improved protection for its occupants during crashes; and, second, providing from its tests a data base for specifying and designing a car which will inflict minimum damage to the occupants of other cars which it strikes. We have specified occupant survivability in crashes and velocities as shown on Slide 17.

In its simplest terms, good crashworthiness performance involves reducing, to a minimum, crash-induced forces that constitute a threat of serious injury or fatality to any vehicle occupant. An immediate complication is that the limits of human tolerance to injury are not precisely known in many cases, particularly in the lateral and vertical directions. It was, therefore, necessary to choose human tolerance values based on the best available research information and proceed with specifying performance for the first generation of safety vehicles. Further research will improve our knowledge of human tolerances to injury but it is expected that any changes will be in degree, rather than in basic concepts and that the foundation laid by the Family Sedan specifications will serve as the broad basis for the design of more effective and safer vehicles.

In order to obtain basic data on the interaction of various components and structural subsystems, the vehicle is somewhat arbitrarily divided into six subsystems for purposes of specifying crash perform-

ance. It is recognized that there are interdependencies from subsystem to subsystem but precedence is to be given to the solution that provides the best overall occupant crash-injury reduction. An additional important reason for individual subsystem structural specifications is to provide better data on the interaction of the front of the safety vehicle with the front, rear and sides of other vehicles, including vehicles which are both larger and smaller.

A further important requirement relates to the tremendous economic losses our country experiences in low-speed collisions because of vehicle damage. While not directly related to occupant safety, it was concluded that providing front and rear low-speed crash protection for the vehicle up to 10 mph impact velocities was not incompatible with our major aims. Therefore, this requirement was made a part of our specifications.

Slide 16

PRIORITY RATIONALE	
1. COST EFFECTIVENESS	
2. TECHNOLOGY AVAILABILITY	
3. APPLICABILITY OF SYSTEMS APPROACH	

Slide 17

CRASHWORTHINESS		
SURVIVABLE CRASHES		
	MPH	
	CAR-TO-CAR	SINGLE CAR
FRONT AND REAR CRASHES	75	50
SIDE	30	15
ROLLOVER		60-70

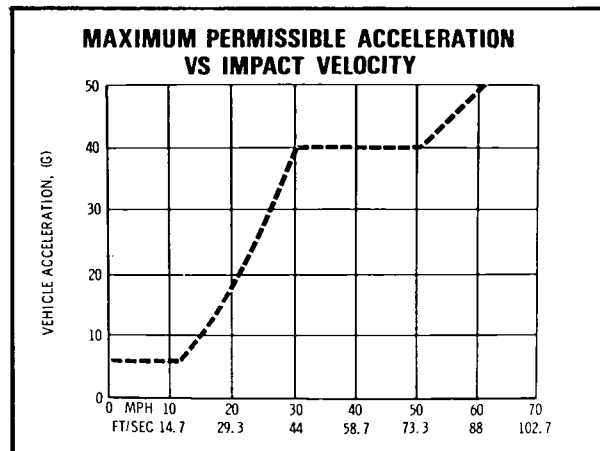
Front Bumper Specification

Since the front of the vehicle is involved in more than half of the crashes which occur in our country, we specified the front bumper/front vehicle structure subsystem performance in three impact velocity regimes as shown. (SLIDE 18) The low-speed impact region of this curve, 0 to 10 mph, covers the no damage requirement for the front end. A "6 G" maximum deceleration is specified to minimize the effects of these low-speed impacts on the occupant. The second portion of the curve from 10 to 30 mph sets the maximum rate at which the deceleration of the vehicle can increase as the impact velocity increases. The third regime, covering impact velocities from 30 to 50 miles per hour sets a maximum permissible deceleration for this range of impact velocities. It is important to recognize that the specified decelerations are maximum allowable values, with provisions for short-term spikes not shown on the slide. Actual performance of the vehicle should be below these values to the greatest extent possible, particularly in the intermediate impact velocity region from 20 to 40 mph. It is in this intermediate velocity range that we believe there is a special challenge to reduce forces on the occupants. This challenge applies, first to protecting the occupants of the striking vehicle, whether the frontal impact is with a fixed object or with another vehicle. Of equal challenge, we believe it is possible, by proper design of the striking vehicle, to alleviate the severity of the crash to the struck vehicle in car-to-car crashes, particularly if the striking vehicle is the larger of the two cars. The importance of this possible alleviation is apparent when we note that in the U.S., substantial numbers of deaths that occur in collisions classified as frontal collisions occur in the struck vehicle whether it be hit in front, side, or rear.¹ The front bumper specification was established as the best overall compromise of allowable acceleration forces over the total speed range to 50 mph with due regard for both the striking vehicle and the struck vehicle.

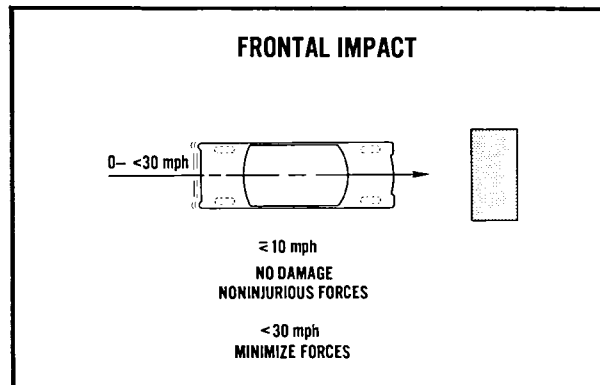
(SLIDE 19) Here we show our requirements for low-speed frontal impacts. As mentioned earlier, we hope to eliminate vehicle damage below 10 mph without undue discomfort to the occupants. We also believe we can minimize forces on the occupants in the range from 10 to 30 mph as well as reducing damage to the struck vehicle. This is the region of the curve shown earlier in which

$\frac{dG}{dV_{\text{impact}}}$

has a positive slope indicating velocity sensitivity in the subsystem. Note that the specification does not require that the velocity sensitivity be confined to the 10 to 30 mph impact velocity range. In fact, the specification allows velocity sensitivity over the complete range from 0 to 50 mph, but only requires it, at a minimum, over the 10 to 30 mph range. The next two slides depict frontal 50 mph rigid (SLIDE 20) flat barrier impact, and pole (SLIDE 21) impacts. For these impacts, at the maximum velocity specified, 50 mph, we hope to keep the forces on the occupant in the survivable range and maintain passenger com-

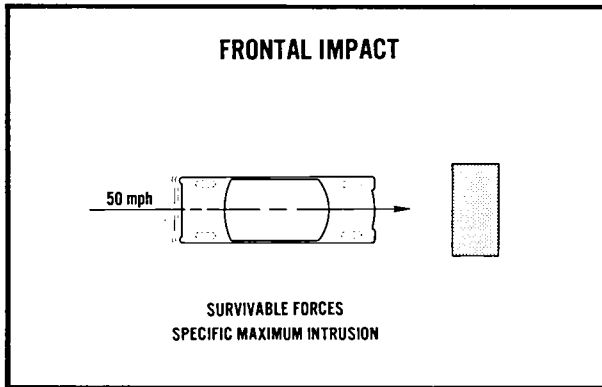


Slide 18

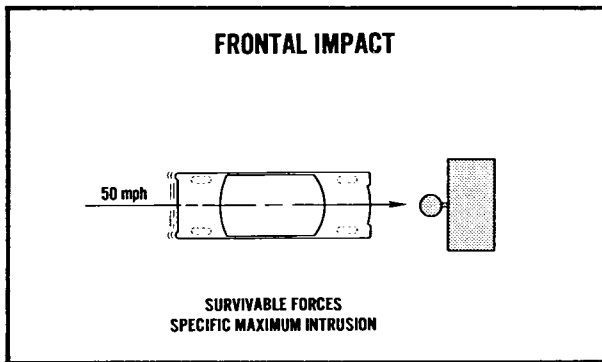


Slide 19

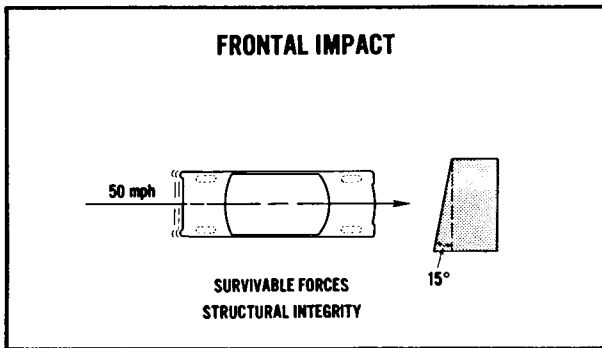
partment integrity within the 3-inch intrusion limit specified. Here we show frontal impacts at 15 with a (SLIDE 22) flat rigid barrier and a (SLIDE 23) pole.



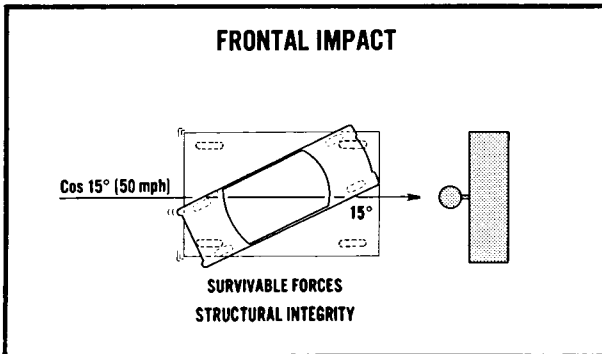
Slide 20



Slide 21

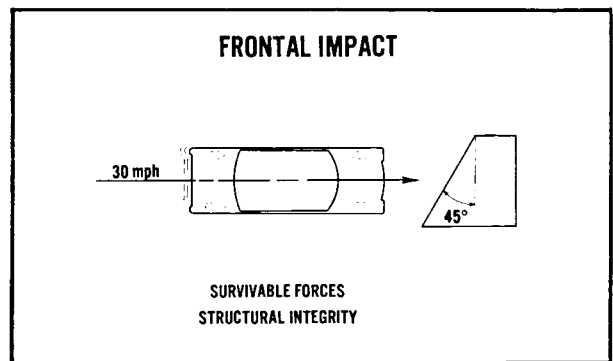


Slide 22

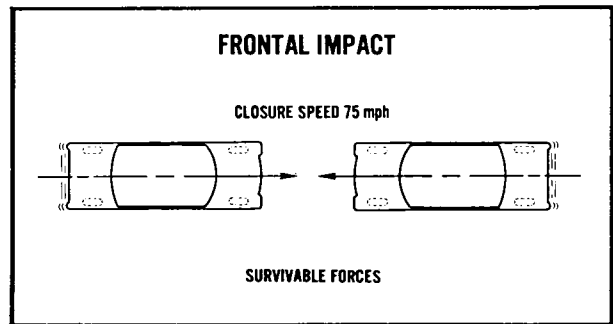


Slide 23

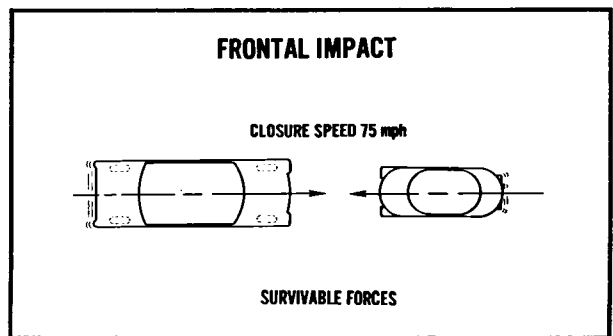
Our goals for these crash conditions are identical with the 90° specifications just stated. In addition, the 15° crashes will provide a more severe test of our bumper alignment requirements, particularly in the lateral direction. (SLIDE 24) This illustrates an even more severe angular impact at 45° to further test the bumper stability as well as occupant protection. In this case, the impact velocity has been reduced to 30 mph. The final test for the front subsystem consists of car-to-car impacts at 75 mph as shown here. (SLIDE 25) Our goals are basically the same as for the other collisions, but since the test will be less reproducible than the others, more emphasis will be placed on occupant interactions with the vehicle. (SLIDE 26) We are also concerned about the collision between large and small cars and believe the front bumper specification is a good compromise with respect to this condition in all collision modes.



Slide 24



Slide 25



Slide 26

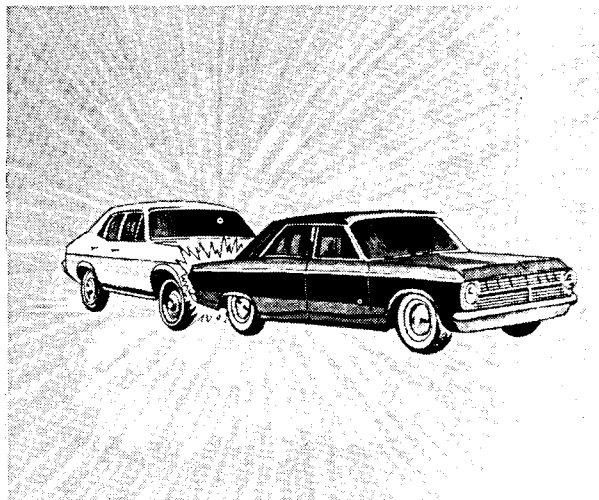
Rear Bumper Specifications

(SLIDE 27) While less important from the standpoint of fatalities, rear impacts are frequent in our traffic system with a large contribution to human impairment and misery as well as extensive vehicle damage. Space is available in the rear of our automobiles for the installation of energy absorbing subsystems utilizing concepts similar to those that must be developed for the front. Therefore, we have specified impact velocities for the rear of the automobile that are the same as those specified for the front. There is, however, one important difference. A 4000-lb. moving barrier has been specified for all crash tests from the rear, as shown (SLIDE 28) rather than the fixed rigid barrier that is specified for frontal impacts. Dynamically, this is a very different situation. It can be approximated for an automobile weighing 4000 pounds as a reduction in fixed barrier impact velocity to 70% of the moving barrier velocity. (SLIDE 29) Our goals for the rear are otherwise the same as for the front, i.e., low forces on the occupants and structural integrity.

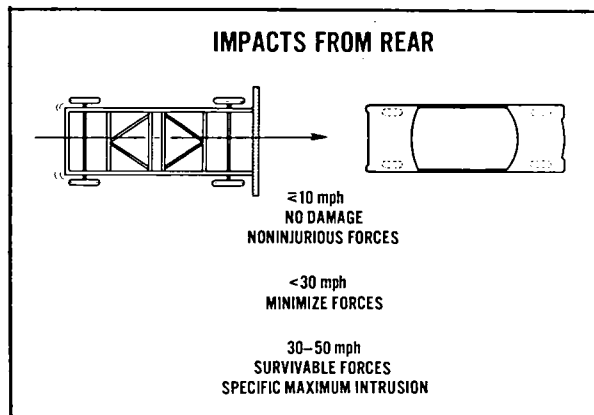
Side Structure Specifications

Side impacts impose extremely severe conditions from the standpoint of crashworthiness. We are all aware of the paradox that exists in lateral collisions. In order to attenuate impact forces and absorb energy, we must use distance. On the other hand, very little distance is available without intrusion of the passenger compartment. To further complicate the problem, the human tolerance to lateral impacts appears to be lower than the tolerance to longitudinal impact. Recent research performed under contract to DOT² indicates that while the frequency of fatality producing side impacts is only $\frac{1}{4}$ the frequency of frontal collisions, the number of fatalities in side impacts is nearly the same as for frontal collisions. Our approach to this extremely difficult problem has been to maintain passenger compartment integrity and to attenuate occupant forces to the extent possible inside the passenger compartment for both (SLIDE 30) rigid obstacle and (SLIDE 31) car-to-car collisions. In addition for car-to-car collisions, we hope to attenuate the impact forces in the front of the striking automobile, as discussed earlier.

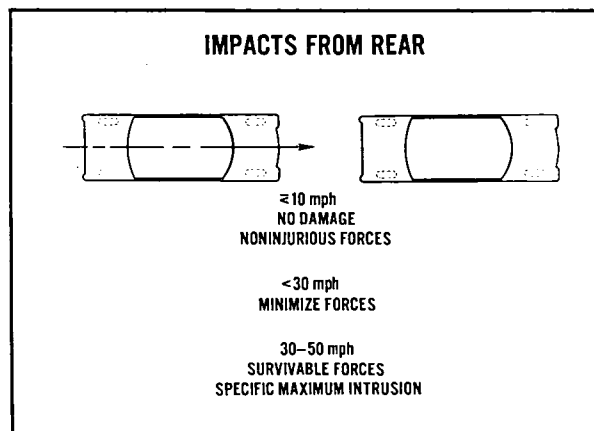
Slide 27



Slide 28



Slide 29



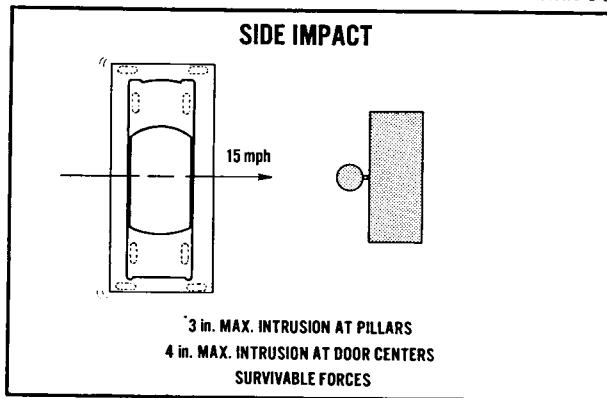
Rollover Specifications

(SLIDE 32) Protection from rollover poses another extremely difficult problem. According to our U.S. data, rollovers cause more fatalities than any other accident mode even though they occur much less frequently than frontal collisions. Our approach to this problem has been to specify passenger compartment integrity and attempt to keep the occupant in the car since more than half of the rollover induced fatalities are caused by ejection.

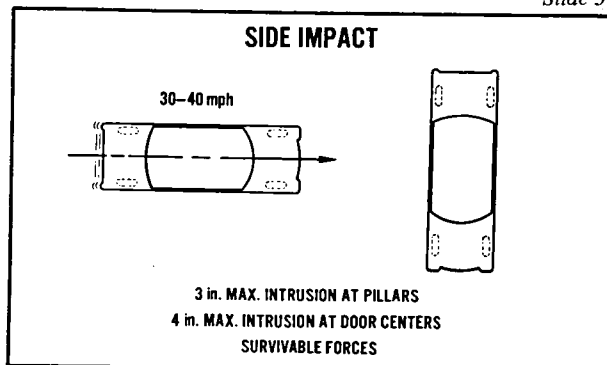
Interior Design Specifications

The U.S. approach to interior specifications is to provide occupant protection without restraints to the highest practical impact velocity change. (SLIDE 33). Shown here are some of the concepts that we chose. With regard to protrusions, a very small breakaway force was specified to encourage the recessing of controls. A 20 mph velocity change was specified to provide adequate protection with padding at a speed well above the deployment velocity if inflatable restraints are used. Sixty G's were specified as a maximum requirement for the forward deceleration of the occupant. Lateral, vertical and rearward decelerations are given as objectives in the contracts rather than as requirements and the values given for them are very conservative.

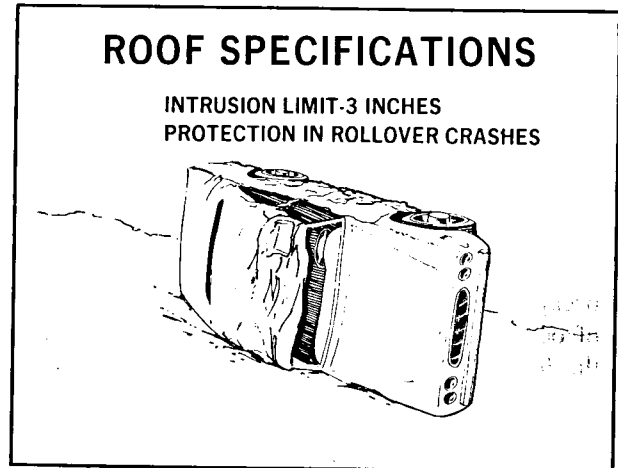
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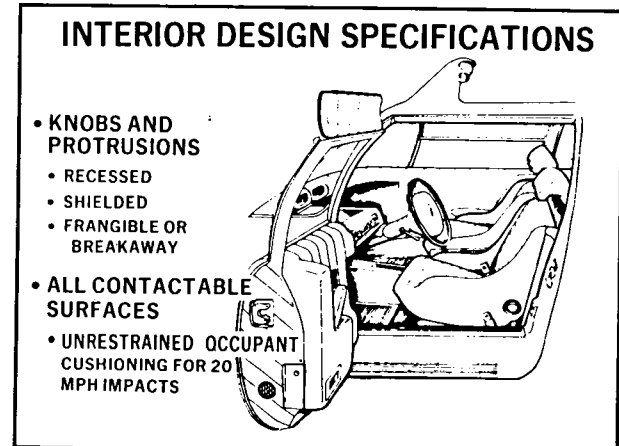
Slide 31



Slide 32



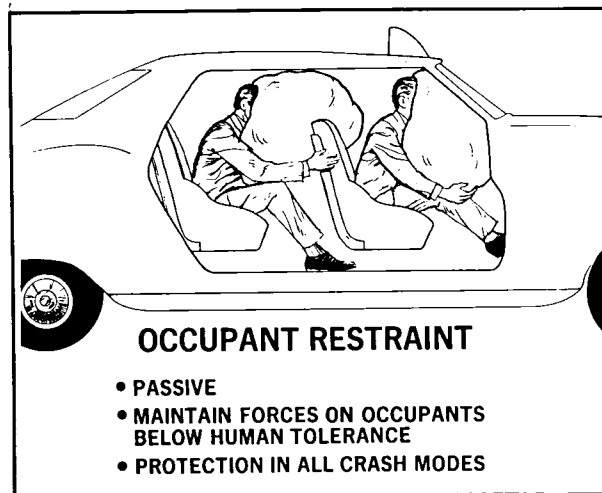
Slide 33



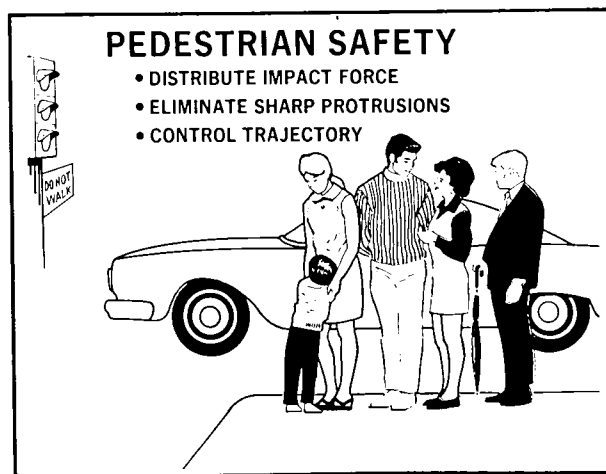
Restraints System Specifications

Passive restraints which require no action by the vehicle occupants are required by our specifications. (SLIDE 34) One concept, inflatable restraints which are triggered or deployed at an impact velocity between 10 and 20 mph, might be used to meet these specifications. However, there may be other concepts which will also provide the specified performance. We consider interior padding, energy absorbing steering columns, etc., as passive restraints with possible limitations on the velocity range over which they are effective. In any case, passive restraints are required because of the demonstrated lack of use of active restraints which require action by the vehicle occupants. We hope to provide protection for a range of occupant sizes from the 5th percentile female to the 95th percentile male. With regard to occupant protection requirements, they are generally the same as those given previously except that 80 G's are allowed for head impacts. For those who are familiar with our original specification as given in the contracts, we have recently raised the allowable femur load from 1200 pounds to 1400 pounds and deleted entirely all other force and pressure specifications (SLIDE 35).

Slide 34



Slide 35



(Afternoon Session)

MR. SLECHTER:

The accident avoidance specifications include the definitions and requirements for the major subsystems listed on Slide 1. The subsystems categorized under accident avoidance include, but are not limited to, brakes, steering, lighting, power train, and visibility. (SLIDE 2) the ESV accident avoidance specifications also were derived from the concept and feasibility studies performed in 1968. For the accident avoidance specifications, however, our Phase I contractors were limited in data to individual experience and available literature on the subject. Although general types of specifications and test procedures were recommended, the task of quantifying vehicle performance for modern production vehicles remained to be accomplished before an actual hardware producing program could be initiated. Further, in areas such as yaw response, there was little or no data to indicate what could be termed "safe" performance. It was decided that since one of our basic objectives was to influence the design of 4000-pound sedans, it would be best to design a vehicle that behaves very similar to the ones to which most drivers have become accustomed. This concept of defining the ESV performance was chosen over the alternate concept of subjectively and arbitrarily choosing vehicle responses that the average domestic driver must become acclimated to and thereby gamble the safety effectiveness of the vehicle. It was not, of course, necessary to approach all ride and handling factors in this manner. As will be pointed out later, the state-of-the-art was advanced whenever possible.

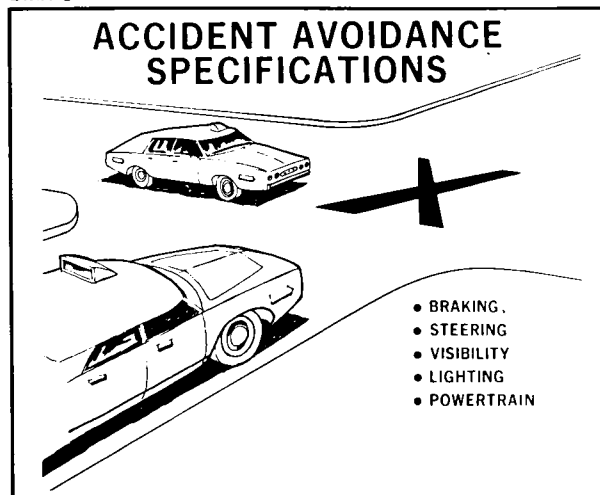
Having chosen our course of action, a six-car test program was started in June 1969, appropriately titled *State-of-the-Art Definition of Vehicle Handling*. This program was designed to furnish baseline performance data from which the ESV specifications

could be written. The six cars were 1969 production models that we believed represented the overall spectrum of production vehicles from the sports class to the luxury class. They were a Lincoln Continental, a Chevrolet station wagon, a Ford Galaxie sedan, a Plymouth Road Runner, a Rambler American, and a Jaguar XKE. At the completion of the six-car test program in spring of 1970, the ESV specifications were finalized and appear today in our contracts with Fairchild Hiller, AMF, and GM. These specifications were also modified and updated where appropriate by DOT research programs. The specifications finally developed represent the first attempt by DOT to quantify vehicle performance. We recognize that having accomplished this first step, changes in testing techniques and parameter identification may be expected for future ESV generations. Those of you now working with the 2000-pound vehicle face similar problems in defining that vehicle's safe performance. In some cases, our complete specification may be useful to you, whereas in others, only the test procedure or performance parameter can be used. As we proceed through the specifications, I will remark accordingly.

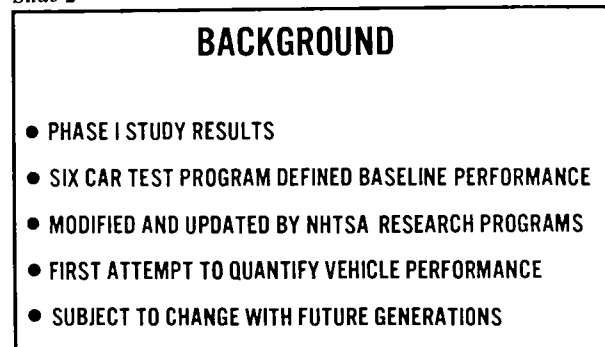
(SLIDE 3) From our first concept of an ESV, it was decided that this vehicle would fully employ the *systems analysis* approach. This is the only way we could hope to scientifically attain our objectives in both the accident avoidance and crashworthiness areas of development. Using this approach, some of the more immediate design conflicts are brought to light and are summarized on this next slide.

In the left column of Slide 4 are listed the design parameters, in the two center columns are listed the design direction favored for Crashworthiness (CW) and Accident Avoidance (AA), and in the right hand column are listed the primary *considerations* for CW and AA. The first item shown is the mass of the vehicle. For crashworthiness, we would like to increase structural mass, while for AA, we would like to decrease mass and thereby improve braking, lateral response and acceleration. For the second item, mass distribution, one of our first priorities for CW is a 50 mph barrier collision. This requirement places a great demand on forward structure, front bumper, biasing the weight distribution forward. This kind of weight biasing reduces brake effectiveness, and adversely affects steering response by increasing the yaw inertia. The next item, frame rigidity, should be low for CW so that uniform controlled crush may be obtained. On the other hand, if the frame is too flexible, there can be no precision in steering, handling, and braking. (SLIDE 5) The fourth design parameter, suspension

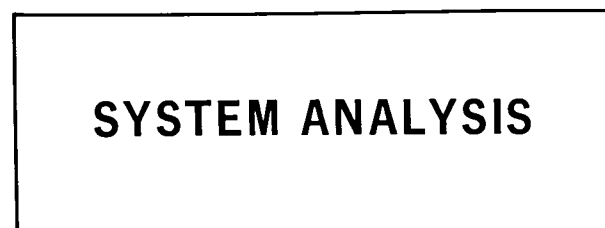
Slide 1



Slide 2



Slide 3



Slide 4

SYSTEM REQUIREMENTS

DESIGN PARAMETER	CRASH WORTHINESS	ACCIDENT AVOIDANCE	PRIMARY CONSIDERATIONS
MASS	INCREASE	DECREASE	BRAKING, LATERAL RESPONSE AND ACCELERATION STRUCTURAL REQUIREMENTS
MASS DISTRIBUTION	FORWARD BIAS	REARWARD BIAS - LOW YAW INERTIA	BRAKING AND STEERING RESPONSE CRASHWORTHINESS PRIORITIES REQUIRE CONSIDERABLE STRUCTURE FORWARD
FRAME RIGIDITY	LOW	HIGH	PRECISE STEERING, HANDLING, AND BRAKING CRASHWORTHINESS REQUIRES A SOFT CRUSHABLE FRAME

travel, represents another design conflict. For CW, it would be well to minimize suspension travel and thereby increase available crush volume and structure. As this parameter is minimized, however, suspension spring rates increase, affecting ride, tire sizes decrease, and wheel locations must be adjusted. The next parameter, visibility, is one of the more obvious design trade-offs. For CW, we would like large pillars with small windows to attain maximum roof strength. This directly conflicts with the driver's visibility. The last item, called the center of pressure, is a function of the design silhouette of the vehicle. Our CW priorities necessitate that vehicles have a relatively long hood line and shorter than average trunk line. This factor could shift the center of pressure forward of its location on most production sedans today. The net effect may be adverse vehicle handling in cross winds.

In summary, there is very little a designer can do in one subsystem without affecting the performance objectives in other subsystems; hence, we believe, the necessity for a *total systems approach*.

The next few slides summarize the ESV specifications as they are presently written for our contractors. Slide 6 covers service brakes. This is one of the areas in which the state-of-the-art has been advanced. We are requiring that the ESV be able to stop from 60 mph in 155 feet without wheel lockup and remain in a lane 12-feet wide. For surfaces with low coefficient of friction and for all load variations, braking efficiency shall be 80%. The parking brake shall hold for a 30% grade with actuation effort less than 90 pounds for a hand system, and less than 125 pounds for a foot system. Under emergency conditions, that is, either loss of front system, or booster failure, the vehicle shall be capable of decelerating at .35 g (343 feet) with a pedal force not to exceed 150 pounds. SLIDE 7 illustrates the brake pedal modulation required for ESV. For normal operation, the brake pedal force must lie between lines 1 and 2 for the deceleration rates shown with a preferred maximum pedal force of 85 pounds. Pedal force is to be between lines 1 and 4 for a front system failure, and between lines 1 and 3 for a booster failure. The curves on this slide have been obtained from the six-car test program, and it would appear that a portion of these requirements may be applicable to the 2000-pound class vehicle. Certainly, the booster requirements are different for lighter cars. However, pedal forces for normal operation and for "one system out" could be applicable. I should also add that not all of our 6 cars produced data which met this specification. We chose a specification that we believed optimized safety performance. We also followed the recommendations of a DOT study by

Slide 5

SYSTEM REQUIREMENTS (CONT.)

DESIGN PARAMETER	CRASH WORTHINESS	ACCIDENT AVOIDANCE	PRIMARY CONSIDERATIONS
SUSPENSION TRAVEL	SMALL	LARGE	CRUSH VOLUME LIMITS VERTICAL SUSPENSION TRAVEL, TIRE SIZE AND LOCATIONS
VISIBILITY	LOW	HIGH	PILLAR WIDTH
CENTER OF PRESSURE	FORWARD	AFT	CRASHWORTHINESS STRUCTURE FORWARD AFFECTS CENTER OF PRESSURE LOCATION

the University of Michigan on brake force requirements.

I will now discuss the specification for the yaw responses of the vehicle. (SLIDE 8) The curves have been generated for maneuvers that produce .4g lateral loads on the vehicle. We chose .4g because it is beyond the linear range of tire performance, This value is also beyond the range the average driver experiences daily, yet could easily reach in a sudden evasive maneuver. The slide on yaw response typifies the type of requirements for steady-state performance. On the left can be seen how the vehicle is driven, in this case on a constant radius circle, and on the right is shown the envelope in which a particular trace must fall to meet the specification. As you may expect, our domestic vehicles tend to understeer to a high degree, hence the shape of this curve. We would recommend that vehicles of other weight classes use this type of specification although the values here may not be directly applicable.

Slide 9 indicates how we require the transient yaw response of the vehicle to behave. The vehicle is tested by driving it through a "J" turn as shown on the left side of the slide. We show on the right how a typical trace may look when meeting the specification. This test is run at two velocities, 25 and 70 mph. The 70 mph performance must be below the upper limit of the envelope shown, and the 25 mph performance must be above the lower limit.

As in the case of steady state yaw, it is improbable that this data is directly applicable to a 2000-pound car; however, we believe the test to be extremely valuable in quantifying vehicles in yaw response.

Slide 10 shows our requirements for returnability (sometimes called feedback). On the left, the vehicle is driven around a circle of constant radius and at some predetermined point, the steering wheel is released and the trajectory of the vehicle is recorded. The curve on the right indicates the relative heading for the test velocities. For our six-car program from which this test was derived, four cars had power steering and two were manual. The four vehicles with power steering and one vehicle without exhibited high damping characteristics and quickly reached a steady-state course. The other vehicle without power steering went into a divergent oscillatory condition and eventually spun out. It is that type of characteristic we are trying to quantify, and then through specifications hope to eliminate, in specifying the 4000-pound Family Sedan. As in the case of the other two yaw responses, the behavior of a 2000-pound vehicle for this type of test is unknown to us relative to larger vehicles, however some of you here may now have data for small car performance of this parameter. We do believe the test itself is valuable for evaluating the inherent stabilities of the vehicle.

Slide 6

BRAKING PERFORMANCE

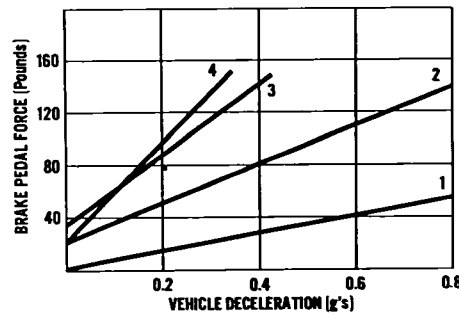
SERVICE BRAKES (SURFACE SKID NO. 70 TO 80)
 VEHICLE + 40% RATED LOAD @ 60 MPH - STOPPING DISTANCE: 155 FT. (.78g)
 • NO WHEEL LOCKUP
 • WITHIN 12 FT. LANE
 • MEET SAE J843a FADE TESTS
 • PEDAL FORCE 85 LBS. (MAX.)

SERVICE BRAKES (LOWER FRICTION COEFFICIENT SURFACES [2 TO .8])
 ALL COMBINATIONS OF VEHICLE LOADING - 80% BRAKING EFFICIENCY

PARKING BRAKE (30% GRADE)
 VEHICLE + FULL LOAD
 • 90 LBS MAX. HAND SYSTEM EFFORT
 • 125 LBS MAX. FOOT SYSTEM EFFORT

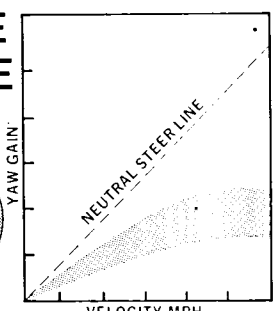
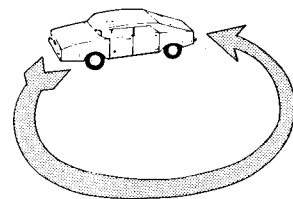
EMERGENCY BRAKE (BOOSTER OR LEAKAGE TYPE FAILURE)
 VEHICLE + 40% RATED LOAD @ 60 MPH - STOPPING DISTANCE: 343 FT. (.35g)
 • PEDAL FORCE 150 LBS. (MAX.)

VEHICLE DECELERATION VERSUS BRAKE PEDAL FORCE



Slide 7

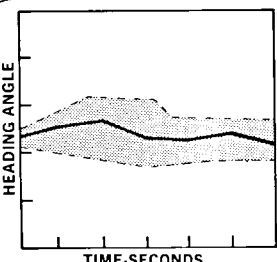
STEADY STATE YAW RESPONSE



CONSTANT RADII CIRCLES
 YAW GAIN
 YAWING RATE
 FRONT WHEEL ANGLE

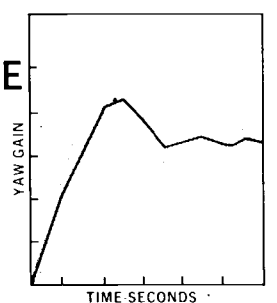
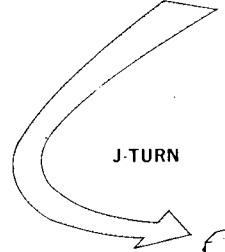
Slide 8

RETURNABILITY



Slide 9

TRANSIENT YAW RESPONSE



Slide 10

The next group of slides have been categorized as handling specifications. We recognize the over use of this word; however, we differentiate from the previous slides on "steering" by virtue of the fact that they were concerned primarily with the steering system and vehicle response as it is affected by *driver* inputs. The specifications under "handling" are concerned largely with vehicle performance as it is affected by outside disturbances, such as crosswinds and pavement irregularities. It is well understood there is no simple way to isolate and quantify the performance of all subsystems concerned and then relate those results to an integrated system performance specification.

Under handling (SLIDE 11) we indicate the maximum lateral acceleration the vehicle must attain for various tire pressures under wet and dry pavement condition. It is not uncommon for average car owners to neglect their tires. We are attempting to assure the vehicle is not overly sensitive to this parameter, nor are tires put on the car which perform well on dry pavement and poorly on wetted surfaces.

The next maneuver under handling (SLIDE 12) is an attempt to quantify vehicle performance when it is in the "out of control" mode or when maximum lateral acceleration capabilities have been exceeded. This test is called "control at breakaway" and is run by placing the vehicle on a constant radius circle and accelerating until the vehicle moves outward to a radius 10 ft. greater than its original radius. At that time the throttle is closed and the vehicle is maneuvered back to the original path. The time to regain the original path is specified as four seconds maximum. No braking during recovery is allowed and steering inputs are also limited.

The next group of three slides on handling show the ESV requirements for directional stability. The first one (SLIDE 13) is crosswind sensitivity. The vehicle will be exposed as shown, to a 50 mph crosswind for a distance of 20 feet. Course deviation after this exposure must be no more than that shown on the curve. As an example at 50 mph (147 ft. in 2 secs) maximum course deviation allowed is approximately 4 feet. The ESV's sensitivity to pavement irregularities (SLIDE 14) will be determined by driving the vehicle over a one inch radius ridge lying 30% to vehicle direction of travel. The total allowable course deviation is one foot measured two seconds after ridge contact. The third and last slide under handling (SLIDE 15) is intended to assure the driver of some feel of the road through his steering system and also to prevent an undue amount of effort required by him in the event the power steering system fails. The specification requires that a minimum torque of 5 inch-pounds be necessary to

produce a yaw rate of two degrees per second. In the event of a booster failure the torque required at any velocity above 5 mph shall not exceed the "power on" torque by more than a factor of 5.

Within these handling specifications as with the steering specifications, we have considerable doubt that much of the data will be directly applicable to the small cars since as stated earlier, it was derived from basically full-sized vehicles. The procedures are believed to be applicable. However, the task remaining is to define the baseline performance for small cars.

Slide 11

HANDLING - LATERAL ACCELERATIONS

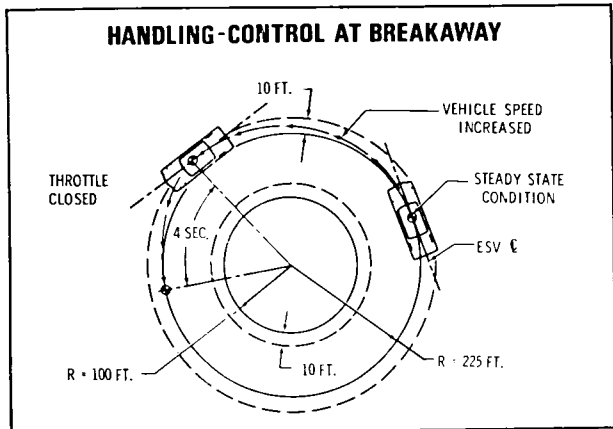


SURFACE	TIRE PRESSURE	LATERAL ACCELERATIONS (g)	
		FIXED CONTROL	MANUAL CONTROL
DRY CONCRETE OR ASPHALT	DESIGN VALUE	.60	.65
	120% DESIGN VALUE	.60	.65
	80% DESIGN VALUE	.55	.60
	120% DESIGN FRONT		
	80% DESIGN REAR	.63	.68
WET CONCRETE OR ASPHALT	DESIGN	.59	.64

* VALUES TO BE RELATED TO ACTUAL PERFORMANCE ACHIEVED ON DRY SURFACE IN PROPORTION TO WET AND DRY TEST SKID NUMBERS.

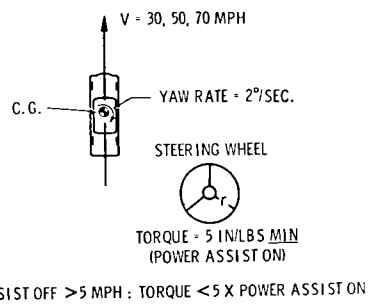
Slide 12

HANDLING-CONTROL AT BREAKAWAY



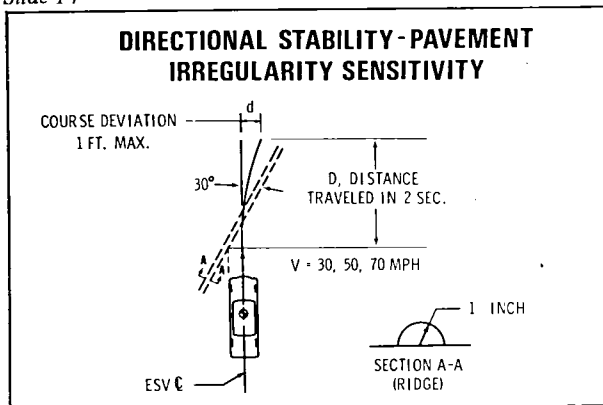
Slide 13

DIRECTIONAL STABILITY-STEERING CONTROL SENSITIVITY



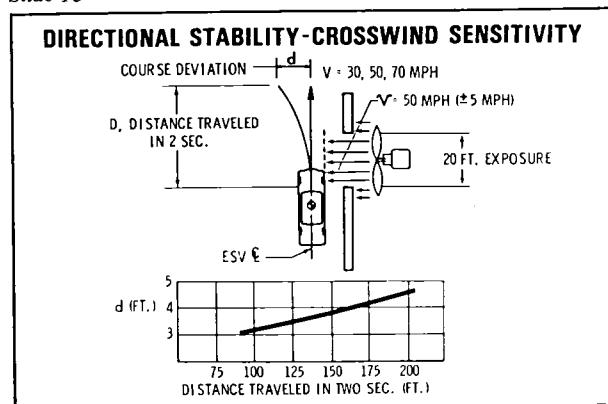
Slide 14

DIRECTIONAL STABILITY-PAVEMENT IRREGULARITY SENSITIVITY

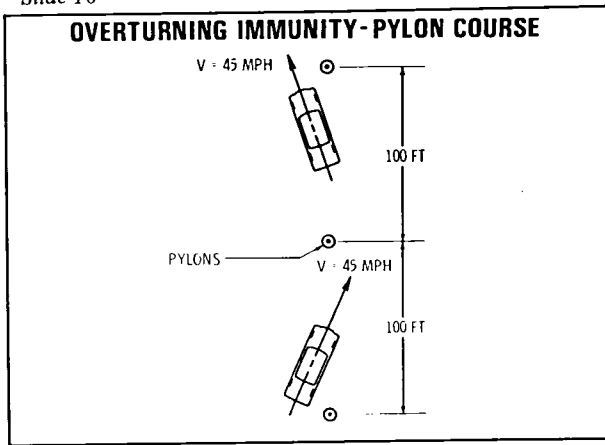


Slide 15

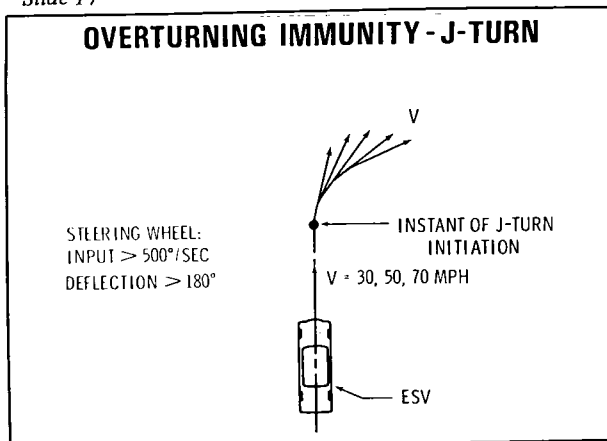
DIRECTIONAL STABILITY-CROSSWIND SENSITIVITY



Slide 16



Slide 17



The next major item within the ESV specifications is to verify that the vehicle is immune to roll over. We propose two tests to verify this characteristic. However, we reserve the prerogative of subjecting the vehicle to any combination of braking and steering. One test (SLIDE 16) consists of negotiating a pylon course and the other (SLIDE 17) consists of a series of "J" turns at various velocities. Both of these tests could be used for the small-car program.

Slide 18 and the last one directly related to vehicle dynamics, indicates our ride requirements and engine performance. The ride performance specification is based on the data from the six-car program mentioned earlier, with the natural ride frequencies specified for the front and rear suspensions. The engine, as stated on the slide, shall accelerate the vehicle from 30 mph to 70 mph in less than 12 seconds, be capable of constant performance under a constant lateral force influence of .5g, and meet the emission requirements for the 1973 U.S. Federal Standards.

This completes the specifications discussion related to vehicle dynamics.

Slide 18

RIDE PERFORMANCE	
• FRONT	.9 - 1.1 CPS
• REAR	1.2 - 1.4 CPS
ENGINE	
• 1973 HEW EMISSION STANDARDS	
• MINIMUM EVAPORATIVE LOSS FROM FUEL TANK	
• RANGE: 250 MILES @ 60 MPH	
• ACCELERATION: 30 - 70 MPH IN LESS THAN 12.0 SEC	
• LATERAL ACCELERATION CAPABILITY: 100 FT RAD CIRCLE - .5g	
ACCIDENT AVOIDANCE PERFORMANCE TEST CONDITIONS	
• VEHICLE LOADED TO 60% CAPACITY (600 LBS.)	
• TEST TRACK SURFACE SKID NUMBER 70 TO 80	

(SLIDE 19, 20, 21) Here we list other accident avoidance subsystems and design factors addressed in our specification. While we have not depicted them in the detail we did for vehicle dynamics, they are nonetheless essential toward the overall safety effectiveness of the vehicle. As an example, for the visibility and lighting specifications, we did extend the state-of-the-art wherever it appeared that a significant gain could be made at a low expenditure of development funds. For rear vision the addition of a periscope was encouraged and for headlighting, candle power was increased to 150,000.

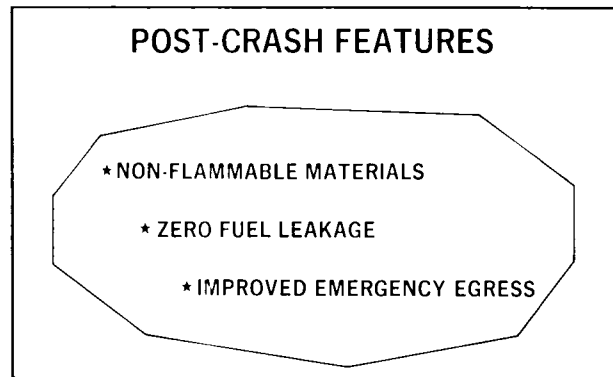
This concludes my presentation on the United States Experimental Safety Vehicle 4000 lb. performance specification.

Slide 19

OTHER SUBSYSTEMS
PERFORMANCE SPECIFIED

HEADLIGHTING	FORWARD AND SIDE VISION
REAR LIGHTING	REAR VISION
SIGNALING	DISPLAY AND CONTROLS
WINDSHIELD WIPERS	WASHER
DE-FOG-DEFROST	GLARE

Slide 20



Slide 21



QUESTIONS AND ANSWERS

MR. LISTER (U.K.): Mr. Edwards, I would like to ask a general question, more as a research worker than a politician.

You stated in the beginning that the small car had certain economic advantages but that the crashworthiness would be a difficulty and that you might have to adopt a different standard, or a slightly different standard.

What is wrong with the philosophy that if as you say the smaller car does have economic advantages, certainly in traffic. What is wrong with putting a penalty on the larger car, rather than putting the penalty on the smaller car? You therefore ask the larger car to cater for the impact with the smaller car, while you are using the systems approach.—This is quite feasible. You have in the larger car more space, more weight and more possibilities of building in protective devices or protective deflections to ease the problem for the small car. What is wrong with that philosophy?

MR. EDWARDS (U.S.): Well, it is an interesting thought, Mr. Lister. In general terms, I find the facts of life are that the smaller car hits trees and hits telephone poles and hits bridge abutments just like the large car does, quite independent of the presence or absence of larger cars and consequently in the crashworthiness area, which I think you were alluding to primarily, we still have the basic problem of preserving the integrity of the passenger compartment. So that while we don't mean to imply that one car can be designed without consideration for the other, and it is certainly not our intent to do so, that any car with a passenger in it and a driver and other occupants, must necessarily be capable of taking care of itself in those collisions which occur with considerable frequency in our country against inanimate objects that are not controlled by another driver.

So we are not really certain that saying let the little car go its own way, if you will, would really be the answer to the question.

Do you wish to comment Mr. Slechter?

MR. SLECHTER (U.S.): We are observing a trend in the United States as we head toward the 1980 period. The attractiveness of the smaller car is going to continue and we may find that the family sedan in the United States in 1980 to 1985 period may be a 3,000-3,500 pound class vehicle. But that is not true today.

Today we have 54 percent of our cars that are five-passenger family sedans of approximately the 4,000 pound weight class so we in the United States have to cater, if you want to call it catering, to the problem that we have 60,000 people who die in automobile accidents. We can do the most for that particular problem right now by catering to the larger car. I do see that the trend for the future, will be moving in the direction of more and more use of smaller cars.

MR. MATTHEWS (FRG): I think that the question which has been asked by Mr. Lister did not refer to what you call single-car accidents but to so-called two-car crashes, and in that case the masses of the two vehicles certainly play a role in the consequences for the occupants.

Now, what Mr. Lister meant, in my opinion, was it is easier to design the big car in such a way that it catered, so to speak, to the small car than vice versa; and that is what you, Mr. Chairman, said in the introductory remarks of the U.S. technical presentation. You said that you could compensate for the disadvantages of the small car by having a velocity sensitive protective front end; but this, of course, holds true for big cars as well.

And then consider that a big proportion of the two-car accidents are lateral impacts, where it is particularly difficult for the small car to protect its occupants, it may be that there is some merit in the observations made by Mr. Lister.

MR. EDWARDS (U.S.): Thank you, and you are certainly correct. In those crashes that occur under 30 miles per hour, we do have in our specification a requirement for velocity sensitivity and in so doing attempt to lower the force levels that are generated in crashes up to that speed.

The contractors are not required or told that they cannot use velocity sensitivity capabilities throughout the entire spectrum of their program but this was established as a minimum. So we think to some degree we have tried to approach the problem from that point of view.

Mr. SLECHTER (U.S.): I would add that we in the ESV office are very sensitive to the point you are making. The specification that we did arrive at, we feel compromised somewhat our hope that the big car would be less intrusive of the smaller car; but we

felt that, while it was a compromise, it is our first approach and we left the option open to the contractors to stay well under that curve that I showed of G values versus velocity, the impact velocities.

I think I can state that at least one of our contractors will be well under that curve and using his car, in the prototype testing, we will be able to derive or get a first indication of just what the upper limit is that we can achieve in the big car's attack of the small car, and in holding down that attack. I don't want to underemphasize the fact that we are very sensitive to that point. I am sorry, Mr. Lister, but I really misunderstood your question.

MR. KRAFT (FGR): In order to animate the discussion I would like to be as provocative as possible. While we have seen a series of slides, interesting slides, and they all showed cars which you can see and accept as being attractive cars except perhaps the last one. But for all those who know the U.S. specifications, you realize that none of these vehicles fulfill the totality of the specifications; that is to say the visibility, upper visibility, et cetera, the high range counter.

Now the question I want to put is the following: Did you just elaborate these for discussion? Is this just a question of publicity or do you really think that you can achieve such things? Do you just want to show that with these specifications the project is hardly meaningful. It is indeed meaningless. That is to say that you show attractive cars but you knew very well that you couldn't follow the specifications or is just that you had lack of time that you haven't completed the project yet? Thank you.

MR. EDWARDS (U.S.): I think we will all take a little piece of the action on that question. We honestly felt that the specifications in the crashworthiness area were capable of being realized. In the areas related to visibility, for example, which you cited, certain of the contractors, in fact, plan to meet those requirements and specifications; others feel that it is not feasible nor practicable from a point of view of sale ability of product because they feel they might literally impact on styling too much, and I am talking about the periscopic, for example, versus non-periscopic approaches to the problem; so we did not, we definitely did not develop an 'Alice in Wonderland' dream here; we felt that it was realizable and it was up to us after we took delivery of the product and analyzed it and assessed it, to make a complete evaluation that would have practicable impact in the safety-standards area.

Once again, we should not imagine that every item exactly and explicitly, as called for in the specifications, will ultimately be reflected in a specific safety

standard. We will go again with a systems analysis within a systems analysis so that the total cost effectiveness framework required to really implement standards properly will be achieved—at least we hope so.

MR. SLECHTER (U.S.): I think it is important to realize that now that we are well into this program, and in fact we could have waited until 1980 to start and probably then would still have holes in specifications. We still are not able to absolutely identify everything that we wanted to identify with relationship to safety, but we felt the time was now that we should start.

We specified the car to the best of our ability from the information we had available from research. We feel now that we have a program and a specification that are actually *goals* to the contractors in the United States. What are the contractors doing? They are looking at the vehicle design requirements and each of them is weighing the importance of these requirements vis-a-vis total system performance.

For example, visibility versus the need to stiffen the roof structure—well, the contractor is immediately saying to himself, is it more important to have one degree of up angle or is it more important to have a little more roof structure? He knows that our first priority is crashworthiness, so he makes his design decision.

This kind of rationale is being used in every subsystem and every component of every subsystem and we don't believe that everyone is going to meet every requirement. As a matter of fact we have set up some requirements which we absolutely call goals

because we don't quite understand what the realistic requirement should be.

The 8 degree down angle in front visibility is another good example. We know that today's cars are on the order of 3 to 4 degrees down angle and we know that we want better, fuller visibility. We specified 8 degrees down and presented the challenge to the three contractors. We have had lots of fights over that particular requirement.

Possibly none of the contractors will make 8 degrees down. Possibly they will make only 7 degrees down. The result of the program therefore will be that we know what the upper limit is on forward visibility angles. I think it is important to recognize the intent and spirit of the specifications that we have put together and that it is necessary for you people to approach the specification for your car in the same way.

We don't know all the answers by any means.

As a result of our mutual programs and their test results, we are going to determine collectively what the future safety requirement will be. So this is not a rigid game that we are playing; it is very much flexible and we are all learning as we try to determine what our limits really are.

MR. EDWARDS (U.S.): One of the main goals of this conference is to communicate viewpoints on these specifications and to get your inputs; so it would appear that we are off to a good start.

section 2 part 2

The German Technical Presentations

THE GERMAN EXPERIMENTAL SAFETY VEHICLE PROGRAM

DR. ING. GUNTHER BRENKEN

GERMANY

I do not want to present here a historic background of the development of the Experimental Safety Vehicle in a European version of about 2,000 lbs because this has already been done at the beginning by the government representative.

On 7th August, 1970, the German automobile industry began preparations for the development of the Experimental Safety Vehicle in a European version, as requested by the Federal Minister of Transports, Mr. Leber on the same date the German automobile industry constituted a VDA Working Party of safety experts belonging to the following firms: Audi NSU, BMW, Daimler-Benz, Ford, Opel, and VW.

To create a uniform base for the constructive development of the ESV the Working Party decided to structure the technical requirements on the basis of those for the U.S. ESV.

During four Working Sessions the requirements were determined and laid down in a booklet. On 21st December, 1970, the President of our association, Mr. v.Brunn, handed them to the Federal Minister of Transports, Mr. Leber, who presented them to the public in a press conference.

Already on 12th October, 1970, the Volkswagenwerk declared in public that they would develop and build the prototype of a 2,000 lbs ESV based on the requirements compiled by the German automobile industry committee. During the design and development period a narrow co-operation with the U.S. National Highway Safety Bureau will take place, which has been laid down in a Memorandum of Understanding agreed upon on 5th November, 1970, between U.S. Minister of Transport John A. Volpe and the Federal Minister of Transport George Leber.

Contrary to the U.S. requirements the German conditions have been divided into two sections. The first part comprises the technical requirements and the second one the testing conditions.

Please let me make now several general remarks on our "Lastenheft" - as we call it in German -:

The Technical requirements apply to ESV, the design and construction of which correspond to the following essential objectives:

- Investigation into the technical feasibility of essential progress regarding the characteristics of riding safety, anti-pollution measures and occupant accident protection.
- Incitement of public interest for problems of passenger car safety.
- Encouragement of carmakers' efforts to intensify research and to adopt safety features for series production.
- Application of the knowledge gained during construction and testing of the safety car to further development of motor vehicles.

In any one of the partial fields important for safety the vehicle components or assemblies must meet exacting requirements, so that as a general rule specific developments are required in order to meet such maximum requirements separately. Considering the normal operating conditions of a production vehicle in highway traffic, however, the car-maker may be compelled to search for a compromise between various contradicting requirements, in order to secure the every-day usability required by the car-owner.

When drafting the Technical Requirements, a curb weight of the vehicle of approximately 900 kg had been used as a base. The requirements can be applied analogously also to vehicles having a different curb weight.

During the compilation of the German "Lastenheft" some divergencies from the US requirement were necessary due to different weights of the US and European ESV and on account of the legal prescriptions and standards to be considered in Europe.

In the form of an extract I want to mention the following divergencies:

	U.S.	E.U.
number of seats	5	4
curb weight	1,800 ± 90 kg	900 + 200 kg

These different curb weights have been necessary on account of the big weight differences among the smaller European vehicles. As regards the big U.S. cars these differences are smaller.

payload	450 kg	360 ± 40 kg
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As regards the state of the art only the SAE standards have to be considered in the USA. During design of the European ESV the recognized rules of technology must be observed, which generally are defined by applicable standards and procedures. Notably the DIN standards and ISO recommendations should be observed. If required, also other standards such as SAE should be referred to. The same happens by recognizing regulations. The legal provisions regarding the manufacture of motor vehicles, unless they are in contradiction with these technical requirements, must be observed. This principally applies to the provisions of the StVZO (Highway Traffic Licencing Code) and the pertinent procedures, as well as to the procedures for testing a vehicle component.

In the United States only the Federal Motor Vehicle Safety Standards (FMVSS) have to be recognized.

In the section concerning measures for the prevention of accidents some data of the service brake system had to be slightly modified when converting the British measure system into the metric one.

As to the steering and restoring characteristics severer measures were laid down which partly serve already as a base for the European models.

As to the riding characteristics rounded off data were laid down which are within the range of measure toleration.

The restoring moment on the steering wheel is only measured at a riding speed of approximately 50 km/h, as riding speeds of 80 and 110 km/h are unrealistic in this case.

The U.S. test of the pavement irregularity sensitivity does not seem to be practical and is considered to be unnecessary.

In order to prevent overturning a special testing procedure is developed for the tipping stability. Also in this case our conditions are severer than those of the U.S. requirements.

In the chapter of "visibility for driver" it is desired that regarding headlights also future developments (such as polarized light) be included in the investigations. These future aspects are not mentioned in the US requirements as well as a washing device for the headlamp lenses which is only demanded in the German "Lastenheft".

As to the visibility ahead and to the sides the German conditions are ordering two degrees less upwards and downwards to the road in riding direction. Long term experiences and tests have shown these data to be sufficient and consistent with rollover requirements.

Emission characteristics shall correspond with the regulations announced for the future - at least with those for 1973. It should be examined whether already now a longer period should be contemplated (up to 1975 or 1976), as in the last time the targets for Environment Protection were announced for such periods in the USA and in Europe.

In the chapter of "measures of occupant protection from accidents" there are some slight differences. In the U.S. statement of work there shall be no passenger compartment intrusion greater than 3 inches from the normal inside surface. In the VDA statement the testing devices (manikins) *shall not be damaged by structural parts displaced to the inside*. It shall also be possible to remove them from the vehicle without damaging them.

For occupant retention devices the German statement orders two types:

- Passive retention devices which become effective only on impact without actuation by the occupants.
- Active retention devices which must be designed in a way that they can be operated with a minimum of physical effort.

In the U.S. statement of work only the passive retention devices are mentioned.

In this short confrontation most of the important differences between the two statements of work are put forward. We believe them to be adequate and justified in all cases, especially on account of the different weight classes of the two safety vehicles.

We hope to have herewith contributed to the development of the experimental safety vehicles in Europe and in the USA.

At the end I would like to emphasize that our "Lastenheft" comprises only the technical requirements analogue derived from the US specifications. As important as the technical perception seems to be the economic effects which will have great influence on the sale of automobiles. It must be observed that the buying power of an American buyer is generally much greater than those of a European one. A more expensive car as result of several new safety elements may still find a market in the USA; in Europe this would surely be more difficult.

Besides political consequences must be drawn by the government authorities in a way that result in realistic laws. Only after considering the three components of this development—the technical, the economic and the political—can a safety car result with a maximum *of profit for those concerned*.

BRAKING DEVELOPMENTS

DR. BURGHARD

GERMANY

Ladies and Gentlemen:

It is rather difficult to speak of the future of brakes since today's brake systems have achieved such a high degree of perfection. I will, therefore, have some trouble in talking to you about new developments since it concerns an as yet unknown field.

Brake development has been characterized as evolutionary rather than revolutionary. It has been accomplished by small steps consisting of concerted efforts toward improved components in order to achieve a better total system.

That is why our vehicle brakes will not be different in the future except that all new cars will have 4 wheel disc brakes. For vehicles of a certain weight, the disc will still be air cooled. In the use of dual brakes for increased safety, the competition will continue between the different systems and development will be aimed in particular toward the best overall qualities. Yet, we must look at the obvious: No dual brake system is perfect, but each system has its own advantages and disadvantages. The choice of the system that ultimately will be adopted, depends on the qualities that are of particular importance to the vehicle manufacturer.

The heavier and faster vehicles will have, as they do now, different hand (parking) brakes than lighter vehicles. They will be connected to the disc brake clamp. The devices that point out a failure of a circuit are also of great interest. Some improvements are possible in this area. However, we must guard against exaggerations; for example, the indication of the sinking of the float in the (brake fluid) tank is enough to prove that a connection has failed. A simultaneous indication of this failure, by a change in the differential pressure is useless and also dangerous. Indicating the malfunctioning of components doesn't make sense except when they (the components) cannot themselves be checked. So the indication must alert the driver.

The heavier and faster vehicles will most likely also be equipped with power brakes in the future. Contrary to the present situation, some smaller models will undoubtedly also profit from power

assisted brakes because of the smaller pedal force required.

Until the present, vacuum power brakes have been used a lot. Some other future plans are also possible since with exhaust purifying engines, the available vacuum will be reduced, thus implying for the future either the use of separate vacuum pumps or the use of another power source, perhaps accumulators. The future will tell us which device should be preferred.

The technical methods that have just been briefly outlined, allow for the development of absolutely safe brakes. It is not necessary to depend upon essential future improvements that, in our opinion, are no longer necessary. Modern brake systems have become so safe (reliable) that in general a failure is quite improbable as long as the brakes are well maintained.

The preceding remarks refer only to the vehicle and its technology. However, in reference to total safety, not only technology but also the human aspect must be considered. The best brake system cannot function properly without a good driver. Following this line of thought, the inexperienced driver certainly is occasionally faced with an emergency. A sudden locking of the wheels after a bad maneuver can't be prevented by the brake construction alone, even with the most perfected brakes. That is, the brake system ought to be set up in such a way that upon processing the pedal with even a woman's light force, the tire traction of fully loaded vehicle could be entirely held by the brake on a normal road surface. The wheels will thus not reach the locking limit. In the case of emergency braking, the driver, particularly if he is a strong person, will apply more force to the pedal, causing one or more wheels to lock. If the vehicle is lightly loaded and the pavement is slippery, the locking will occur even if the pressure on the pedal is very light. Maneuver-ability and stability are thus lost. The amount of pressure on the pedal in an emergency braking situation requires that the driver has sufficient control, a certain amount of experience, and keeps his cool, which frequently is not the case. Acting instinctively in such a situation, he slams on the brakes instead of acting according to the particular circumstances.

If the front axle is locked while the rear wheels continue to turn, the car will move straight forward despite possible attempts at steering. It will always continue in the same straight-ahead direction, which is very important. On a straight road, this motion is relatively favorable. It is not, however, possible to turn a corner without releasing the brakes. Needless to say, in a turn this "forward motion" is rather dangerous. If, on the other hand, the back wheels

lock while the front wheels turn, the car will move sideways very easily at the rear axle since the locked wheels no longer offer any lateral guidance. In general, front wheel locking is less dangerous. We must therefore, turn our efforts towards designing systems to meet these conditions. It would be easy to do this by a general weakening of the brake system on the rear axle, but this somewhat simplified method would result in lengthening the stopping distance since the traction of the back wheels would be partially used. The optional result would be reached if the distribution of brake force over the front and rear axles was adapted to the effective loads on the axles, while in each case, reducing the portion allotted to the rear axle, in order to avoid locking the rear wheels. However, the load on the axles is not constant, but depends on the road and the force of deceleration. This latter force, itself, is a function of the condition of the road and of the tires.

The necessary adjustment cannot, consequently, be achieved simply. We try to approach the imaginary-ideal curve by means of brake force regulators, which are more or less effective but which, depending on the situation, are effective in certain cases, but not in all the situations that involve the whole gamut of brake applications occurring on the road. For the described reasons, the use of brake force regulators will prove very difficult.

Considering that a significant increase in safety in the case of emergency braking cannot be obtained except by reducing the demands put on the driver, we have looked into some new technical solutions. It has been recognized that an automatic pulsating application of brakes, that is of the braking force, could bring about a decided improvement. It would prevent wheel locking and maintain brake slippage within prescribed limits in an attempt to attain optimal traction. Such devices are called antilock (skid) systems.

All such regulating systems known today are based on the same fundamental principle: when a wheel has a tendency to lock, this is noted by a special device, the sensor. The pressure in the brake wheel cylinder is then reduced through a reduction in the brake fluid in such a way that the braking power diminishes and the wheel doesn't lock. The wheel accelerates once more until it revolves at a speed corresponding to that of the vehicle, after which the brake fluid again flows into the brake wheel cylinder, increasing the pressure and consequently the braking effort. Any further tendency to lock and the process repeats itself. During the entire regulating cycle no power is exerted on the master cylinder except when the

driver steps on the brake pedal. Once the fundamental principle has been established, we can regulate one axle or all the wheels, according to the system employed. If we only regulate the rear axle, for example, we will not use the front axle to any advantage over that of a nonregulated system, however, straight ahead movement of the rear axle would be certain. Shortening of the stopping distance would be minimal if not non-existent. Hard braking on curves would not be possible since a sudden braking on the front axle would move the vehicle in a straight line with the front wheels locked.

To avoid these circumstances, it is necessary to regulate all 4 wheels. This is being done all over the world. In the most simple case, you regulate each axle according to the wheel which has the weakest power transmittal, which the experts call the "select-low" adjustment. You see immediately that if the braking force on a given axle is uneven, this setting would not permit optimal braking since each axle moves as a function of the wheel with the weakest power transmitter. In taking a fast corner, such a car would hardly brake at all since the braking force of the axle is set to the unweighted wheel which is at the inside of the curve, a wheel which can exert only the weakest force.

One certain improvement consists of independently regulating each front wheel and regulating the rear axle according to the "select-down method. If it is well constructed, this system will allow for considerable forward movement. Handling on a curve, however, remains questionable. Undoubtedly, the best solution is regulating each wheel independently, depending on the traction.

The requirements are as follows:

1. During braking, the driving stability of the car ought to be entirely safe so that the brake pressure increases slowly up to the point of locking and beyond whenever the pressure increases suddenly as in the case of an emergency braking.
2. The regulating system must optimize the grip on the road thus assuring the shortest possible stopping distance.
This condition applies to roads where the maximum power transmittal of the tire in a light skid is greater than with a locked wheel. An ice or packed snow the coefficient of friction is generally independent of the slipping skid but tire-wise the maximum coefficient of friction could also be reached with a locked wheel. A shortening of the stopping distance by means of a regulating system is

not physically possible in either case. No matter what the cause, it is always mandatory that the steering and therefore the maneuverability be controlled; the stopping distance is hardly greater than with locked wheels.

3. As long as the speed of the vehicle is slower than the maximum turning speed, you could brake on a corner without losing stability or maneuverability. In this case also, the stopping distance should be the shortest possible. In speaking of maximum cornering speed, you refer to the speed at which the car can handle a turn of a given radius without leaving the road due to centrifugal force.
4. The regulator should adapt quickly to changes signaled by the power transmitter so that, for example, sheets of ice on an otherwise dry road, will not cause loss of control upon braking.
In addition, some extreme modification should be made in cases where a vehicle goes from a dry pavement to an icy pavement so that the wheels do not lock on the ice and the effect of the braking over that part of the road which is dry is not diminished.
5. In cases where part of the regulating system fails, it is necessary to have a safety control that does not impair the normal automatic braking system. If one part stops functioning in the course of a series of regulated brakings, the normal braking system should quickly take over so that the car would remain stable. It is necessary that a lighted signal alert the driver that the regulator is out of order.
6. The regulator should be built to work perfectly from the maximum speed down to a stand still.

Only the independent regulating of each of the four wheels can meet this requirement and thus meet future safety requirements.

One plan ready for mass production has already been presented. It unfortunately involves employing considerable technical devices of the sort that at first can only be installed in expensive vehicles. In order to install them in more vehicles, their price must be reduced so that small cars can also be equipped with this additional safety feature. It will thus be possible to provide all cars with maximum braking safety.

All our efforts ought to be aimed at one goal: reliable brakes for the average driver.

CRASH TESTING

MR. KRAFT

GERMANY

Ladies and Gentlemen, I intend to be very brief. Safety tests, mainly simulations of collisions—the car is forced to collide and, for example, occupant reactions are simulated, etc.

Now, thank goodness we don't simulate collisions of dummies against dummies, although one day this is going to have to take place, I believe.

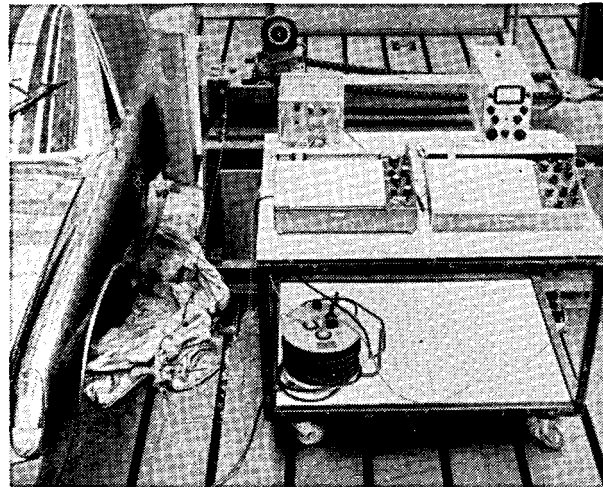
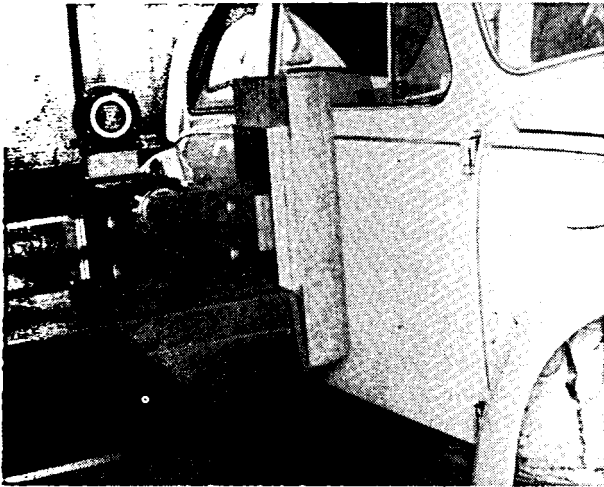
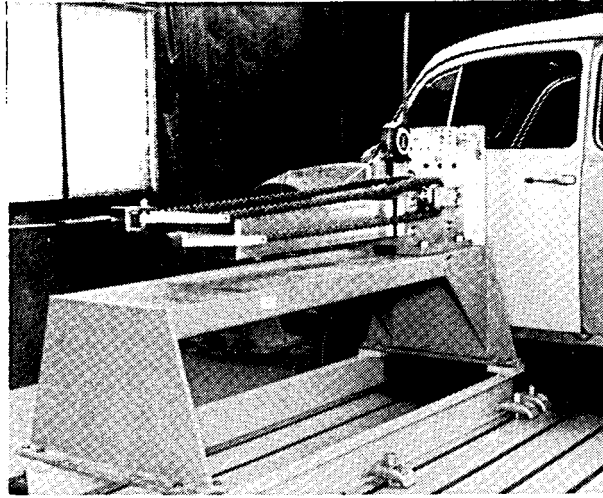
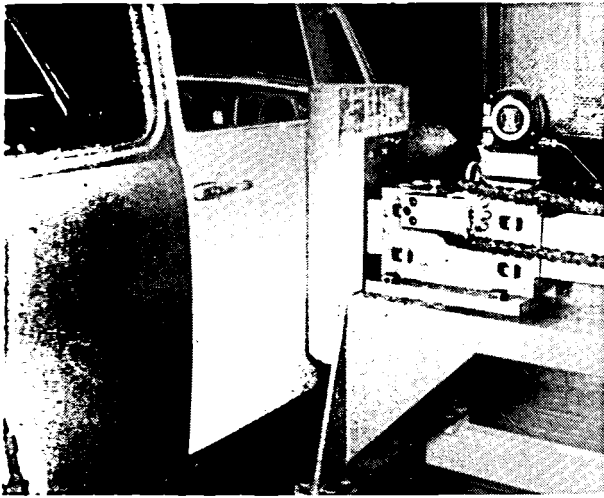
I had the good fortune of traveling in a Paris bus and I hit my head against the head of another occupant of this bus and well, what is going to be the future of all this?

There aren't any laws against hitting people's heads in buses yet.

Where the German specifications are concerned, for the ESV, we have tried to be compatible with the specifications of the Americans. We have adopted the same specifications as those in America and our aim for the lighter car has been to obtain the same performance as those required in America for the heavier car. This has already been said. These are the goals that we have to achieve. We don't know whether we will be able to achieve them, however.

The individual tests have already been dealt with in great detail today, therefore, I don't intend to repeat these problems. I would just say very briefly that the barrier crash tests with a moving barrier have been accomplished by various firms. We also have a pendulum device and of course we have accomplished static tests for the doors.

Our static tests for doors could be called a sort of a crash test, I would like to show you some slides.



Here you see a device which is introduced into the side door of a vehicle. There one can measure the resistance of the door. Now the meaning, the importance of these tests for vehicles is not completely understood in Germany.

In order to fulfill requirements the door has to be reinforced in order to increase the security of the occupant. Undoubtedly this will lead to the fact that during accidents an open door could be struck and this also must be examined.

These tests are not included in the German specifications but they are not included in the American specifications either.

In the framework of ESV developments a large number of such tests must be carried out by those people who are dealing with such projects. We are very interested in these tests and indeed are extremely enthusiastic. The ESV project in Germany was started very early, especially in the Volkswagen factories. This was not only to obtain safety in road transport but also because, within the framework of international legislation for vehicles, there exists an

unacceptable situation. That is many requirements and legislations are contradictory.

In the original statement of the project, we thought the intention was to obtain meaningful safety standards. At the moment we are disappointed. The people who started these projects are burdened with a whole multiplicity of standards the requirements of which to a certain extent are exaggerated and require a multiplicity of tests which exceed the capacity of even a relatively large automobile manufacturer.

You see I am speaking now as a Volkswagen engineer and I would like to express the hope that the work will be carried through in such a way that in the future safety standards will be incorporated in meaningful context.

Thank you.

section 2 part 3

The Japanese Technical Presentations

THE TOYOTA AIR BAG SENSOR

MR. TOYOTARO YAMADA, *Chairman*,
JAMA ESV Committee

JAPAN

Some of you probably remember that an initial presentation was made on the Toyota Air Bag System in May of last year at the General Motors Proving Ground at Milford at a Conference on Passive Restraint Systems co-sponsored by NATO and the Department of Transportation.

Today, on occasion of the International Conference on ESV it was requested that Toyota make another presentation on further developments in the Toyota Air Bag Sensor. I am responding to this request to the extent possible, because although our system is nearing completion of the research stage it is still under development.

In order to save time and to avoid duplication I shall summarize what I mentioned last May:

1. The Toyota sensor is a radar type sensor with which we can predict an unavoidable frontal crash in certain conditions.
2. As compared to the G-sensor, the Toyota system can use a much longer period of time between sensing and completion of Air Bag inflation.
3. The system can use relatively low pressure nitrogen gas for bag inflation. No gun-powder is necessary.
4. The sound pressure level is around 140 db which does not harm vehicle occupants.

These is a brief summary of the previous presentation. Of course the system had several problems to be solved. Today's presentation will summarize the present status of Toyota Air Bag sensor. There are some points that we do not wish to disclose at this time due to pending patent applications. I hope you understand this.

SUMMARY:

1. Close distance radar system using micro wave of 10 GHZ is adopted.
2. The following measures are composed to be converted into electric figures as information for predicting crash.
 1. Relative velocity — Shift frequencies due to Doppler Effect is used.
 2. Relative distance — Reflective signal level from hazardous objects within a certain close distance is used.
Special measures are adopted so as to bring the level difference due to size, shape and material of hazardous objects to minimum for practical use.
 3. Relative angle—Optimization of antenna directivity is devised.
 4. Stabilization of crash prediction signal — Interference due to variation of propagation path and phase interference by antennas have been solved by proper selection of mounting height and directivity of antenna and microwave emitting method.

Mis-operation:

Such problems as:

1. Correct detection of closely by-passing car
2. Effect of weather condition such as rain, snow and flying object like water and mud
3. Interference of signals emitted from other cars and our cars are handled by special microwave emitting method together with directivity of antenna.

These summarize our sensor system.

Now I am going to show some slides and film for those who did not see the film I presented in May of last year. These includes somewhat newer components and tests.

ANALYTICAL STUDY OF AIR BAG RESTRAINT

MR. FURUSHO

JAPAN

Introduction:

This report analysed the energy absorbing characteristics of the air bag in a form of a simple model and confirmed the appropriateness of the assumption by comparing with results determined in a bench test using a body block.

By use of the model also examined were effects of the diameter of the gas outlet and of the bag volume and influence of the bag inflation on the secondary impact.

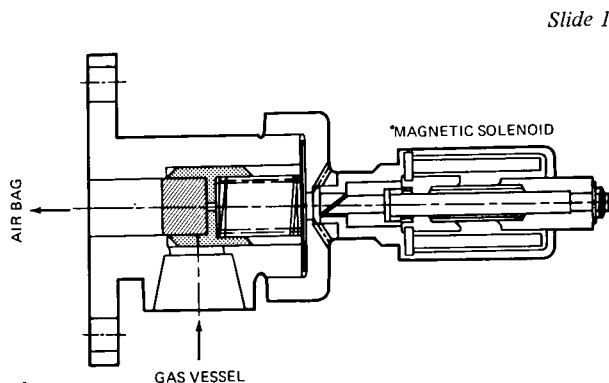
A model of a vehicle occupant with bag installation was also thought out and simulation was made regarding the occupant behavior in the impact under the equation of motion of 7 degrees of freedom, and its appropriateness was studied.

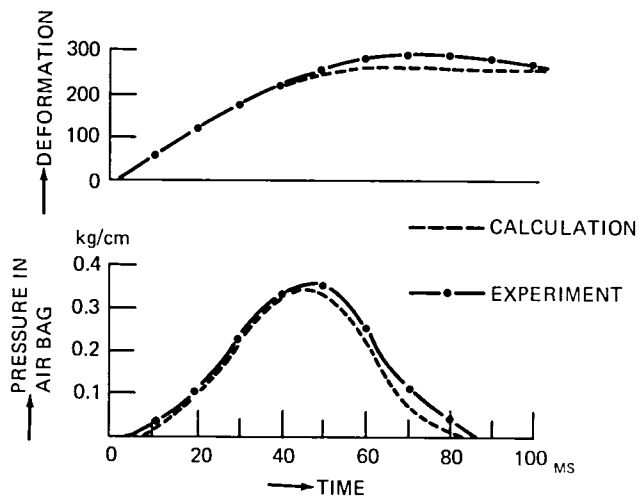
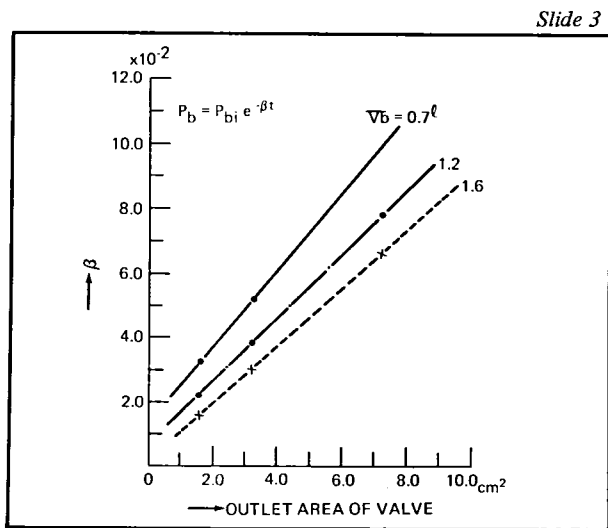
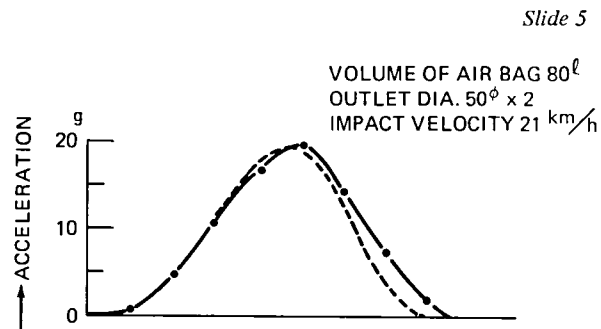
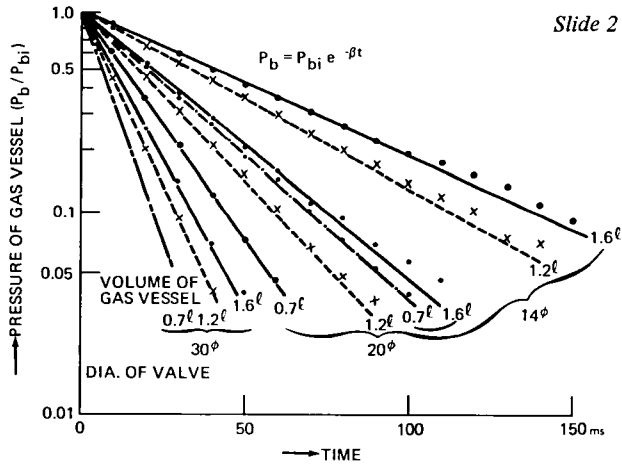
Gas flow characteristics of the valve opening mechanism:

In this valve opening (SLIDE 1) mechanism an electric current is transmitted to activate the electro-magnet, and then the knife is forced to move to the left toward the membrane and the valve is moved to the right by the vessel pressure. A relatively low pressure of 2,200 psi forces the nitrogen gas into the bag.

Slide No. 2 shows the change of the vessel pressure during the valve opening under this mechanism. This figure notes an exponential decrease of the vessel pressure after the valve opening and a big influence of the size of the valve of the mechanism and of the vessel volume on the decrease of vessel pressure.

Slide No. 3 is a graph with the exponent B on the vertical axis and the size of the valve of the mechanism on the horizontal axis, constituting a straight-line increase of B relating the size of the valve, that is, the bigger the size of the valve is and the smaller the vessel volume is, the less time is required for the gas outflow.





Energy absorbing characteristics of air bag:

In determining the energy absorbing characteristics, it was assumed that the gas inside the bag was subject to the adiabatic change due to the rapid deformation of the bag and that it was also true about the gas flow from the vessel and about the flow from the outlet of the bag. It was assumed that the size of the bag remained unchanged at the moment of impact. However, as the section area of the bag increases in an actual impact due to increase of the bag's deformation, the size of the bag was treated bigger in calculation than an actual object.

Drop test machine for body block (Slide 4 not available) was used in the test.

The body block used here is a cylindrical type prescribed in "JIS Standard D4604-Safety Belt for Automobiles", and the spring rate and the weight all meet "SAE Recommended Practice 944."

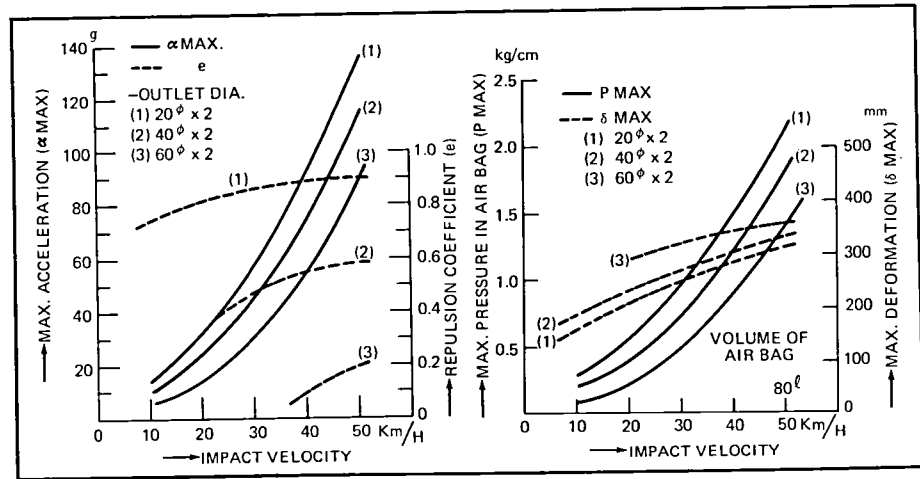
The test was carried out in a way that the dropping body block impacts the air bag installed at the lower part of the testing machine.

Slide No. 5 shows the comparison between the measured and the calculated values regarding the acceleration of the body block, the bag's inner pressure wave, and the bag's deformation at the impact of the body block against the bag already inflated by the gas. Here, the volume of the bag was 80 l, the two gas outlets of 50 mm I.D., the impact speed, 21 km/h. These two values were proved to agree with each other concerning the acceleration of the body block, the bag's deformation, and the bag pressure, and the appropriateness of simulation was confirmed.

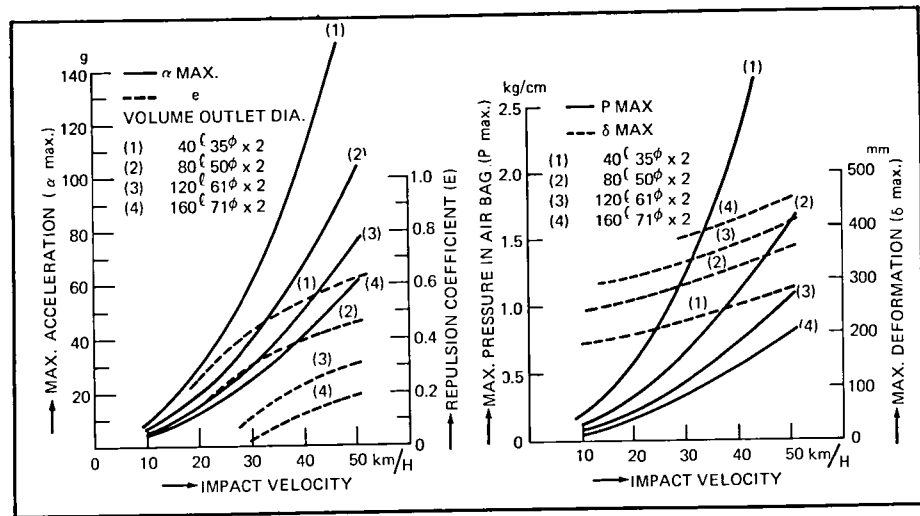
The accord of the measured and the calculated values was well observed in the first half of the test, but in the latter half there appeared a slight deviation that was seemingly due to the calculating method of the contact area.

Therefore, when there is a need of a highly accurate simulation, it will be necessary to have a strict assumption of the contact area with the bag.

Slide 6. Effect of outlet diameter



Slide 7. Effect of air bag volume



Slide No. 6 notes the influence of the size of the gas outlet upon the energy absorbing characteristics of the air bag. Both the maximum acceleration of the vehicle occupant and the bag inner pressure show a similar curve; they tend to increase when the diameter of the outlet is smaller and to mark a quadratic increase in the relation with the impact speed. The rebound rate varies in a big range, showing an extremely high value as the size of the outlet is small. The increase of the rebound rate is in accordance with that of the impact speed. But, on the other hand, the maximum deformation increases along with the size of the gas outlet. If the diameter of the gas outlet becomes big in size, it gets difficult to figure out the maximum quantity of deformation at a low speed when the bag inner pressure doesn't increase enough to produce a rebound, that is, the body block goes under the bag.

Next the effects of the quantity of the air bag were examined. In Slide No. 7, the bag were analogous in shape to each other and the area of the gas outlet was set in proportion to the volume of the bag. As the quantity increases, the bag inner pressure drops in

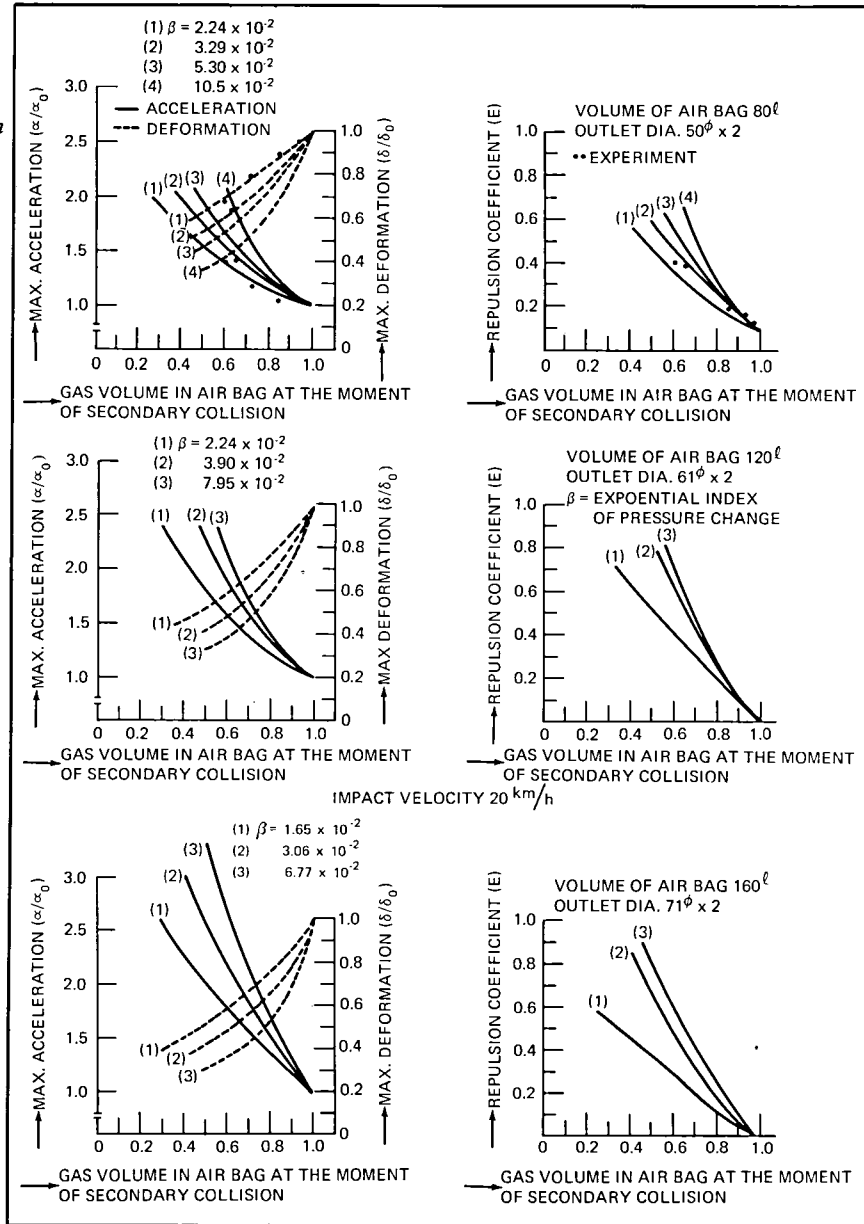
reverse, and the maximum acceleration of the occupant decreases accordingly. Especially, a big effect of this phenomenon can be achieved at a very high speed impact with a small rebound rate, which is a desirable form of the energy absorption, though the increase of the bag's deformation is seen.

The time relation between the bag inflation and the secondary impact of a vehicle occupant varies according to the type, mechanism etc. of a sensor, a gas generator and other equipments comprising the air bag system. In a system which has little time between the bag inflation and the secondary impact, the gas may be still flowing into the bag even at the moment of the secondary impact.

Slide No. 8 shows the calculation results of the energy absorbing characteristics of the air bag in the process that the gas is flowing into the bag, and a circle denotes plotting of measured results. The horizontal axis represents the gas quantity inside the bag at the moment of impact. The quantity 1.0 means the state that all the gas in the vessel has flown out and that the bag is completely inflated.

Slide 8.

Effect of the timing between inflation of air bag and secondary collision



The vertical axis represents the maximum acceleration, the maximum deformation or the rebound rate, and the quantity 1.0 is the value given at the moment of the secondary impact after the complete outflow of the vessel gas. The measured and the calculated values here are relatively in accord. As the gas quantity in the bag is small at the moment of impact, that is, the time between the bag inflation and the secondary impact is short, the maximum acceleration and the rebound rate increase rapidly, and the maximum deformation decreases on the contrary.

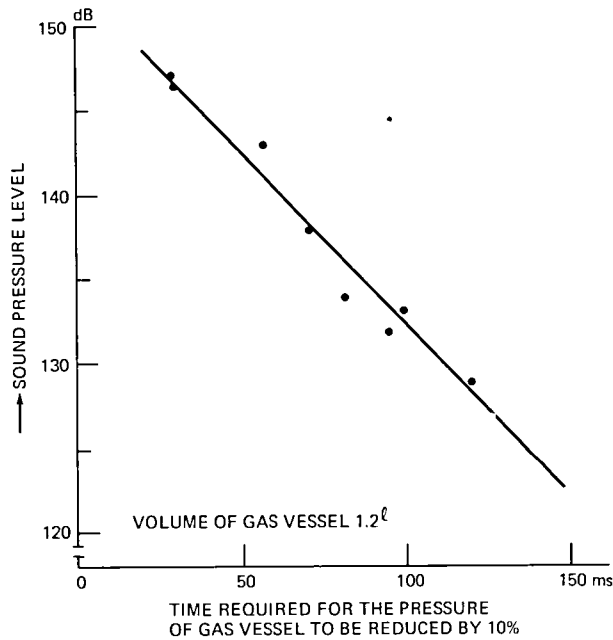
This is because the inner pressure of the bag is raised by the gas supplied by the vessel in the process of the bag's deformation. Therefore, the maximum acceleration and the rebound rate show a rapid increase as the quantity of the outflow from the vessel

is big for the unit time.

However, provided that the time between the bag inflation and the secondary impact is fixed unchanged, the increase rates of the maximum acceleration and of the rebound rate are smaller in the case of a bigger value constituting a more rapid bag inflation.

Slide No. 9 shows the result of an examination of the relation between the outflow time from the vessel and the sound pressure level. The sound pressure level marked a rapid increase, as the required outflow time was short, and here arises a problem of hearing damage of a vehicle occupant.

Thus it has shown the limit of the rapid inflation of the air bag and the strong need that the sensor should control the timing between the bag inflation and the secondary impact.



Slide 9. Relation between release time of gas and sound pressure level

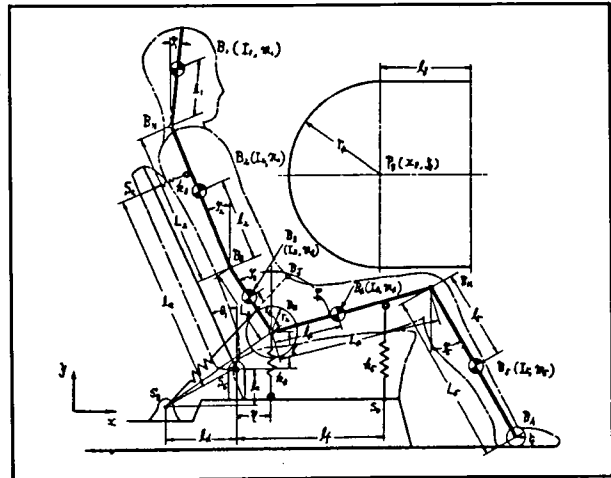
Simulation of occupant behavior

The mathematical model as shown in Slide No. 10 was used in the evaluation of the behavior of the vehicle occupant. It consists of five components, namely, head, torso, pelvic region, the femoral region, and lower leg. Springs are set in the seat back and the cushion and the stepping force by foot is taken into account. It was taken that the reactive forces were distributed to each pivot of the components and that loads were imposed perpendicularly on the center of contact area, the quantity being in proportion to the contact area of the occupant with the bag.

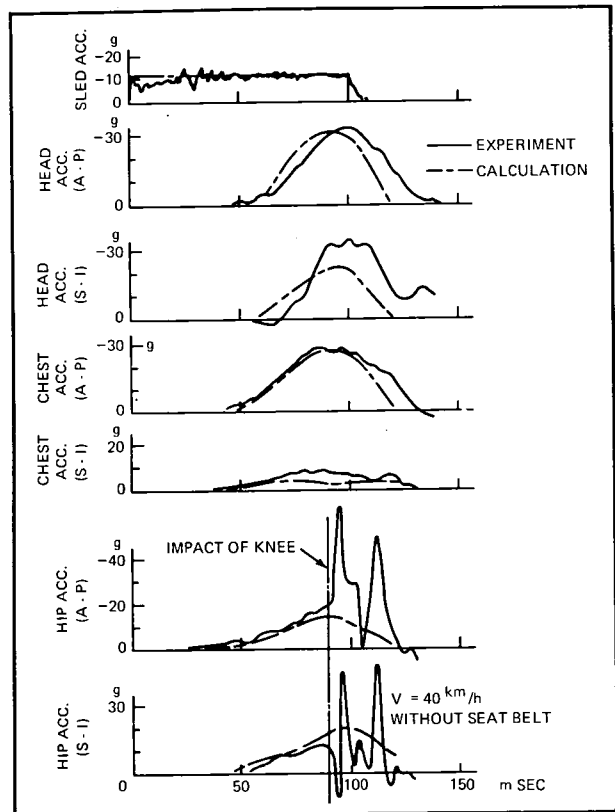
An impact sled was used for the test (not reproducible). The passenger compartment was fixed on the sled and an air bag was installed there in front of the front passenger seat. The calculated values of the occupant's acceleration which were to be compared with the measured values were determined with the acceleration of the impact sled approximating a rectangular wave.

Slide No. 12 shows the acceleration of each part of the dummy. Comparison of the measured and calculated values found that both of the values generally accorded with each other except that there was a phase difference between them for the head acceleration. The pelvic acceleration showed an abnormally high value in the measurement due to the fact that the knees impacted the dash board around 90 milliseconds. To summarize, a general accord was

Slide 10. Mathematical model of occupant in head-on collision (equipped with air bag)



Slide 12. Acceleration of dummy

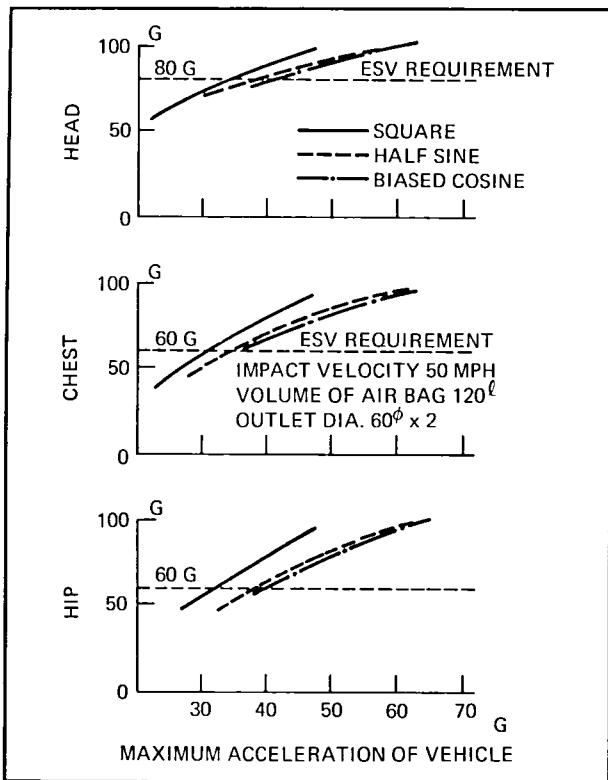


confirmed between the measured and calculated values regarding the acceleration of each part of the dummy and its locus.

Influence of crash characteristics on occupant's impact

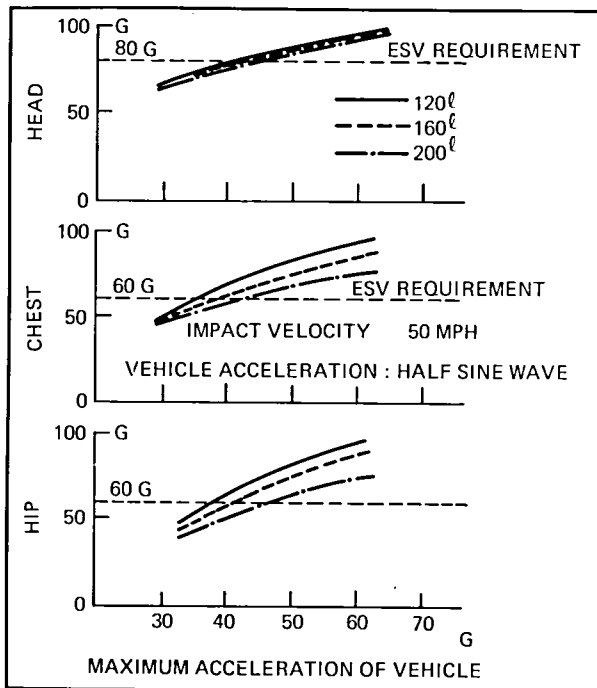
Influence of crash characteristics on occupant's acceleration was studied by use of the mathematical model explained before. Slide No. 13 shows the relation between the maximum acceleration of the vehicle body and the acceleration of each part of the occupant in the cases that the acceleration waves of the vehicle body are of square, half sine and biased cosine respectively. It is indicated that the acceleration of the vehicle body need to be less than 40g in order to meet the crash injury criteria; head acceleration-80g, chest acceleration-60g prescribed in E.S.V. specifications. This agrees with the acceleration specified for E.S.V. front bumper-structure at 50 m.p.h. speed impact.

Slide 13. Relation between maximum acceleration of vehicle and maximum resultant acceleration of occupant



Slide No. 14 is about the effect of the bag volume on the occupant's acceleration. Increase of the bag volume seems to reduce the chest and pelvic accelerations but little effect is seen on the head acceleration.

Slide 14. Effect of air bag volume (Relation between maximum acceleration of vehicle and maximum resultant acceleration of occupant)



Summary:

Fundamental characteristics of the air bag were analysed in a form of a simple model, and effects of the size of the gas outlet and of the bag volume and influence of the bag inflation on the secondary impact were examined. The mathematical model of an occupant with air bag installation was thought out, and simulation was made regarding the occupant behavior under the equation of motion of 7 degrees of freedom. Generally, the calculated and the measured values agreed with each other and the practical worth of this model, though rather too simplified, was confirmed. The guidance and constructive criticism of Dr. Tohru Takahashi, Manager of Technical Research Dept., and Mr. Toyotaro Yamada, Deputy Manager of Technical Administration Dept., both at Toyota Motor Co., Ltd. has been invaluable and I express my deepest appreciation to them.

PEDESTRIAN SAFETY RESEARCH IN JAPAN

AKIRA WATANABE

JAPAN

ABSTRACT

According to the accident statistics in Japan, the number of fatalities and injuries of pedestrians is still increasing. Pedestrians account for about 37% of the traffic accident fatalities and this higher rate indicates a characteristics of the Japanese traffic.

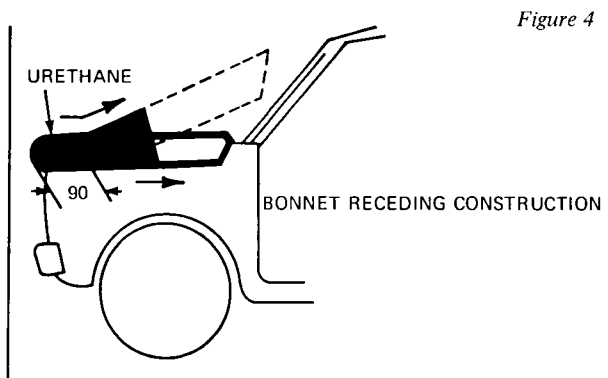
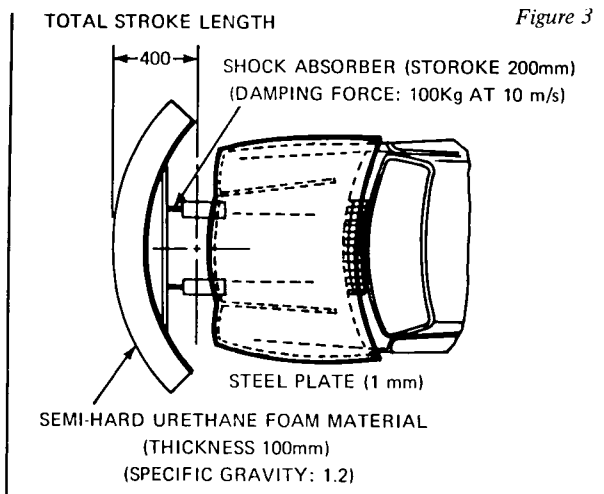
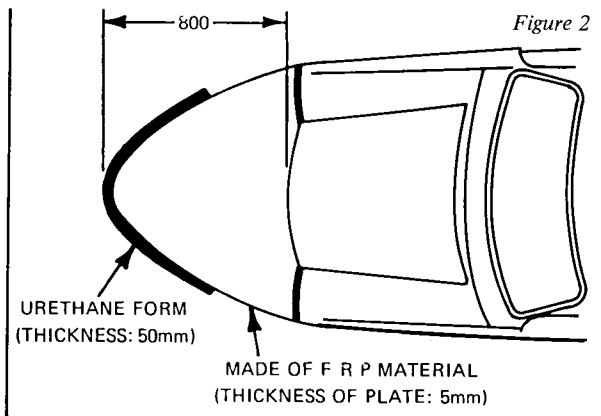
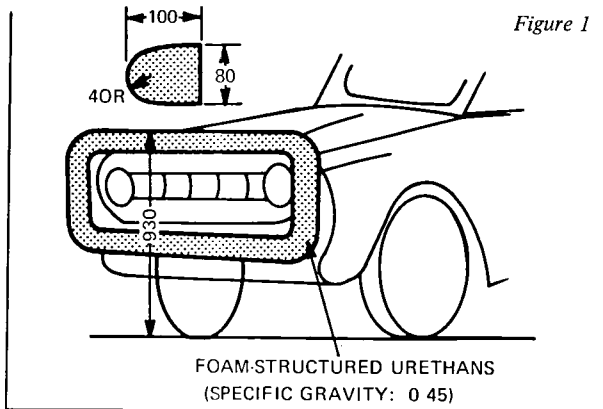
Much attention and interest has been risen to solve this urgent problem.

As for the accident statistics, reliable data available were gathered by the National Research Institute of Police Science in 1964 and 1965, and by the Society of Automotive Engineers of Japan in 1967 and 1968 with close cooperation with the police. Results drawn from the analysis afford us valuable design concepts for countermeasure and for the test methods.

The first pedestrian collision test was presented by the NRIPS in 1967 and precious data on the trajectories and impact acceleration of pedestrian dummies were obtained. The laboratory test with a pendulum impact method was also performed.

In 1968, comprehensive experiments were performed under the promotion of the Japan Automobile Manufacturers Association. Some significant results relating to the vehicle exterior design were obtained, but at the same time the difficulty of the trajectory control of a pedestrian was recognized.

In 1968, JARI established the pedestrian safety measure research sub-committee. A phase I research to develop an experimental pedestrian safety vehicle has been promoted by the group of Tokyo University of Agriculture and Technology. In parallel, other basic researches from the stand point of the human engineering are done chiefly by the group of Osaka Industrial University and Kansai Medical college. Main themes are, pedestrian behavior and physiological and psychological response just prior to the impact, the rear view mirror and visibility, the dynamic visibility at twilight and at night, aerodynamic study of a vehicle approaching a pedestrian and several kinds of pedestrian dummies, one instance, a walking dummy. These subjects are at an early stage, and most of them in an unexplored field.



AUTO-PEDESTRIAN COLLISION EXPERIMENTS

I. EXPERIMENT BY JAMA:

Specification of test vehicles

- 1) An energy absorbing rubber front bumper. (Fig. 1)
- 2) A wedge shaped front-end structure. (Fig. 2)
- 3) An energy absorbing front bumper with hydraulic damper. (Fig. 3)
- 4) An energy absorbing engine hood with hopup mechanism. (Fig. 4)

Conclusions

- 1) A passenger car decelerated by the emergency brake is not likely to run over a pedestrian, after a collision against him.
- 2) For an adult, the direct percussion affects the legs severely and secondly, head shock from striking the road, causes elevated death rate and a severe injury rate.
- 3) For a child, the primary percussion affects his whole body.
- 4) When the front-end bumper is of an energy absorbing type, considerable favourable effects can be obtained for reducing the impact force on the leg.
- 5) With the bumper provided with a lowered point of collision against the lower part of the leg, the collision acceleration value against the lower part of the leg can be reduced.
- 6) By proper modification of the front structure, some improvement in sideward repelling and shock reduction can be obtained. However, improved sideward repelling leads to the possibility of runover by other vehicles.
- 7) Poor results were obtained in effective reduction of head percussion on the road; this particular percussion is fatal and this problem remains as the most difficult one to be solved in the future. (Fig. 9)

EXPERIMENT BY JARI:

Tokyo University of Agriculture
and Technology

Specifications of test vehicles

- 1) An expanding scoop net type. (Fig. 5, 6 not reproducible)
- 2) A friction energy absorbing net on the engine hood with a foamed polystyrene bumper. (Fig. 7 not reproducible)
- 3) Energy absorbing engine hood (Laminated foamed Polystyrene blocks) (Fig. 8 not reproducible)

Design policy of the trajectory control on the experimental vehicle.

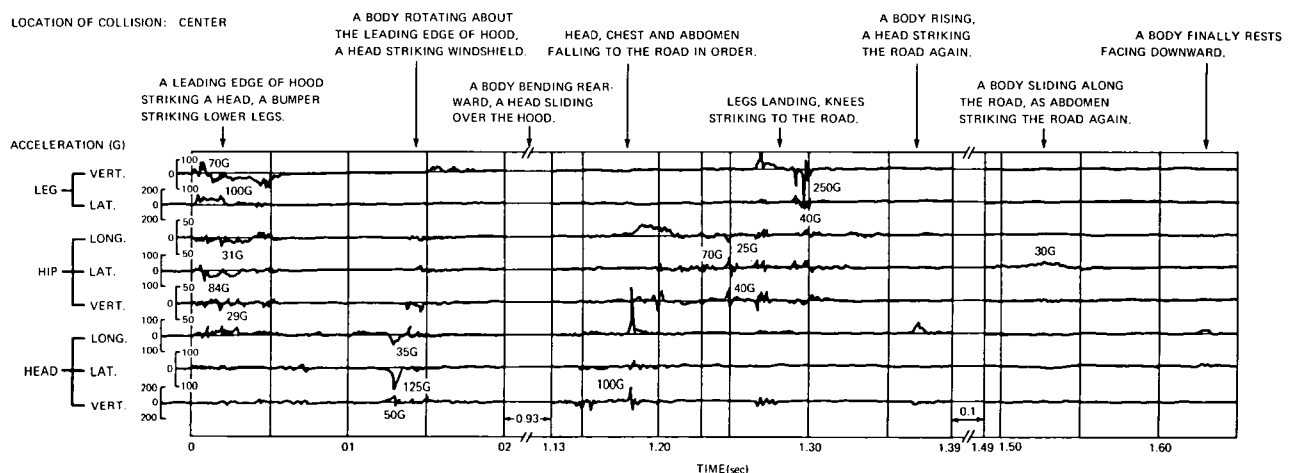
- 1) A pedestrian colliding against the center front of the vehicle should be initially cushioned by the bumper, then the rebounded body should be received on the engine hood with energy absorbing characteristics.
- 2) Keep the pedestrian on the engine hood from falling off the hood down on the pavement. If impossible, let him fall on legs.
- 3) At post-collision, a pedestrian should not be run over or dragged by the vehicle.

Good results were obtained at vehicle speed less than 20km/h.

Similar scoop net type pedestrian safety measure was tested by one of the automobile manufacturers and obtained good results.

Figure 9

VEHICLE EMPLOYED : SMALL TYPE
BUMPER TYPE : CONVENTIONAL
VEHICLE VELOCITY : 38.2 Km/h
DUMMY : ADULT
LOCATION OF COLLISION: CENTER



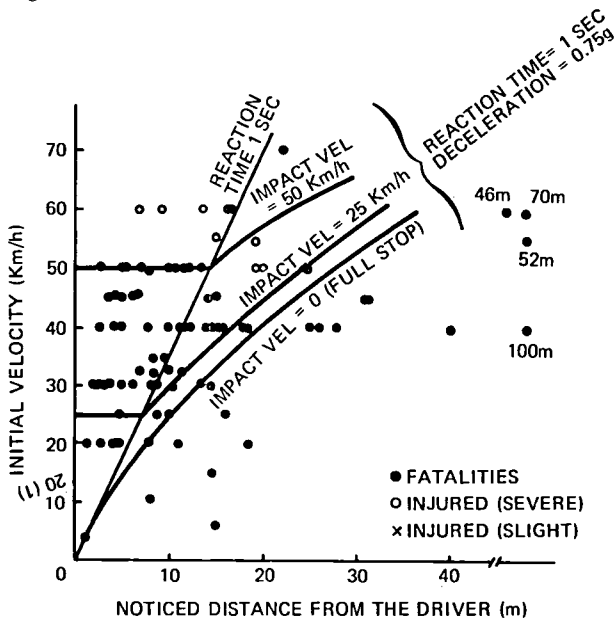
SOME ANALYTICAL STUDIES

Accident Statistics Analysis.

We can obtain some ideas for safety design and auto-pedestrian collision test methods by investigating accident data.

Impact speed range of pedestrian accident can be estimated from Fig. 10. Injured region of pedestrian upon 1st and 2nd collision is shown in Fig. 11 which agree well with the dummy collision tests.

Figure 10



() NUMBER OF FATALITIES

BODY REGION	1ST COLLISION	2ND COLLISION
HEAD	29 (7)	89 (9)
FACE	14 (0)	2 (0)
CHEST	10 (0)	4 (1)
ABDOMEN	7 (2)	1 (0)
PELVIS	60 (2)	10 (1)
UPPER LEG	25 (5)	
LOWER LEG	54 (3)	8 (3)
UNKNOWN	24 (1)	89 (5)
TOTAL	223 (20)	223 (15)

SAE OF JAPAN 1967

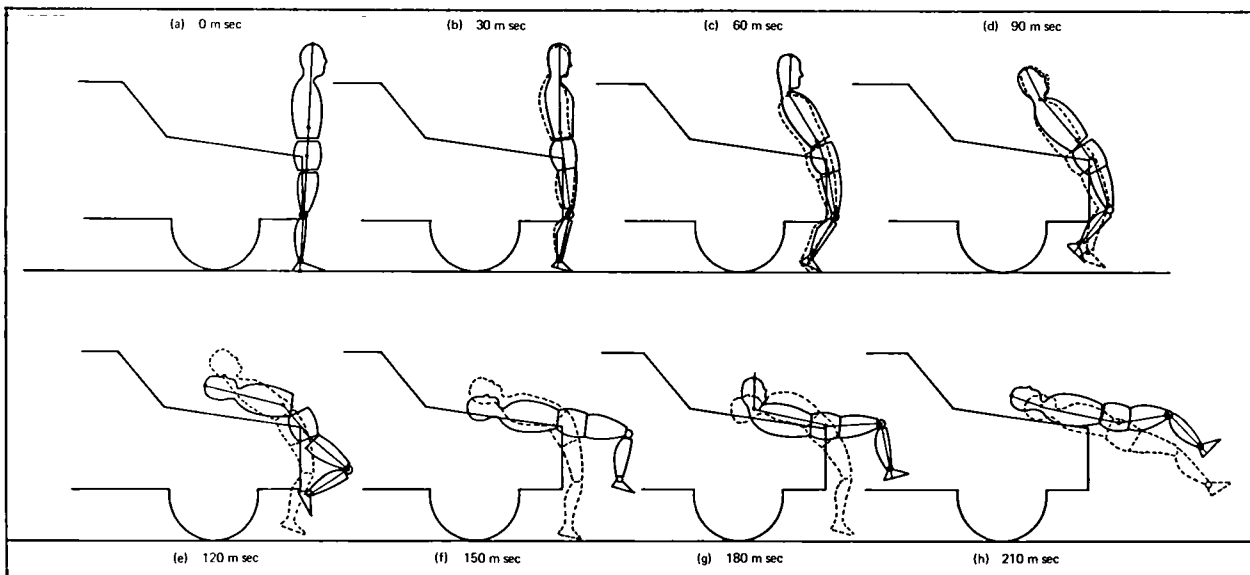
PEDESTRIAN INJURIES

Figure 11

Mathematical Analysis of Pedestrian

Simulation of auto-pedestrian collisions by mathematical model show good results when compared with experimental data. Both the trajectory and impact G are calculated. Katayama used seven degrees of freedom for pedestrian model.

Figure 12



Pedestrian Behavior prior to collision

Study of pedestrian physiological and psychological response is not only important for accident avoidance but also useful for designing dummy for experiments. Unique experiments were conducted by Asano and his test method and data are shown in (Fig. 13).

Figure 13

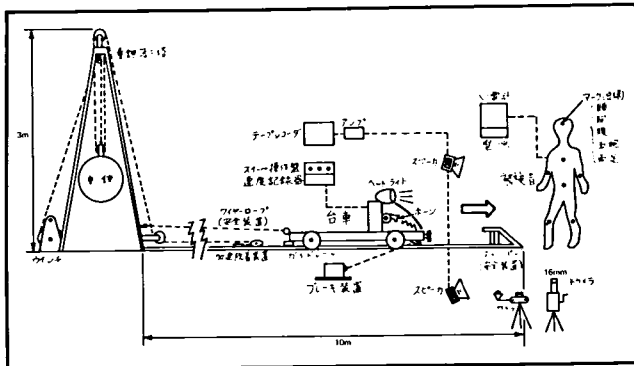
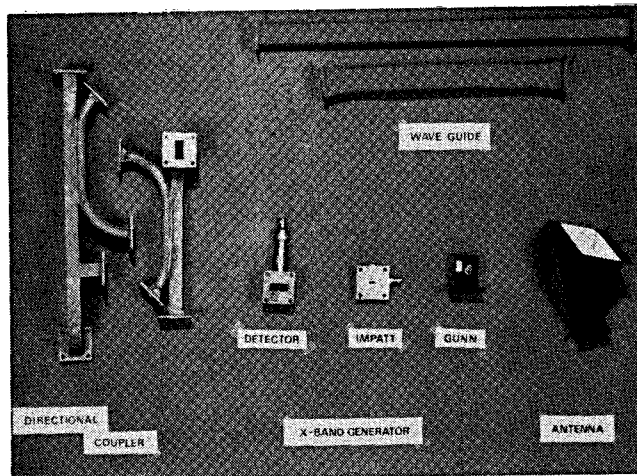


Figure 14



ACKNOWLEDGEMENT

The author gratefully acknowledges the guidance of Prof. Dr. Kondo, director of JARI, Mr. Ohkami, manager of JARI, other authors of reference paper who sent me films, Mr. Taneda of JARI who helped me and Toyota motor co. for the scoop net film.

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Figure 15

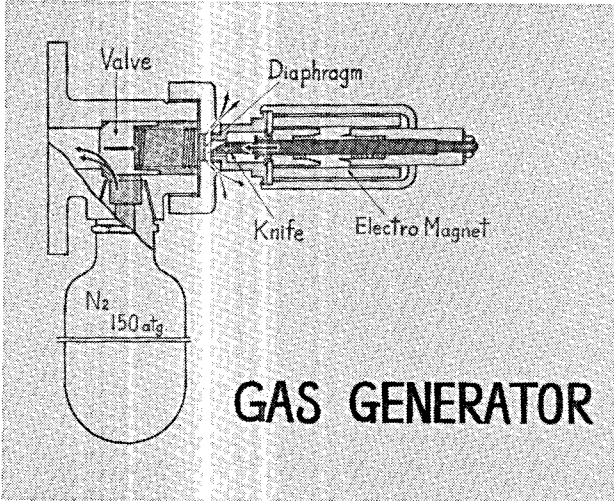


Figure 16

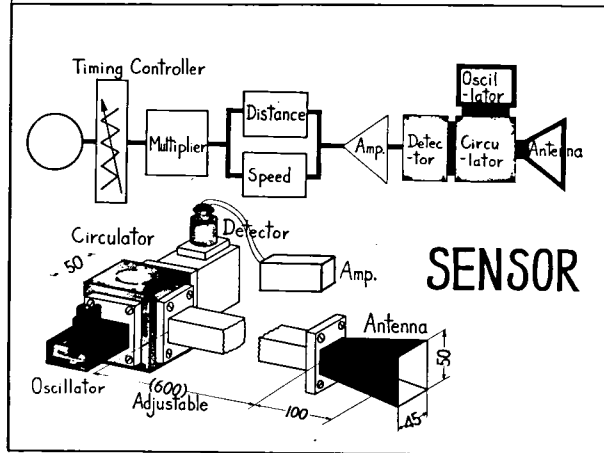


Figure 17

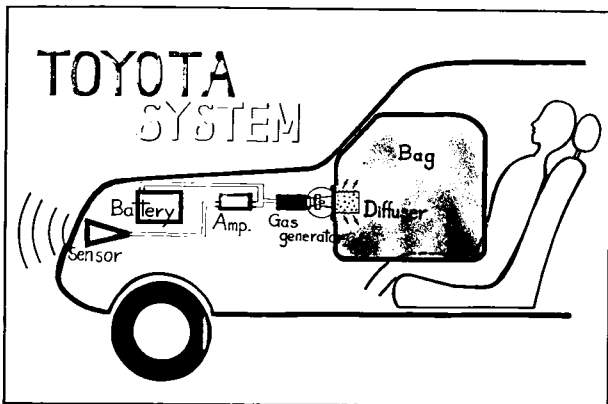
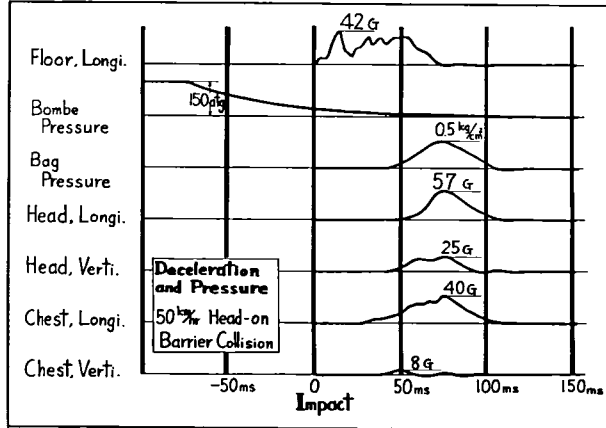


Figure 18



QUESTIONS AND ANSWERS

MR. CLAVEL (FRANCE): These are a few remarks, Mr. Chairman on the presentation made by Toyota yesterday on the Toyota air bag system. The classical air bag, the original air bag, has the advantage of being able to put itself into operation under deceleration, given deceleration, whether it is triggered off with the mechanical actuator or whether it's triggered through a sensor. This original system which is fairly simple in principle uses the kinetic energy absorbed by the deformation of the front part of the car and has the advantage of operating in an optimum fashion wherever the vehicle is and regardless of its payload.

Conversely, the Toyota air bag system which operates by electromagnetic sensor before the collision or the crash, independently of the deceleration factor, can only operate efficiently on a given vehicle, a given car, and for a given payload.

Would the Toyota representative address this first point.

A second question, I note that the Toyota air bag system impacts the body during the hundreds of a second preceding the crash. Therefore, it is no longer possible for the driver to try last second maneuvers to avoid the obstacle. In addition, he is deprived of any reflex action to prepare himself for the collision such as hanging on or to tense his muscles.

The third question, what system do the Toyota people suggest to enable the sensor radar equipment to distinguish between two obstacles of similar dimensions or similar volume? For example, a man who is crossing the road or a dog crossing a road or a small tree that the car is aiming for, or for a sign or a billboard. For the second example, it is absolutely essential that the system operates — in the first example of the man, it is absolutely essential that the system does not operate unless there's a dovetailing of the accidents.

The last question, assuming these difficulties, these numerous and very serious difficulties, could be eliminated what would be the cost of such equipment. I also ask the same question regarding the

anti-skid facility. The German delegation expressed quite correctly last night that the high costs of such safety devices may prevent many low income people from being able to afford such a car. The U.S. administration and the government must be aware of this and take account of this. Thank you, Mr. Chairman.

MR. YAMADA (JAPAN): As I said yesterday, some of the matters are still pending on the patent application, so I may have to answer in general terms.

Regarding the first question, I will repeat the question, if I may. The question was as to the payload effect between the ordinary G-sensor type, the crash-type sensor, and our sensor.

I think there may be some small effect because of the payload of the vehicle. But I don't think the payload plays a big role in sensing effect. The ordinary G-sensor type is rather simple compared to ours, but as I said in yesterday's presentation, G-sensor has merits and demerits.

Our system also has merits and demerits, but we are trying to solve the demerits. We are making progress in our development, and I believe we should make greater use of our system. Although our company has not yet determined which system we are going to use for the passive restraint system, the decision is our. We may use the radar system.

Now going to question number two, the possibility of avoiding crashes by the driver's maneuver. Well, in our system the air bag deploys just about four to five feet away from the obstacle and at relative speed of . . . You can set this speed as you wish. For instance, when the relative speed of your car and the obstacle is more than, say, 20 miles per hour, you can set up to 30 miles per hour or 15 as you wish. Also the relative distance between your car and obstacle can be varied.

In our case we believe four to five feet will be best distance setting for our system. So that when the sensor triggers and the air bag inflates on our system the accident will almost certainly occur and there's no possibility to avoid the accident.

Does that satisfy you?

MR. CLAVEL (FRANCE): Only partly in this regard the lack of visibility in the last fractions of seconds would prevent any reaction on the part of the driver.

MR. YAMADA:—But in the last four or five feet at a speed of more than 20 miles per hour, there is very little chance that you could avoid the accident. That's the way we think.

I didn't mention this yesterday, but we can evade the very close-by passing of cars, oncoming cars, even if it's very close. The sensor will not trigger and the bag will not inflate in these conditions.

The third question was, how do we distinguish between objects on the road such as trees, people or metallic types of material. There is difficulty in distinguishing various object or material. In our case we set the levels to the optimum. In other words, if you want to set the air bag, set the sensor, and timing, so as to make the air bag activate rather readily, you can set it so, or if you wish otherwise, in other words, not to activate the bag until the accident is very certain, you can set the sensing accordingly. So this will be the final adjustment to your desire, so to speak. Does that answer the question?

MR. CLAVEL: Yes and of course we can carry this discussion on further, in the panel on crash worthiness. So that if you want to expand on this dialogue and discussion, we can do so later on today.

MR. YAMADA: The last question was about the cost. Our radar system may be expensive as compared to G-sensor type system, and it may be a little difficult for small cars — that we understand. However it depends on the quantity of production. We can cut the price down, the cost down, as the volume of mass production increases.

section 2 part 4

The French Technical Presentations

THE FRENCH ESV PROGRAM

MONSIEUR FRYBOURG

FRANCE

Mr. Chairman:

This paper will discuss the French ESV Program. I will briefly discuss at first where the ESV program fits into our highway safety effort. I will then discuss the objectives of the program. Then I will describe how we are achieving these objectives. Finally I will mention the main problems of decision making, that normally accompany program development.

1. ESV's place in highway safety-

In France, improved highway safety is part of an overall plan. The efforts devoted to this plan take two aspects into account. As a plan aimed at protecting human life, safety must be placed with other activities that have the same purpose but involve different circumstances, (such as health, industrial accidents, natural disasters, etc.) As a plan involving vehicle on the road, safety must find its niche among other factors involved in transportation of people (speed, cost, comfort, convenience, etc.)

Within the framework of this double involvement, we recognize that highway accidents pose a national problem. We also recognize that improved highway safety will not come from actions limited to one aspect of the problem (the road, the vehicle, rulemaking, etc.) since we could then only expect marginal effects of each particular action. That is why it is necessary to have a coordinated program, involving government and concerned industries, in all areas of possible action. Whenever

possible, these areas have been grouped under the following headings:

- Road structure
- Use of roads
- Vehicle
- Driver Education
- Emergency services
- Public Information, etc.

Of course this is not the place to discuss the various actions which we have undertaken or intend to take in these different categories. But in the one category of "Vehicles" where the ESV program is placed, it may be useful to mention that two important types of activity are being conducted in parallel; one concerns the design of the vehicle, or more specifically the rules concerning the design, and the other concerns the maintenance of necessary or required equipment. In reference to the second activity, research is underway to evaluate the safety effectiveness of various possible modes of vehicle technical control.

2. **ESV Program Objectives-**

In the general highway safety plan of France, and particularly the vehicle aspect, we can ascribe to the ESV program, the general objective of making possible the development of tougher safety regulations relating to vehicle design, based on scientific facts. This general objective can be achieved by a shift to innovation in highway safety technology. That is, only technological innovations will enable us to determine to what extent we can improve safety performance. Technical-economic evaluations of new methods allow us to know what level of performance in the realm of the possible, should be required of the auto industry. Of course, technological innovation should be continuous in order to allow for a periodic reevaluation of the minimum performance thresholds. Obviously, France has a specific interest in the common vehicles on its roads, that is, vehicles in the 750-1200 kg class. On the other hand, I should mention that France views with great interest, the international cooperation in this field since it at least partially limits the research efforts of each individual country and because automobile rulemaking problems can no longer be confined within the borders of one country. It is because of this interest that France participates in the activities of the O.C.D.E., the European Community, and the European Economic Commission of O.N.U. For the same reasons it partici-

pates in an inter-European committee concerned with ESV's and is also looking into a bi-lateral ESV agreement with the United States, under the auspices of NATO and specifically under CCMS.

Specifically, France hopes to promote the development, of prototype subsystems affecting primary safety (accident prevention) and secondary safety (protection of accident victims). These subsystems will be integrated into vehicles that will be subjected to experimental performance tests. We will also examine the costs implied in mass production by subjecting all the necessary parts to technical-economic appraisal. In addition to these technical innovations, the government has begun a research program in the field of biomechanics to determine human impact tolerances. These tolerances will be considered whenever possible to appraise the value of innovations.

At present, we do not consider it necessary for the French government to incorporate, in one vehicle, all the most advanced safety features we can think up. Of course, problems will arise, concerning, for example, cost, weight and volume, in incorporating all these safety features in one vehicle, and perhaps problems of alternative types of safety equipment will also arise. The solution to some of these problems will perhaps result in the building of the ESV where more new subsystems will be incorporated. But we believe that once a certain number of economically acceptable minimum safety specifications are set, it will be up to the manufacturers to optimize the use of compatible subsystems in designing these cars. We also think that this method will accelerate the technological development of safety in France and will limit the cost of our preliminary research studies. We understand, however, that other methods could be explored in order to reach the same goal, and we also think that it is beneficial to the success of this operation that different measures toward attaining the same goal be taken in other countries.

3. **Methods for accomplishing an ESV Program-**

In order to accomplish the objectives that we have just reviewed, France has just launched its first ESV program for 1971 and 1972 at a cost of 8 million francs, half of which are government funds. Decisions concerning the 6th Plan

(1971-1975) have not yet been made, but we hope that R&D funds for vehicle technological innovations will reach 20 million francs in 5 years. In the first stage, the French program will be principally concerned with improving secondary safety, that is the protection, following a crash of vehicle occupants and pedestrians.

Relevant subjects proposed to the automobile and equipment manufacturers cover the areas of survival space (interior intrusion) in case of a front or side impact, the protrusion factor of vehicles vis-a-vis pedestrians and other vehicles, the protrusion factor of interior equipment (controls), active and passive safety features, fire prevention, and lighting and visibility improvements. Only the last two are concerned with primary safety. However, we anticipate expanding the program in the near future, to the whole area of primary safety, that is accident prevention. We still have to cover areas such as; signals, braking, road grip and "driving assistance," that is putting the most adequate complete information and controls at the disposal of the driver, so that he can quickly make decisions in potentially dangerous situations. And even more ambitiously, we hope to incorporate at least partially, automatic decisions for driving tasks.

The procedure used in this program consists of requesting industry and research centers, concerned with a particular innovation, to propose themselves the levels of performance that they plan to meet thru the development of a new subsystem. The proposed projects will be undertaken, taking into account the performance goals, the efficiency and the research experience of the organization, and the cost of developing and testing the subsystem, all within the budgeting constraints of the ESV program.

We hope, by this flexible procedure, to develop

some concrete and progressive improvements in vehicle equipment and structure without having to wait for the satisfactory resolution of all the problems.

4. Problems arising from administrative decisions-

As I have just explained, the ESV program ought to provide objective information enabling us to make administrative decisions in the area of rulemaking. However, this is not the only information to be considered and we must mention the additional problems which involve the goals of the ESV program. We can classify the problems that arise in making decisions into two categories: the first involves the problems of technical and financial choices, the second concerns the problems of international rulemaking coordination.

The problems of choice arise each time that a number of different approaches lead to the same ends. For example, in braking systems, we could improve the road surface, or the tires, or the braking system itself, all of which reduce the frequency of emergency braking situations.

These problems of making the best choice between two standards by determining which will have the best payoff in improved safety—are very complicated and require a number of studies like cost-effectiveness to be included in a study of the total system.

Nevertheless, happily or unhappily, considering the present level of highway safety and considering the anticipated, in the future, effects of various methods, we are not trying to substitute one solution for another, but we are trying to increase the effects of all of them.

We can not forget the problems that arise from international automobile rulemaking. It is ob-

vious that it is in the interest of the consumer and increased safety, that the standards set by different countries ought to be as uniform as possible and the modifications of these standards ought to be coordinated and announced early enough so industry can meet these standards in the most economical means possible.

The area of international rulemaking is the concern of various specialized organizations, specifically the European Economic Commission and its Working Party 29. These organizations cannot stop their work during the implementation of an ESV program.

But it seems that from now on the really notable innovations in rulemaking cannot be introduced until after the results of the ESV programs are known.

Thus, it seems to us that it will be necessary to put a greater priority on the ESV program achievements than on the procedures for presenting the results of the ESV program to the national and international spheres.

The collected facts ought to concern not only the performance achieved but also the financial and social repercussion of the tested innovations. Only in this way can a coordinated attempt at profitable and innovating rulemaking be undertaken.

Thank you very much.

VEHICLE DYNAMICS IN SAFETY RESEARCH

MONSIEUR SEZNEC

FRANCE

Since the birth of the automobile, French manufacturers and users have set a great value upon handling quality. Since that time this interest has never decreased and a very strong feeling remains that handling is a prime factor of safety. Accordingly, manufacturers have been dedicated, year after year, an important part of their research activity to this field. This found expression in design, the connection with ground, the tires in particular, underwent a constant evolution resulting from the search for still better stability, often at the price of an increase in the cost of the vehicle.

If the French Authorities did not identify *handling* in the list of the safety research items they are ready to finance, they did so because they were aware of the efforts that the manufacturers have already undertaken in this field and of the results they have already achieved.

We are pleased to see that others throughout the world have the same concerns and questions as we do and we hope that this opportunity to exchange views will be followed by other opportunities.

It appears through what already has been published concerning Experimental Safety Vehicles that the prime concern is to make handling quality more *objective*. We fully approve of this approach, as presently it is easier to design vehicles that are satisfactory in this respect than to explain why they are satisfactory.

The currently quoted criteria are of three types very different by nature, creating a method and a state of mind that are also different:

- 1) Tests measuring a characteristic of the vehicle, but not reproducing a practical driving situation (e.g. measurement of the understeer coefficient on a skid-pad).
- 2) Tests reproducing a current driving situation (response of the car to a steering input).
- 3) Design requirements (suspension frequencies).

We shall not discuss here the elements of the classical debate over advantages and disadvantages of these various criteria (one may refer to the exhaustive work of Cornell Aeronautical Laboratory on this issue) but we shall address this subject later on.

We will try to explain more precisely the chief reasons for our investigation of this most vast problem and at the same time to give a overview of some of the areas we have identified for research work.

We should point out however that, we lack precise informations on the exact correlation between handling and safety. In parallel with the technical considerations, accident investigation could help solve this problem. We have certain ideas of this correlation, but they need improvement.

In Europe, the concept of stability is outdated. The problem is to improve as much as possible the ease of driving. The average driver should be able to face the most varied driving situations and easily guide his vehicle, resorting only on his judgment. There are three requirements to accomplish this:

- feed back to the driver only worthwhile information,
- on the other hand, give him in a reliable and precise manner the necessary information to enable him to make an easy judgment and a quick and sound decision,
- then, after that decision, give him a vehicle with an excellent response to the order given.

These requirements pose the following implications:

- Near the adhesion limit (admitting that a significant percentage of accidents occur in that condition) it seems to us more interesting to know the behaviour when approaching that limit than its exact value as the test conditions on a stabilized and prolonged turn are rather artificial. (It may be pointed out that low-powered cars may be penalized by lack of tractive force in those tests of transverse acceleration).

For high transverse accelerations it is important for the driver to preceive the approach of the limit of adhesion and to instinctively undertake the ultimate preventive maneuvers. Taking the maximum advantage of adhesion leads in general to non-forewarning vehicles.

In the same line of thought the interest of breakaway type tests would be notable reinforced by limiting the possible wheel lock angle and the speed of rotation of the steering wheel so as to reproduce

the behaviour of the average driver and avoid acrobatic maneuvers (any reference to racing cars must be prescribed).

- We also endeavour to specify a significant type of test regarding the influence of motive torque. In this respect, the general layout of the car is not immaterial (mode of propulsion).
- Mere understeer characteristics measured at constant speed on a skid-pad seem too inadequate and unrealistic to give an understanding of the dynamics of the vehicle.

It is easy to design cars with equal understeering but which have quite different behaviours. Other information is necessary (damping, response time, overshoot, oscillatory or non-oscillatory character). It is more important to try to correlate these responses with a subjective judgment (frequency excitation, importance of transient and permanent operation, roll/yaw phase displacement, acceleration with steering deflection). (See attachment and Fig. 1).

It is equally important to examine the influence of the law of variation of the steering wheel input force on the vehicle response. The search for good stability with steering wheel released must not impair the quality of the response to the driver's input.

- The last aspect of handling, which seems to us of prime importance in the present European traffic conditions, is the ease and stability of handling on uneven road, (but is not this problem common to all countries?).

In this area important work needs to be done for two reasons:

- 1) A poorly designed car moving over unpredictable road unevenness, the steering wheel being either free or blocked, may create for a good driver very dangerous temporary behaviour. It is therefore necessary to study the coupling suspension/handling on uneven ground, as it is quite possible that such driving conditions are the origin of a number of accidents and create a stress and strain that may generate second-degree accidents.

Of equal importance is an examination of the consequences on trajectories and limit values of transverse acceleration resulting from uneven roads that modify the reactions normal to the road and consequently the lateral forces generated by the tires. It is obvious that these shortcomings are caused by different

road features (wavelength of unevenness, large in the former case, small in the latter).

- 2) In the whole array of means to regulate the handling of a car, quite opposed effects, as an example when driving on even or uneven ground is considered.

It is therefore dangerous to have little or no interest in vehicle behaviour on uneven ground. To do so would neglect an important aspect of the problem of motor vehicle handling. (See attachment and Fig. II).

- The requirements of the American statement of work for the ESV which sets narrow limits for the frequencies of front and rear suspensions (with disconnected shock-absorbers) seems to us to be an unproven relationship with safety and comfort. Comfort criteria, function of the shock-absorbers, of the seats (and still many others) must also be considered.

Today's experience already demonstrates that research is sterile when unjustified initial constraints are imposed.

- Data available to-day are too few and insufficiently refined to give a good understanding of the tire as a fundamental element of handling properties.

It is necessary to obtain complete and analytical knowledge of the forces generated by the tire in different types of environment (permanent or transient operation). To this end we are building a laboratory machine that will enable us to get such information.

If we take for granted that the main problem to-day is to fill the gap between subjective judgment and objective appraisal by quantification. And if we admit that the work done on ESVs must above all bring an advance in knowledge, then we feel that the establishment of standards should proceed slowly until some of the uncertainties are resolved.

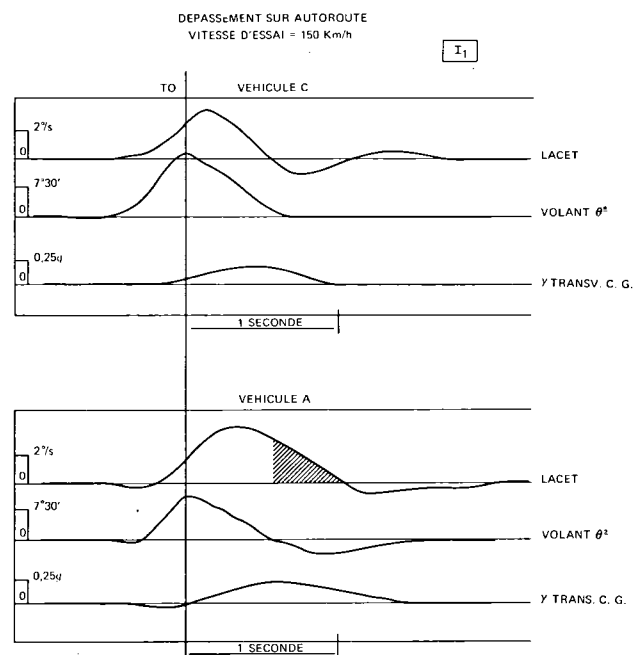
In a first stage, we think it much preferable to have driving situations tests in order to search for the correlation between objective and subjective and to distrust other criteria, as long as a reliable results are not available.

For the present we should allow for the exchange of information that can begin immediately and for the establishment of a research program where ESVs will, by varying handling parameters, create reliable experience data. It should be pointed out in this respect that the European automobile industry is potentially more interesting because of the variety of

designs and because they already have a long-established concern for handling quality. It is of the utmost importance not to constrain the ideas from the start.

For our part we are ready, to proceed with the exchange of information and to initiate a common research safety effort.

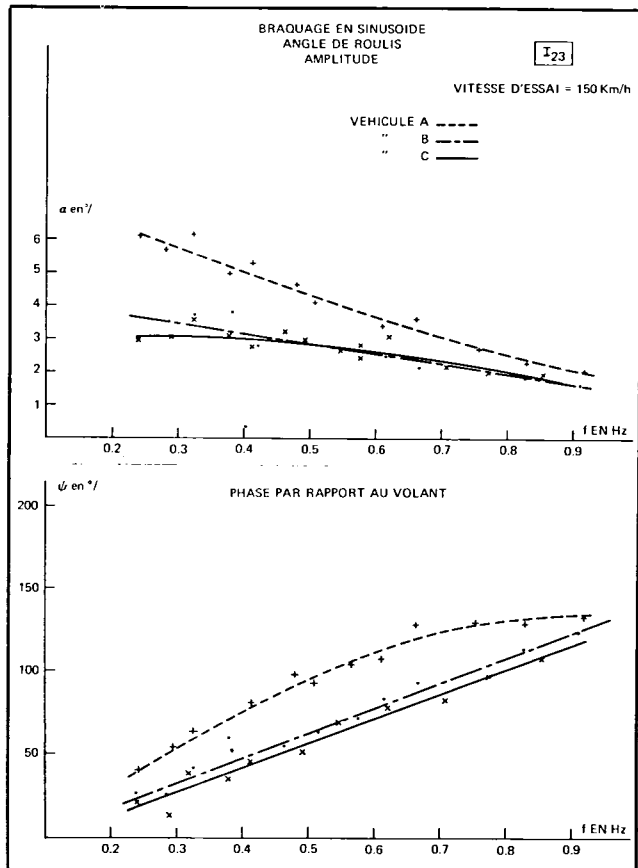
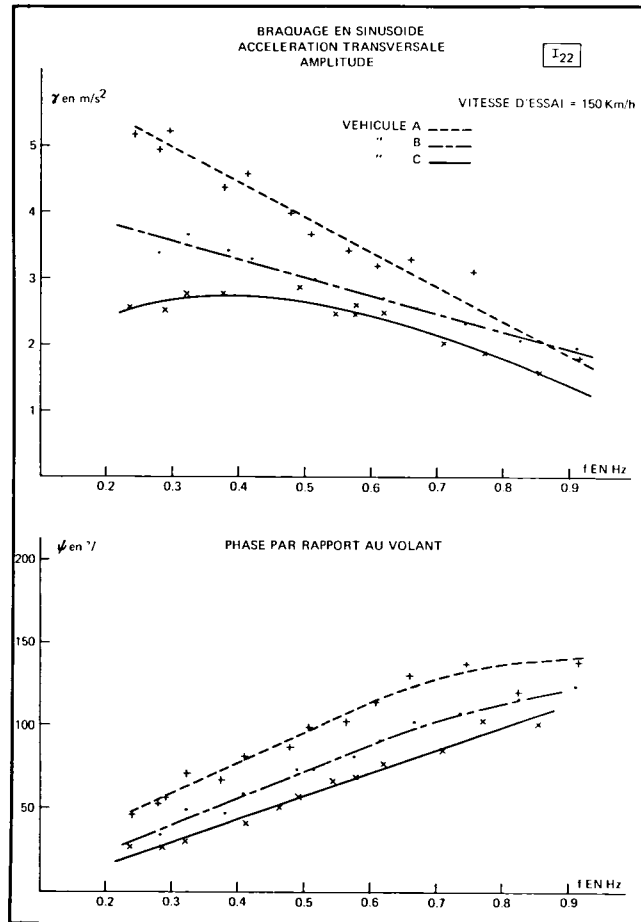
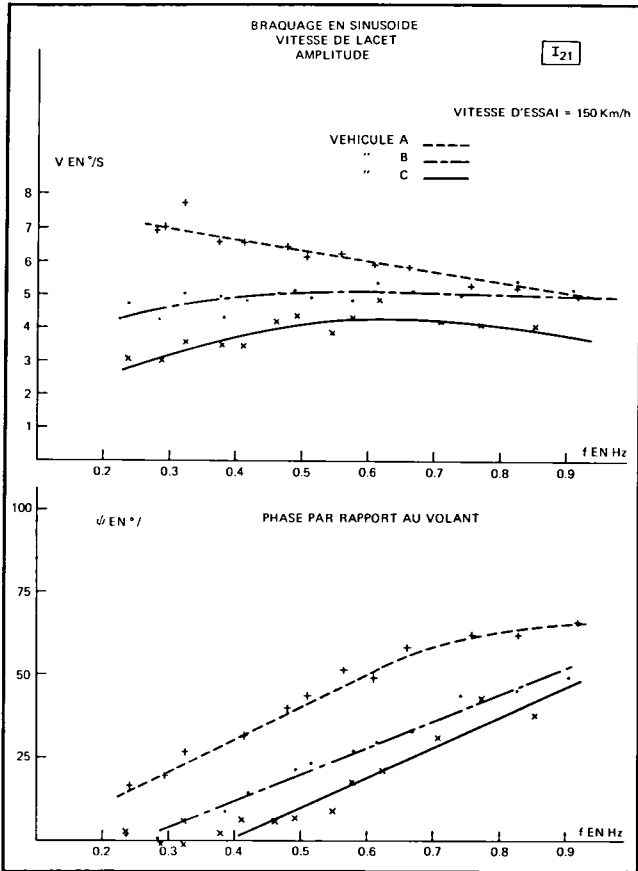
Fig I, 1 gives the response on a motorway of the yaw velocity versus steering input. Vehicle C is judged subjectively far better than vehicle A.



The vehicles are then tested with a sine-wave steering input. Two types of information can then be used: response in transient operation to establish the correlation between objective and subjective, response in permanent operation to the same end and also to establish the correlation between calculation and test.

It should be noted that one of the parameters of handling quality is the phase displacement between steering wheel angle and yaw velocity, in the range of frequencies of quick human input (0.5 hz). That value of phase displacement yaw/steering if very small, gives cars with a sharp response. The driver, having given his order, does not feel the need to alter it.

These cars having been driven a considerable distance and it was therefore possible to record and measure the sum of the steering corrections introduced by the driver: the comparison is in favor of car C.



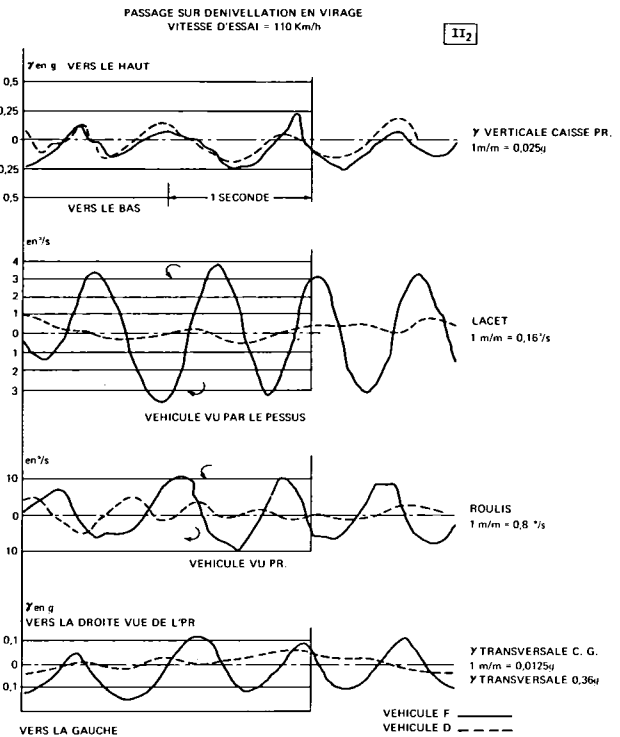
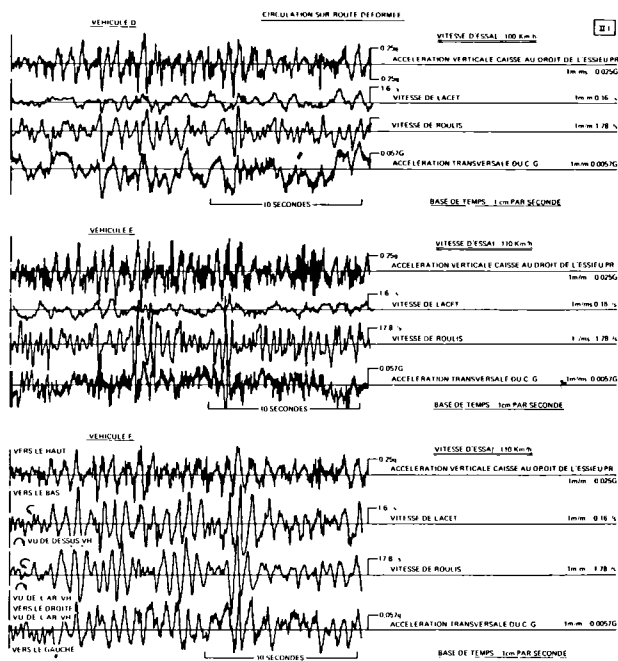


Fig II, 1 allows a vehicle performance comparison, on a road section with a profile warped transversely as well as longitudinally (French national road). The cars D.E.F. have blocked steering.

- Car D is characterized by low yaw and roll velocities.
- Car E is characterized by an important roll velocity, while the yaw velocity remains low.
- Car F has high yaw and roll velocities, both being moreover coupled.

It may be noted that vertical body accelerations are very close to one another on the 3 cars.

The subjective judgment indicates that car D is excellent while car F is termed difficult to drive, requiring a constant attention, without however being judged as dangerous on this road.

These 3 vehicles are then, as shown by Fig II, 2 tested on a turn presenting an unevenness 3 cm (1.2 in) deep with a long wave-length that is in no way exceptional.

The observed responses show the same properties as in the previous test.

Car F is, under these conditions, judged as dangerous although the transverse acceleration does not exceed 0,36 g - 0, 1 g.

The importance of yaw, coupled with roll, leads the driver to become anxious and to perform inadequate steering maneuvers.

THE IMPORTANCE OF VEHICLE AGGRESSIVENESS IN THE CASE OF A TRANSVERSAL IMPACT

MONSIEUR CHILLON

FRANCE

WHAT IS MEANT BY AGGRESSIVENESS?

We term "aggressiveness", as the action of a vehicle towards persons outside it in the event of an accident. Aggressiveness is the opposite of "protection", which is the action of a vehicle towards the persons inside it. Aggressiveness can only cause victims; protection on the other hand, is positive if the passenger has been truly protected from aggressive attacks from the outside, or negative if the passenger has been injured on the second impact.

Each constructive parameter in an automobile, plays both an aggressive and a protective part. These two effects should both be taken into consideration in order to obtain a valid opinion of the effect of the parameter on injuries caused in various types of accidents.

Why have we decided to speak today of aggressiveness, whereas it might be thought that this is only one parameter amongst many others? This is because we feel that the "protection" role of the car has been the object of numerous and extensive studies leading to the ESV standards and projects, whereas the aggressive role whose action is equally important (for we have established that aggressiveness occurs in 87% of accidents approximately) remains, generally speaking, under-estimated if not totally forgotten.

WHY HAVE WE ESPECIALLY EM- PHASIZED THE ROLE OF AGGRESS- IVENESS IN THE EVENT OF A LATERAL IMPACT?

-Firstly, because a lateral impact represents a serious danger and is a cause for grave injury as displayed by statistics. (31% of persons seriously injured).

-Because whatever their structure design, all cars

present a congenital weakness in the resistance of their bodywork sides, as opposed to the front and rear blocks capable of absorbing energy by distortion.

-Because owing to the relative weakness of the protection supplied to the doors, the aggressiveness of the car front is both powerful and obvious in the case of direct 'dagger' penetration in a lateral impact.

Lastly, because through the study of the relative action of the "aggressor" front and the "protector" side, we hope to display a certain number of directive ideas concerning the construction dispositions, capable of saving human lives.

We propose firstly to show in this report, how a transversal impact happens. A very short film will specify the reality of the assumptions expressed. Then we shall present a calculation model explaining this behaviour and specifying the roles of the various parameters intervening in this very dangerous penetration.

Next we shall establish to what extent the technical orientations resulting from this inquiry are, or not, compatible with the other construction concerns involving the same parameters: safety of pedestrians, accelerations during the second impact, reinforcement of the car fronts in order to reduce damage in the case of slight impacts.

Finally, we shall propose the conclusions which appear to us to precede from this study.

DEVELOPMENT OF A TRANSVERSAL IMPACT

During the true tests of lateral impacts between cars, which we have carried out on different models, we observed that the behaviour may be outlined very simply.

In the first phase, the striking car penetrates purely and simply almost without distortion into the car struck whose bodywork side is driven in. This penetration reaches practically its maximum value before the car struck commences to slide sideways; this sliding movement commences finally when the base is reached and pushed by the wheel of the striking car. Then the two cars move together with a rotary movement depending on the conditions of the impact. This behaviour is perfectly visible on the film of the impact which illustrates the report.

We have set up a simple calculation programme which can be progressively improved, to better represent reality. It is sufficiently correct so that on a given impact test, it is possible to specify the influence of the parameters*. (plate 1). This calculation presents the impact of the crushing of a series of

non-return springs, representing horizontal sections of cars at varying heights above the ground. These crushing characteristics of each of these springs can be directly measured on the cars under consideration, by either static or dynamic tests. In the case of static tests, an increase coefficient of rigidities must be taken into account in accordance with the results of the study (*).

On plates 2 and 3 we show the drive-in characteristics considered in a test calculation, and the results obtained in comparison with the measurement result.

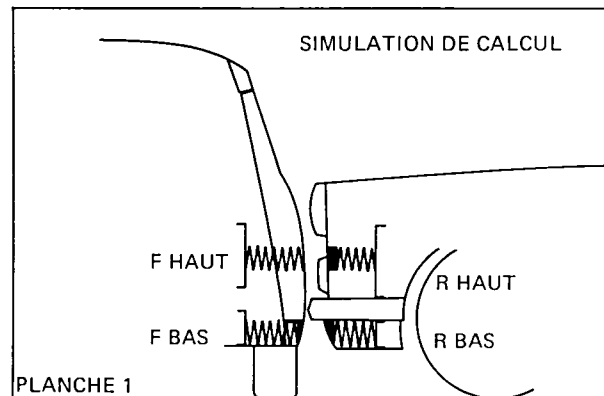


Plate 1

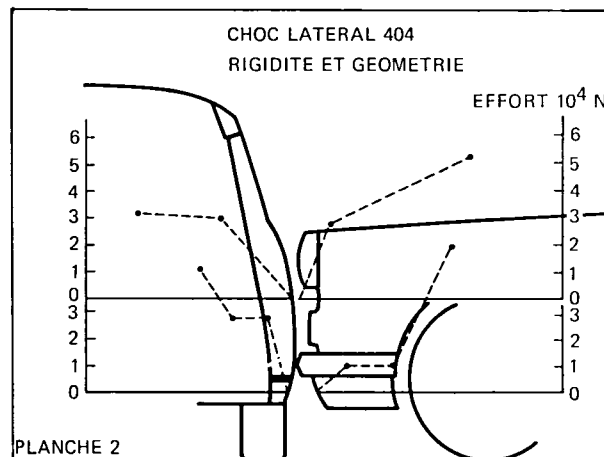


Plate 2

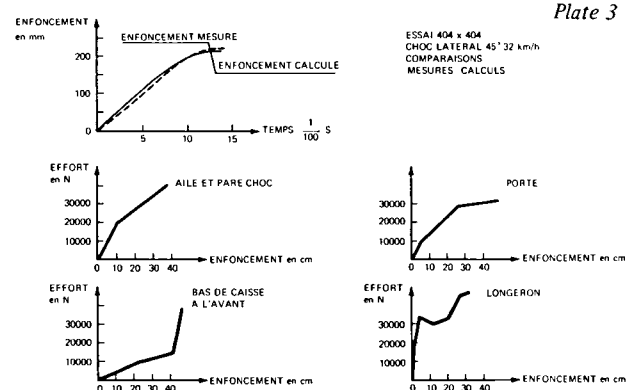


Plate 3

STUDY OF THE ROLE OF THE PARAMETERS

The mechanical study of an impact between obstacles subject to distortion has been the object of much research (*); the fundamental result for our problem is expressed (in a simplified form for the clarity of the report) in the equation

$$E = \frac{1}{2} \frac{M_1 - M_2}{M_1 + M_2} V^2$$

It may be noted that the distortion energy E is all the greater because the masses m_1 and m_2 are both greater, and naturally, when the speed V of the impact is higher. In the most current case for today's vehicles the front of the striking vehicle is far more rigid than the struck side bodywork, the latter only suffers slight distortion and the penetration "e" is expressed by the relation $E = fm$. The penetration is greater for an impact of a given energy when the resistance fm of the bodywork side is weaker.

It is interesting to increase this resistance until it attains a value in the neighborhood of that of the aggressor front. At this point the energy commences to be partially absorbed by this front itself. To take an extreme case, if the resistance of the outside of the front of the striking car is weak, and clearly less than that of the bodywork side, — eventually reinforced — the distortion energy is entirely absorbed by the striking car, and there is no more penetration. The car struck slides transversally pushed by the striking car which is slightly distorted during the impact.

Naturally this outline assumes that sufficient stresses have been applied without requiring exaggerated crushing of the aggressor front which can not be weakened over too great a depth. If the weakening concerns more than 10 cms or so, then it would be the resistance to frontal impact which would be reduced to an unsatisfactory extent.

It is therefore necessary that the greatest stresses

(*) Analysis and simulation of the vehicle to barrier impact; M.M. KAMAL ref. 700414 13th Congress of the FISITA (1970).

should occur as early as possible, lower down than the doors at the base level. The technical point which we wish to emphasize is therefore: "in the first phase of the impact, when the car struck remains practically immobile, it is important that it should be the striking car which is distorted, and not the car struck; the middle and above all the upper part of the front should therefore be less rigid over the first 10 centimeters than the bodywork side".

The second point is that the base should be touched as early as possible (after approximately 10 cms) by a highly rigid component of the front side, which may be the wheel if the overhang is very slight. If this is not possible, a lower bumper component, or a reinforced mudguard eventually resting on the wheel should receive the impact.

This analysis of the parameters of geometry and rigidity is confirmed by the results obtained from the calculation model representing behaviour under impact.

In order for this report to be as clear as possible we have processed by calculation two cases of impact which appear to us to be typical. In the first one a car with reinforced bodywork side is struck and penetrated by a car with a rigid front. In the second case, the same car is struck and pushed without any serious penetration by the other car whose front has been weakened.

It is certainly easier to make calculation diagrams than to design automobiles conforming to them. We believe that it will be interesting to have these problems dealt with within the scope of an ESV or ESSS in view of future applications. Without examining these construction problems, we question whether the present approach is compatible with the other design concerns, involving security.

Case of the pedestrian-

Specialized studies (HUTO - PEDESTRIAN COLLISION EXPERIMENT Devrin SEVERY and Harrison BRINK) (*) have showed that the essential point would appear to be the level at which the pedestrian is touched. In the case of an adult it is

PLANCHE 4: INFLUENCE DES PARAMETRES
CHOC DE BASE 404 x 404 - 45° - 32 Km/h

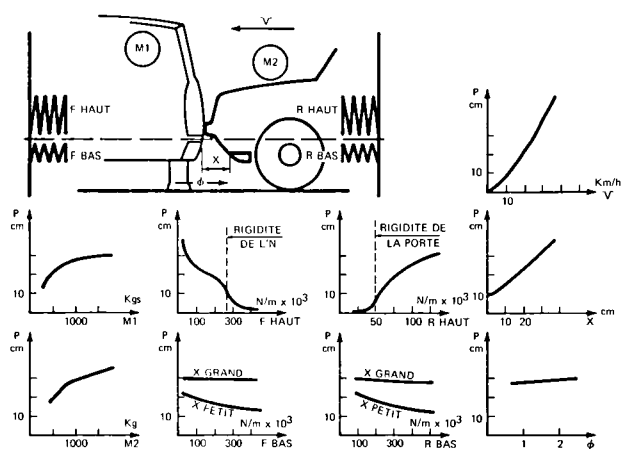


Plate 4

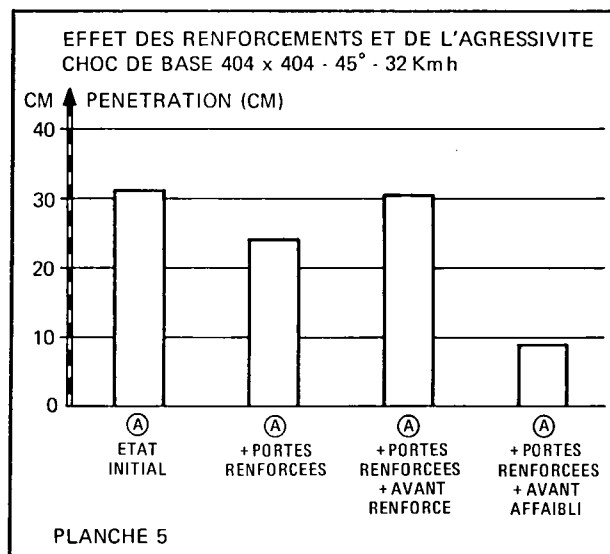


Plate 5

important that the impact should take place lower than the knee in order to avoid a complex fracture of an articulation if the impact is violent. The maximum danger is represented by cars with overhanging fronts which strike the pelvis and cause the most serious injuries.

In the case of children, the contact line of the bumpers should also be lowered and overhanging fronts avoided in order to reduce the risks of children, instead of passing over the bonnet, being knocked down and in great danger of being run-over. There is therefore, compatibility between the orientation proposed for the transversal impact and the safety of the pedestrians.

With regard to our analysis it may be considered that the passengers saved from injuries by intrusion, thanks to a reduction in aggressiveness would be subjected to a second impact which could be fatal. We are aware that this question is a serious one; solutions are being sought to reduce the danger of the second impact but we believe that it is certainly useful to remove a cause of serious injuries which may occur even in accidents at low speed.

The orientation proposed here remains to be compared with the often expressed concern and the object of draft standards, that the fronts of cars should be reinforced in order to avoid all distortion during impacts at low or average speeds. Here the contradiction is very flagrant. We believe that it is useful to reinforce the lower part of the front under the bumpers in order for it to push the base of a car struck more effectively, but the part opposite the door and above all the upper part should in all cases be weaker than the side of the bodywork. Recommendation to reinforce the front sides are clearly in contradiction.

CONCLUSION

The reduction in the aggressiveness of the front forms is therefore a problem directly concerned with safety and with the cost of repairs.

We believe therefore, that aggressiveness should first be restricted, then as a second priority a better compromise be found in forms and rigidities, in order to limit the increase in the costs of repairs for slight accidents in town.

Furthermore, from accident enquiries it would appear to be logical to determine for each construction parameter (mass, form, disposition rigidity) what influence it has on the protection of passengers, and on aggressiveness with regard to pedestrians.

section 2 part 5

The Italian Technical Presentations

THE ITALIAN APPROACH TO VEHICLE SAFETY

GIACOMO POCCI

ITALY

Since the safety car program was first initiated Italy has whole-heartedly supported the concept and the approach. We considered it necessary that we direct our attention to cars of lower weight than that which is common in the United States. Far closer, that is to say, to the size of cars that are more typical of Europe. Of course such studies, carried out on vehicles of the sort that I mentioned, are perhaps constrained by difficulties which crop up such as financial difficulties and lack of research workers. Also, incidentally, it is necessary to conduct statistical studies — studies which are very similar to the American studies, from certain points of view. Later, we will address the problems and approaches that we have adopted, which take into account the requirements of cars lighter than those common in America.

We consider that activities in this field should be developed in different stages. First of all, we must study the solution of problems that are related to the main components of the car with a view towards developing devices that could be used on cars that already exist. And in the second phase, if you like, we should develop the basic ideas which would lead us, after lengthy work, to the development of specifications that can be applicable to different types of cars.

Where the program that we hope to be able to carry out in Italy is concerned, we are absolutely convinced that there are only a few aspects that should be dealt with, that can really be dealt with. Many other aspects can be developed on the basis of the present Italian production cars. That is to say, we can develop something which will be based on existing cars and then, in a second stage we can carry out tests on specific prototypes which will

enable us to derive information which, in turn, will enable us to determine specifications and standards.

These standards would then become applicable to production models of course. This would be the basis of an overall program. In specific cases, we mustn't forget a number of economic criteria which enable us to assess the overall program, taking into account the possible repercussions on the overall production of cars.

We would like to see fruitful cooperation between all European countries in this field, and we would like to see a list of subjects set up. This would enable us, each in our individual country, to direct our work toward specific tasks. Indeed, we should have some form of division of labor, a division of tasks; one country would devote itself to one particular task with the aim being that the results of various tasks would be communicated to all the other European countries.

I think that this is a good working basis. There are specific criteria that have to be taken into account for small cars with small engine displacements. These are the popular type of car in Europe. We will discuss the specific subjects we have opted for up to now which enable us to have a knowledge car safety. Mr. Moscarini will tell you what action has been carried out and what results have been obtained thanks to Italian research in the fields that we deem to be the most important, and the most urgent.

SOME CONSIDERATIONS ON THE CAR SAFETY PROGRAM

MR. MARGARA

ITALY

FOREWORD

It was reiterated at this conference that there are two methods that can be followed to arrive at a safe vehicle: one is to study the car as a whole, build one or more prototypes and submit them to performance evaluation tests and from the analysis of the recorded data establish a set of requirements to be met by manufacturers; the other is to study the single safety themes, develop experiments and apply them gradually in production, thus acquiring the necessary feasibility and reliability know-how to eventually build safer cars.

The U.S. has chosen the first approach and has launched a program for the construction of a 4000 lbs safety car. It is no doubt the right choice, considering that this type of car constitutes the wide majority on American roads. It is however evident that with this approach the program cannot be considered comprehensive. Proof of this being that the U.S. Administration has proposed the study and development of a second E.S.V. in the 2000 lbs class for which it did not contract for but requested participation by other countries.

With these two classes, the cars on U.S. roads may be considered as practically covered, even for future years.

The question now is: can the U.S. program be transferred to Europe? In turn, we also asked ourselves: does the program meet the requirements for traffic safety in Italy?

To answer these questions it is essential to know the current composition of European cars on the roads and to make forecasts of its composition in the future. It is a known fact that the nature of the vehicle population on European roads — and particularly in Italy — is much more heterogeneous than in the

U.S.A. Passenger car production, in fact, spans the range from 500 kg (1100 lbs) to over 1.500 kg (3300 lbs).

In order to have a comparative basis for the evaluation of what will be the on-the-road passenger car picture in Europe in the future, FIAT has requested an Italian Marketing Survey Institute to prepare statistical forecasts on the European car park up to 1980.

ANALYSIS OF THE COMPOSITION OF EUROPEAN ON-THE-ROAD CARS FOR THE 70s.

Illustrated below are the results of a preliminary survey which needs subsequent improvement and extension.

Data refer to 4 car classes:

small	up to 999 cc
medium	1000 to 1499 cc
medium-large	1500 to 1999 cc
large	over 2000 cc

The fact that the survey is based on engine capacities and not on weights is no great difficulty because there is a correlation between these two factors and it is possible to consider for each capacity class a corresponding weight class, broadly as follows:

- Class up to 999 cc
- Class from 1000 to 1499 cc
- Class from 1500 to 1999 cc
- Class over 2000 cc

- : up to 750 kg (1650 lbs)
- : from 750 to 1000 kg (1650 to 2200 lbs)
- : from 1000 to 1300 kg (2200 to 2850 lbs)
- : over 1300 (2850 lbs)

SLIDE No. 1 shows the totals of the number of cars in circulation in different European Countries, taken globally, starting from 1968. Presumable incrementation is hypothesized for future years up to 1980. The total of about 55 million units in 1968 is expected to approximately double in 1980.

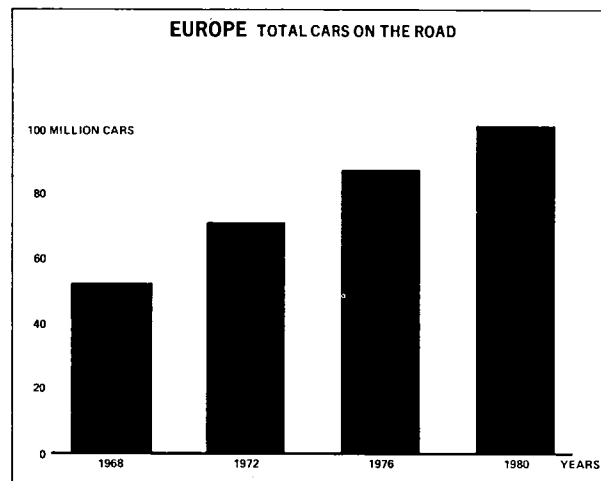
Now, let's see the total of each Country broken down into car classes.

SLIDE No. 2 illustrates the situation in Austria: in 1968 the total was made up of medium (51%) and medium-large (27%) cars; the small class totalled 15% and large cars 7%. It is estimated that in 1980 the class distribution will remain practically unchanged with some slight percentage variations.

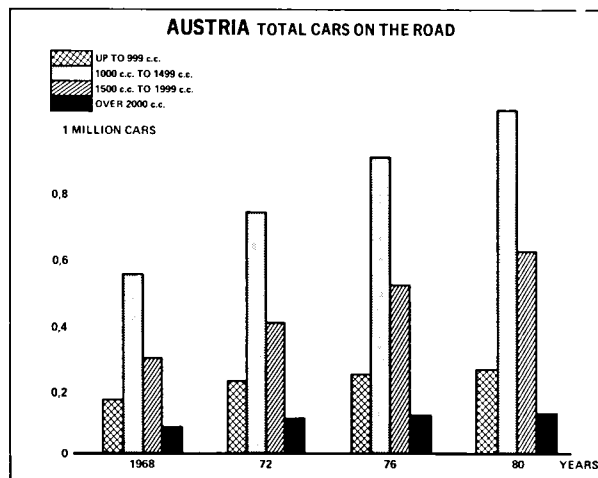
SLIDE No. 3 refers to Belgium and is based on a larger number of years, from 1958 to 1980; during this period the composition of the car total changes quite noticeably. In fact, from a predominance of small cars (42% in 1958) the picture changes to a more uniform distribution in 1968: small (31%), medium (35%) and medium-large (27%). Estimates for 1980 point to a predominance of medium (43%) and medium-large (30%) cars.

In SLIDE No. 4 Denmark shows a majority of medium and medium-large cars, a trend which, presumably, will continue also in the future.

Slide 1



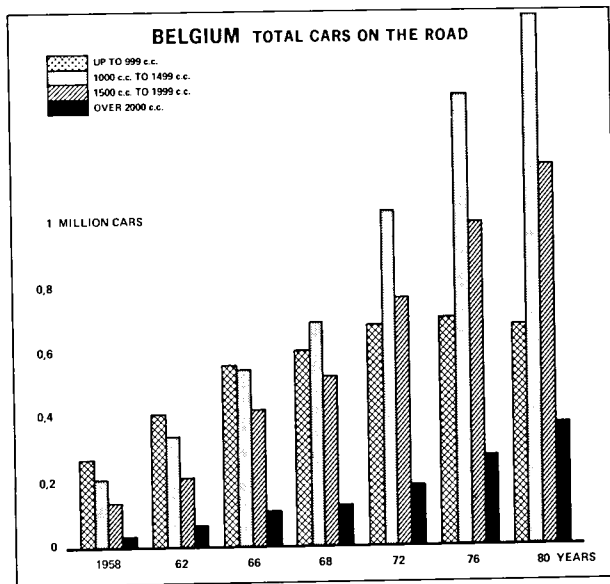
Slide 2



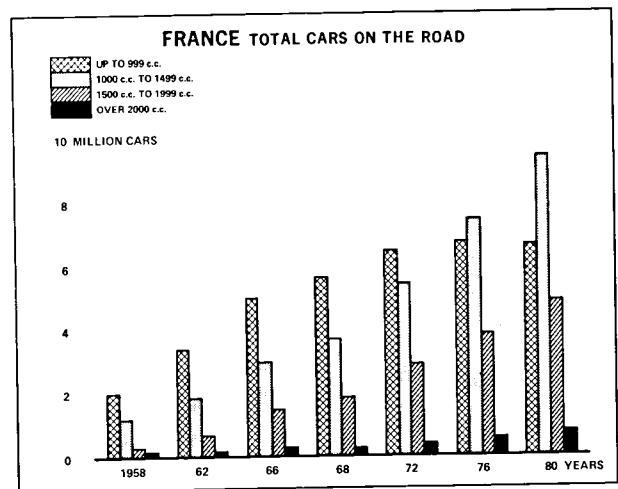
The present and future status for France is given in SLIDE No. 5: in this Country there is, and still will be during the next few years, a prevalence of small cars; only after 1975 will the medium class take a slight lead over the small cars.

Germany - SLIDE No. 6 - shows a definite tendency in favor of the medium and medium-large classes.

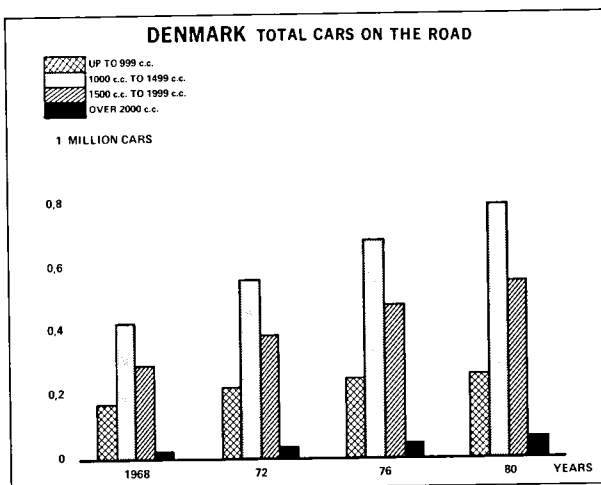
Slide 3



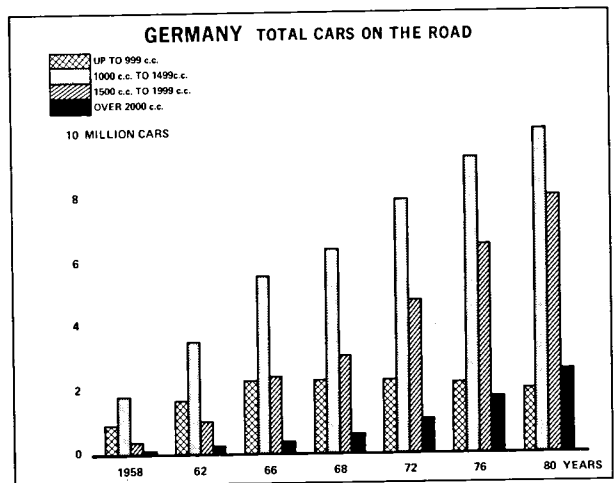
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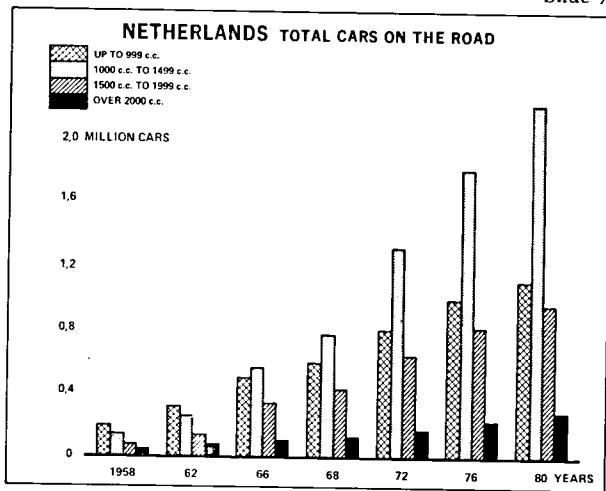
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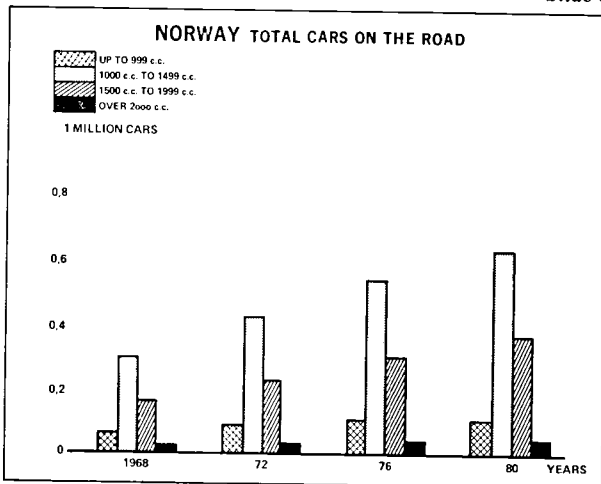
Slide 6



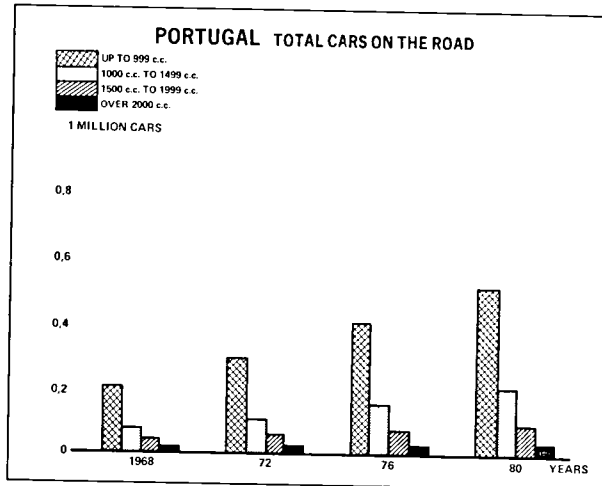
Slide 7



Slide 8



Slide 9



From SLIDE No. 7 it appears that in the Netherlands the trend has changed from a prevalence of small cars in 1958 to an almost uniform percentage share by the three classes in the 60s, with a tendency of the medium size cars to take the lead in the 70s.

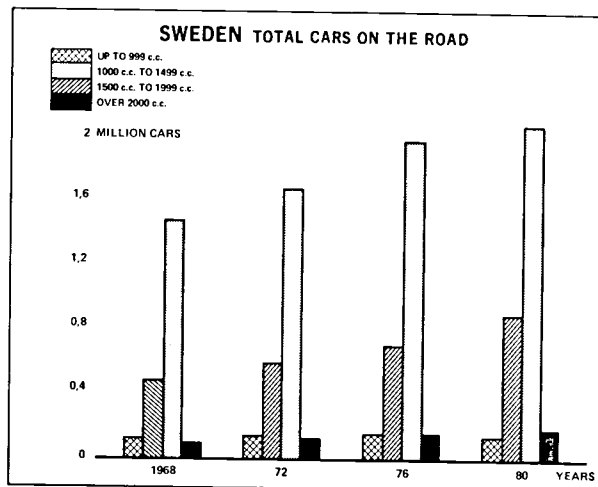
SLIDE No. 8 stresses a consistent marked preferences for medium and medium-large cars in Norway.

Portugal is covered by SLIDE No. 9: here the small cars predominate and the trend appears to continue in future years.

SLIDE No. 10 refers to Sweden, the only Country among those considered in the survey to show a definite majority of medium-large cars.

In Switzerland - SLIDE No. 11 - the medium and medium-large cars share the lead with practically the same percentages.

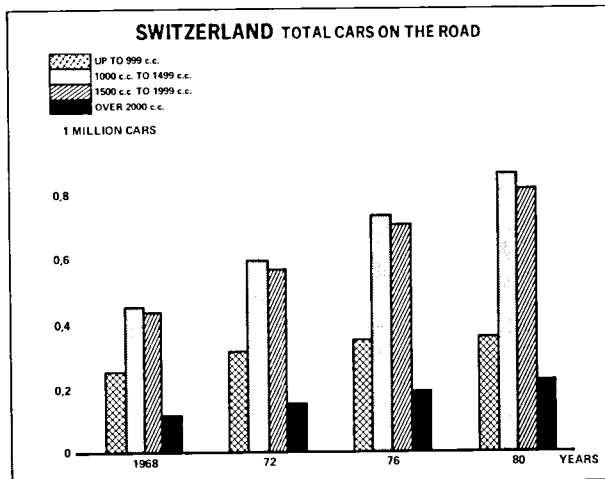
Slide 10



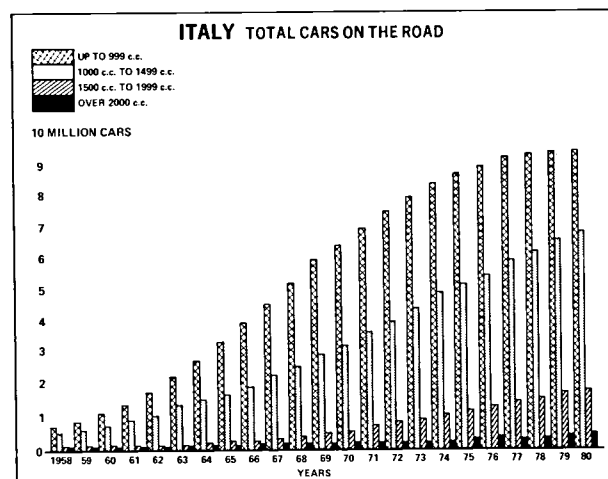
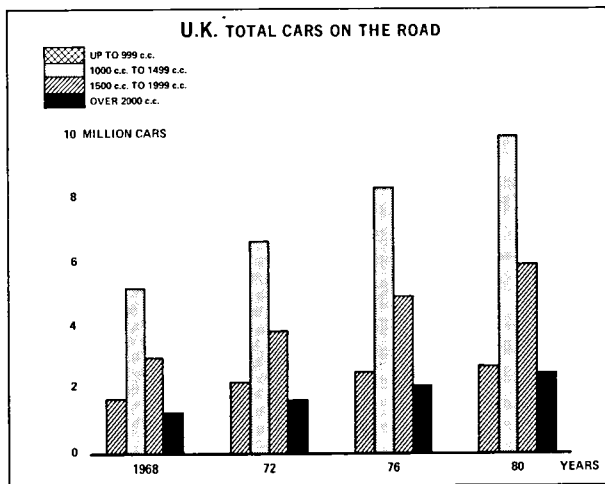
The situation in the United Kingdom is covered by SLIDE No. 12. Medium cars take a consistent majority (46 % in 1968; 48 % in 1980) followed by medium-large cars (26 % in 1968, 28 % in 1980). The U.K. is also the European Country with the highest total of large cars (11 % in 1968; 12% in 1980).

Now, let's consider the situation on Italian roads —SLIDE No. 13— in more detail, year by year, starting from 1958. Small cars take the largest share of the total, from 56% in 1958 to 63% in 1965, which remains unchanged up to 1969, then exhibiting a decreasing trend to the 50 % figure estimated for 1980. Medium class follows suit with percentages of 41 % in 1958, 32 % from 1965 to 1972, and 37 % in 1980. The medium-large and large cars represent only 5 to 10 percent of the total figure.

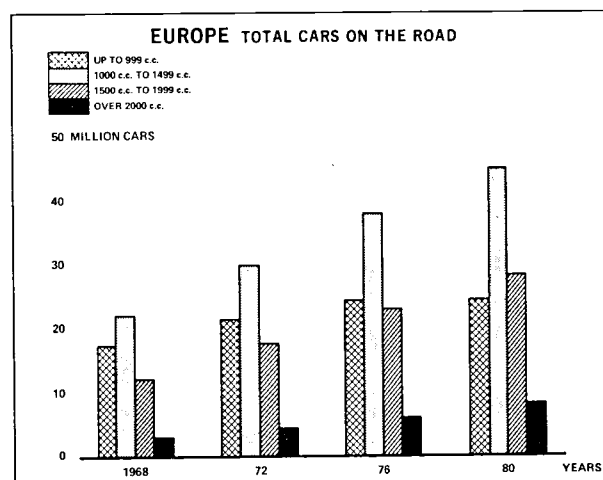
Slide 11



Slide 12



Slide 13



Slide 14

A Country-by-Country overall summary of the data from the single slides is provided on slide No. 14, showing the evolution of the different car classes circulating on European roads in the period from 1968 to 1980.

Although the percentage distribution continues to shift in favor of the medium-large classes - thus confirming the general tendency to-date - in 1980 the small car total will still be considerable, both as a percentage and in the absolute.

FINAL CONSIDERATIONS

From the overall picture we have just seen, ample information may be derived to answer our introductory questions.

The higher standard of living has gradually increased the percentages of medium and medium-large cars; the tendency to larger engine capacities is

clearly indicated but also in the 70s big markets, such as France and Italy, will still demand a majority of small cars (to-day, two out of three cars circulating in Italy are small, and will still be one of every two in 1980).

It seems improbable that in the future Europe will come to the American approach, namely, two classes of car only. Therefore, if the Italian program were to have the same orientation as the U.S. approach it would have been necessary to explore the full range of cars between the 1100 and 3300 lbs classes. Then design many safety cars for at least three classes which, broadly speaking, could be 1200, 2000 and 3000 lbs. A program of this sort is terrifying and certainly no Country, even the U.S., could finish such a task successfully within a reasonable period even if funds were available.

For this reason we are glad the Italian Government has chosen the approach based on the study of themes, or sub-systems, whatever term is preferred.

Firstly, because the study of valid projects permits contributions from Research Centers, laboratories and individual researchers that would otherwise be excluded from the development of a complete car. Secondly, the study of single sub-systems, and their subsequent experimentation, is a method probably leading to results of high validity and, perhaps, more practical than the ones obtainable from the study of a vehicle as a whole.

Thirdly, the complete prototypes of experimental vehicles that will be built have to be the result of a craftsmanlike, or near craftsmanlike, work; the differences between this type of system and the large-scale volume manufacture need not be explained here.

Fourthly, the development work on sub-systems allows the latter to be introduced gradually into production. This gradual introduction has the benefits of extensive development works in addition to the valuable and hard to replace experience of a widespread mass application.

THE ISAM TEST PROGRAM

FLAVIANO MOSCARINI

Gentlemen,

My request to speak is justified by the fact that ISAM (Experimental Institute of Engines and Vehicles) for 10 years has been conducting tests aiming at an objective evaluation of vehicle behaviour, especially from the viewpoint of safety on the road.

All the tests I am going to illustrate are run on level ground (1% max grade).

Among the different tests that we run on vehicles to evaluate their behaviour on the road, such as slalom, braking, steering-pad, overtaking and J-curve tests, the slalom have so far proved to be the most significant. In the slalom test, as you can see in SLIDE 1, we put rubbercones aligned along a length of 100, 150, 200 or 300 metres at a distance of 10, 15, 20 or 30 metres between them.

In the same slide, the van you see on the right is equipped for recording the data telemetered by the test vehicle through the "cronostatigrafo" (a special apparatus designed by ISAM).

The adoption of distances varying from 10 to 30 metres allows us to obtain useful information both on steering and general behaviour of vehicles under interesting transient conditions such as in slalom fast run tests with cones at a distance of 30 metres.

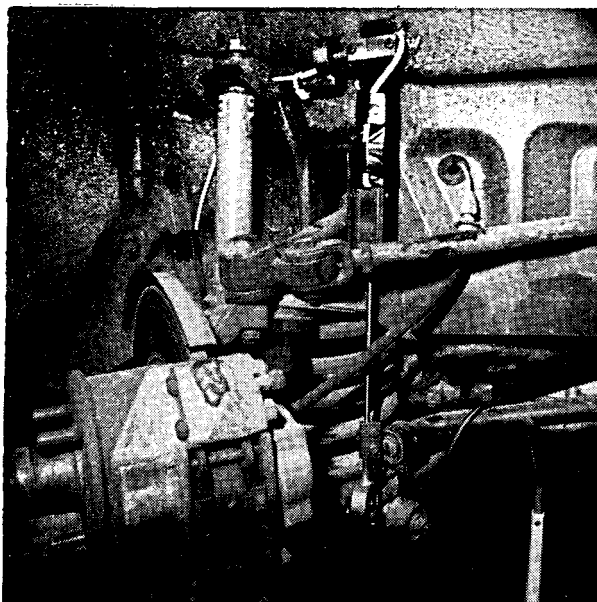
During the test, the different values of parameters (e.g. steering angle, engine rpm, individual suspension deflections and partial and total times) are continuously monitored on the test vehicle, as you can see on SLIDE No. 2, and recorded by the "cronostatigrafo".

On SLIDES 3 and 4 you see the transducers used to measure suspension deflections on front and rear axle.

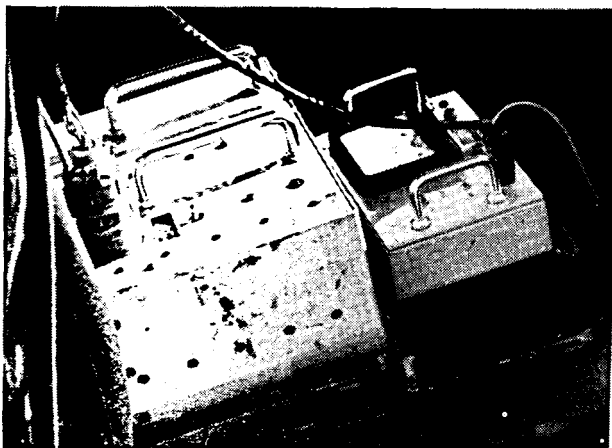
Let us go back to SLIDE 2., please. Near the transmitter you can see an instrument with the dial calibrated in kg. We use this instrument in the braking test.

Slide 1

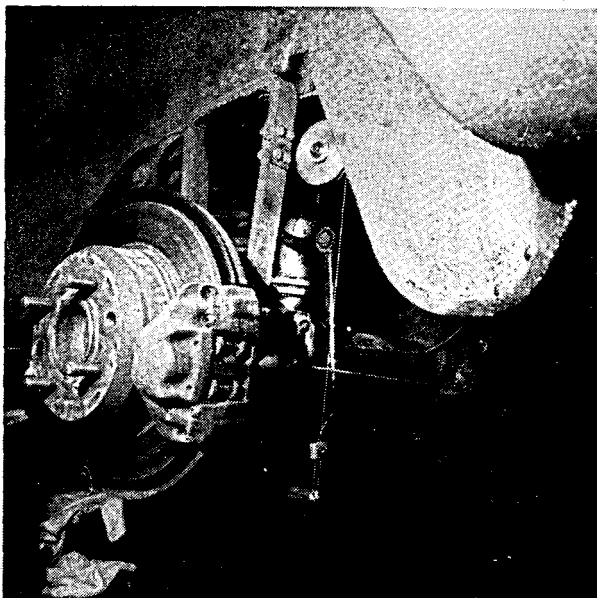




Slide 2



Slide 4



This test is run on a straight and level 3.50 metres wide lane delineated on both sides by rubber cones.

Starting from different initial speeds, with distances measured each 5 metres by photoelectric cells we record the following telemetered parameters: partial and total times (we can in this manner accurately evaluate speed and deceleration during the braking mode), the force in kg exerted on brake pedal during the mode, the rotational speeds for each wheel equipped with tachogenerators, and starting and final point of the mode.

Let us discuss the steering-pad test (SLIDE 5). This test is run using three circumferences with different diameters of 25,50 and 75 metres.

The vehicle is run with the most appropriate gear and at progressively increasing speeds in both directions), on different circumferences in a 3 metres wide circular lane delineated by rubber cones and white painted stripes.

Using four laser sights, which you can see on SLIDE 6 and an electronic multi-chronometer, we measure partial and total times.

Four photocell switches are fitted at the four corners of the vehicle to signal whether the vehicle itself is running off the lane and thus stop the test.

The position of each switch pulse can be readily located on recording bands so that the tendency by the vehicle to over-steering or under-steering can be evaluated.

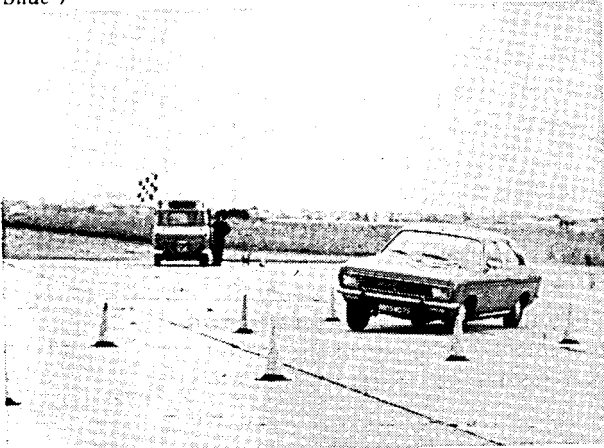
Slide 5



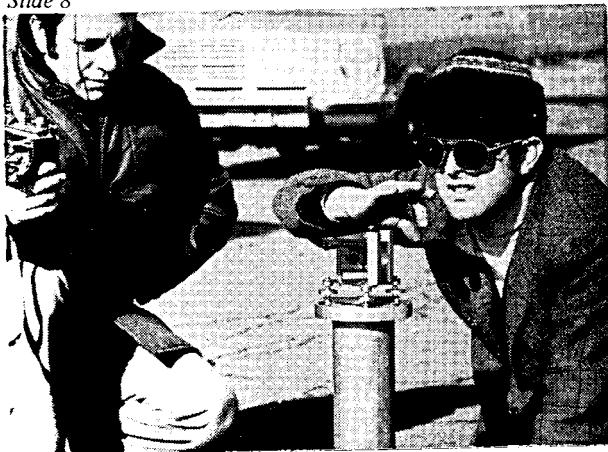
Slide 6



Slide 7



Slide 8



In the acceleration test, the vehicle is run to simulate the overtaking of a heavy trailer-truck.

By using appropriate transducers and sights, useful information on vehicle behaviour when the vehicle is subjected to sudden variations of direction can be obtained during this test.

The last test I am going to illustrate is the J-curve test. As you know, the radius of J-curves varies from an infinite to a finite value according to a given law.

As 10-years of experience shows, the J-curve test is for us one of the most significant, especially considering that its results are independent of driver's skill.

As you can see on SLIDE 7, the vehicle is travelling in top gear along a 3.50 metre wide lane with accelerator pedal released.

By using laser multisight prisms (SLIDE 8) and electronic chronometers with a 10^{-6} sec. accuracy, the partial and total times can be readily evaluated.

It is very interesting to note that at different points of the J-curve the maximum speed, i.e. the speed values above which the vehicle runs off the lane, is practically independent of driver's skill.

To give you an example, if the vehicle is running off the lane at a speed of 90 kph at one point of the J-curve, this value will remain constant regardless of driver's skill providing the weight is practically the same.

The purpose of this brief presentation was to give you some information on what ISAM has been doing up to now. The Institute will be delighted to provide any further information that may be requested as well as receive and discuss whatever suggestions come from this qualified group of experts.

Thank you very much for your attention.

A SUBSYSTEM AND COMPONENT APPROACH TO VEHICLE SAFETY,

**A MEMBER OF THE ITALIAN
DELEGATION,**

ITALY

The subject we are going to consider first will be the proposals made by the Italian delegation at the first meeting held in London to set up the program work and derive the priorities for the future developments of ESV's.

This is an Italian proposal. We will show you what we proposed to our colleagues and we will certainly bow to other opinions that exist at this time.

We are involved in the field of safety. There are a tremendous number of aspects to be taken into account as we have seen by the French delegation presentation this morning. We realize that we must make a very thorough study of all these various aspects. At first we tried to find a list of priorities but were unable to find such a listing. This does not correspond to the way we think efforts should be undertaken before, or after, this meeting.

Considering the passenger restraining devices. We have the conventional type of devices and also are studying new devices. There is a certain proliferation of these devices. We see the behavior of the car in the event of a crash, considering the front crash, side crash, and rear crash, without establishing the speeds or the characteristics of the crash. We must be free of any preconceived ideas. We must determine behavior of the car in case of an overturn or rollover and means of protection against fire, from the point of view of avoiding any loss of fuel and incorporating nonflammable materials. Our American friends have already carried out various studies on this point. We must even study the characteristics of the fuel; you know, that in aeronautics, this is a vital problem.

The internal arrangement of the car, the inside and the decoration is vital if we are to avoid injuries to the passengers. These are considered in the framework of the restraint features which are used, and also in case there are no restraints used.

In another system, the exterior lines of the car must be designed to avoid injury to people outside the car. We saw some very remarkable presentations

on the subject yesterday.

The improvement of the bumper features must be considered.

The braking is point eight. This must be considered very carefully to insure that the approach will yield the maximum adhesion to the road surface. We must also consider what we call residual braking capability which is used when the actual braking system fails.

Point nine is lighting. This is very advanced. We see that very bright lighting devices can be on either side of the car. In dealing with visibility, that is, front vision and rear vision, a compromise is the only solution. A large mirror improves the rear view, but degrades the front view and vice versa.

Then too, we use this expression, improving the conditions for driving the car: the placing of controls such as lighting and placing of various optical devices. Here the way is open for the acceptance of various solutions. Then we must consider the perceptibility and the interpretation of the dashboard instruments, behavior of the car on the road such as road holding on curves and straight lines, and so forth.

Thirteen. There are additional subjects: riding, the strength of the various structures, the various devices that are used to improve the behavior of the car and to help in the handling of the car, and the various alighting points.

In our London meeting, the last London conference, these proposals appeared to be acceptable; if so, they should be distributed among the various countries. Each one will be responsible for a certain series of studies.

First of all we can hope that the contributions made during this meeting, this Paris meeting, have shown that we've hit the target, really. We have concentrated on subjects which have already elicited great interest from many countries.

Some of the points correspond very closely to a series of proposals which the automobile builders have carried out amongst themselves. That is, there are studies by industry which appear to have certain agreement with some of these proposals.

Before concluding, I think I will have to go back a little bit and give you background, an historical view of this problem, and show how it has become a worldwide problem.

When the first Federal American standards came out, it was necessary to do something similar we thought, in Europe; something better than what we had done to ensure safety of the cars. At the European council in Geneva it was decided to give the responsibility for the study to a group of engineers. We gave them a list of points which could influence the safety of the vehicle. The first large listing was prepared to provide passenger safety—active and passive safety—that is, for the accident avoidance and crash-worthiness.

First of all we examined a number of accidents. We thought the most important component was the engine. We considered the power of the engine as a question of safety. The engines, which basically are the cause of a great number of accidents because of their high power, also can ensure safety under certain conditions. This certainly has a bearing on the performance of the vehicle.

We also looked at the braking, the drive train, the tires and the riding characteristics. This can be broken down into several subjects or sub-items—to cover all vehicle behavior was examined during various maneuvers. Also considered were the control arrangement, visibility, and the signals and the lighting devices.

These, too, can be broken down into several subheadings, for signalling; the horn acoustic characteristics are important because of their influence on the behavior of the driver. The ventilation, heating and interior arrangements of the inside of the car also

affect driver behavior. Exhaust smoke must be considered not only from the point of view of air pollution, but also for the effect of smoke and vapor which obscures driver vision.

Steering devices and other factors like mass of the vehicle, the engine displacement, the interior arrangement of the car, and the exterior arrangements, particularly near the bumpers, can be designed such that they tend to reduce accidents. It's quite difficult to get results with the bumpers. The seat belts are included; we are concentrating on seat belts. Now today we are also thinking about a passive system to compensate for changes in loads or weight distribution of the car as in the case of carrying goods. Resistance of the cabin to evacuation of the people in the event of an accident, particularly when you are dealing with busses and so forth, is a still another problem.

Of course, an extremely important problem for safety, is the structure of the windscreen which can, depending on the solution adopted, favor passive or active safety.

Well, ladies and gentlemen, in Italy we have a very considerable interest in these problems, and, via international organizations, we find this interest shared.

I don't intend to repeat what has already been said today. We have always tried to find the best compromise because a good solution for passive safety isn't necessarily good, and may even be dangerous, for active safety and vice versa. Therefore, the best compromise is what we are trying to find.

The list of subjects that I have just covered shouldn't be a list, but it must be incorporated into some form of harmonious whole. And this of course is the ultimate aim.

What we want is for one car to incorporate solutions to all of these problems on our list, and the driver of the car to benefit from the overall solution.

Thank you.

section 2 part 6

The U.K. Technical Presentations

INVESTIGATIONS RELATED TO THE DESIGN OF SAFER VEHICLES

MR. R. D. LISTER

UNITED KINGDOM

For the United Kingdom Technical Presentation it is proposed to describe some of the investigations being carried out at the British Road Research Laboratory related to the design of safer vehicles.

The pattern of road casualties in the United Kingdom which we believe is comparable with other European countries, differs from the American pattern in that a much higher proportion of casualties in the United States occur to car occupants. Figure 1 shows that 77% of the total road deaths in the USA for 1968 occurred to vehicle occupants compared with 41% for the UK. Because of these differences we can understand the great emphasis that the United States placed on protection of car occupants. We also believe in trying to concentrate on those safety measures which are likely to give the best results on a cost effectiveness basis.

Cost Effectiveness Investigation

As mentioned in my introductory remarks, we regard the ratio for the cost of any safety features in relation to its effectiveness as a useful guide to assess the relative merits of car design safety features and a useful guide as to which of these should be applied first. It is difficult to assess the effectiveness of a measure before it is actually in service and its influence on accidents or injuries can be observed. However, by examining the details of accident investigation studies, it is possible to make an assessment whether or not certain changes would have been beneficial. This has been done for 1,000

CLASS OF ROAD USER KILLED	PERCENTAGE OF TOTAL DEATHS	
	BRITAIN	U. S. A.
Motor vehicle driver or occupant	41	77
Motor cyclist or passenger	13	3½
Pedal cyclist	6	1½
Pedestrian	41	18

Figure 1

COST AND EFFECTIVENESS OF VEHICLE SAFETY MEASURES

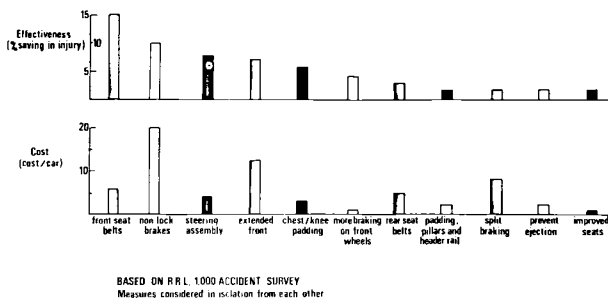


Figure 2

accident studies at the British Road Research Laboratory and the results of these estimates are given in Fig. 2.

The measures indicated have been taken in isolation but of course there may be a considerable amount of interaction and the application of one safety measure might reduce the benefits to be expected from another, for example, an effective restraint system always reduces the importance of door locks; also an efficient non-locking braking system would render other braking changes unnecessary.

Passive Seat Belts

It was clear from cost effectiveness work that seat belts were a valuable safety measure and led to their compulsory fitting in the United Kingdom. However, seat belts are only effective to the extent that they are worn and in line with other countries, we find that the orthodox seat belts are not always worn. In our search to devise means by which seat belts would always be worn, we have been investigating a simple

arrangement in which part of the seat belt is anchored to the door with the inboard end attached to a reel, to reel in and to pay out extra webbing as the door is opened or closed. There is no release buckle needed and as the occupant closes the door the seat belt fits around him. This can be regarded as a passive seat belt as the wearer does not have to do anything to make the belt effective. Figs. 3, 4 and 5 show one such system. We have also tried an arrangement with the reel fitted to the door, Fig. 6. We consider that this type of passive restraint system is of particular importance to small cars as it becomes effective from the moment of impact, there is no lost movement and the whole of the space in front of the occupant can be used for absorbing the impact of the occupant. There is also some recent evidence that in larger cars, because of the greater space available, that the efficiency of seat belts in reducing injuries is increased compared with small cars and their use in the larger cars should not lightly be discounted.



Figure 3

Figure 4



Figure 5



Figure 6

COMPARISON OF DOOR MOUNTED AND CONVENTIONALLY MOUNTED SEAT BELTS

	Door mounted seat belt			Conventionally Mounted Lap & Diagonal Belt
	Diagonal belt		Lap & Diagonal belt	
	Car going straight ahead	Car at an angle of 22.5°	Car going straight ahead	
Speed of Car km/h	50	38	42	39
Stopping distance cms	61	44	50	43
Maximum car deceleration g	22	19	20	21
Maximum dummy chest deceleration g	33	26	36	34

Figure 7

In the case of passive seat belts we are really extending an established and proven system about which we have a considerable amount of accident and injury data. Fig. 7 shows the performance of two different types of passive seat belt compared with a conventionally mounted lap and diagonal belt when subjected to dynamic test. It is clear that the performance of the passive system is comparable with that of the conventional belt and it would seem to be unnecessary to set up arbitrary criteria for estimating their performance. It might in fact be preferable to determine the performance in some particular numerical manner of the conventional belt and use these figures in performance requirements for passive restraints.

Injury Investigation

At the British Road Research Laboratory we regard accident and injury investigation as a most important part of our work which we use not only for assessing the causes of accidents and the causes of injury but by simulating corresponding damage on similar models we obtain an estimate of human tolerance levels in practical accident situations. (Ref. 1) By taking an undamaged vehicle structure and reproducing experimentally under controlled laboratory conditions the damage which has been caused to a similar structure by an occupant injured in an accident it is possible to determine the load exerted between the occupant and the structure. This load is of course that which caused the injury to the occupant and the damage to the structure.

Figure 8

TABLE 5
SEVERITY OF CHEST INJURY IN UNRESTRAINED DRIVERS RELATED TO ANGLE OF STEERING COLUMN IN COMPARISON WITH SEVERITY OF VEHICLE IMPACT - FRONTAL IMPACTS ONLY - CASES OF LIGHT DAMAGE

STEERING COLUMN ANGLE TO THE HORIZONTAL	NO. OF CASES	SEVERITY OF CHEST INJURY			SEVERITY OF VEHICLE IMPACT (DAMAGE INDEX: CAR WEIGHT RATIO)		
		SERIOUS %	MINOR %	NONE %	LOW (0-20)	MODERATE (21-40)	HIGH (41-1)
15° - 20°	52	31	34	35	29	29	42
21° - 30°	107	29	30	41	22	49	29
31° - 40°	64	20	38	42	17	39	44
41° - 50°	67	16	21	63	9	16	75

NOTE 1. SERIOUS INJURY - FRACTURES OF RIBS AND/OR STERNUM WITH OR WITHOUT INTRATHORACIC DAMAGE
MINOR INJURY - GRAZES OR BRUISES OF CHEST WALL

NOTE 2. PERCENTAGES DENOTE OCCUPANTS INJURED OR VEHICLES DAMAGED

As an example, an analysis of the severity of chest injuries in unrestrained car drivers shows that the risk of serious chest injuries is greater for those cars in which the steering column is most inclined and the least in those cars where the steering column angle is the most vertical. Fig. 8.

This of course is not the whole story and a further examination of two identical models of vehicle with the same type of steering wheel and column, but which collapse under different dynamic loadings, showed that there was a considerable reduction of chest injuries when the limiting dynamic loading was reduced from about 1,900 lbs to 1,400 lbs. Fig. 9. This example is taken from real accident cases and would seem to justify reduction in the dynamic load

Severity of chest injury in unrestrained drivers related to steering wheel and column assembly strength showing also the severity of vehicle impact

No. of cases	Type of vehicle	Angle of column to the horizontal	Distance of steering wheel above the bracket	Peak force kN (when tested to fail) (944)	Severity of chest injury			Severity of vehicle impact (damage index: car weight ratio)		
					Serious	Minor	None	Low	Medium	High
15	Merch 1120	45°	240 mm (9.5 in)	6.7 (1400 lb, ft)	17%	37%	54%	7%	21%	72%
12	Austin 1100	45°	150 mm (6 in)	8.5 (1900 lb, ft)	42%	25%	33%	22%	37%	41%

Figure 9

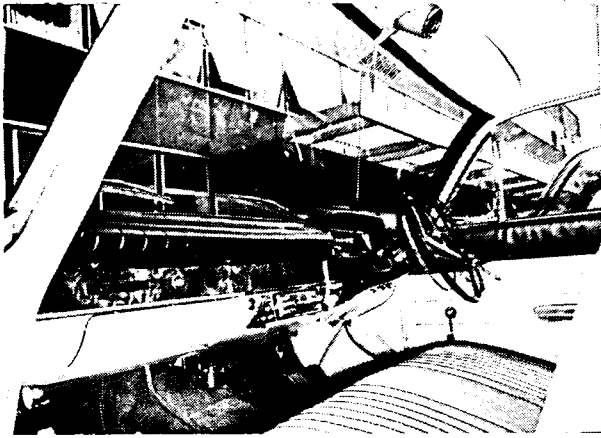


Figure 10a

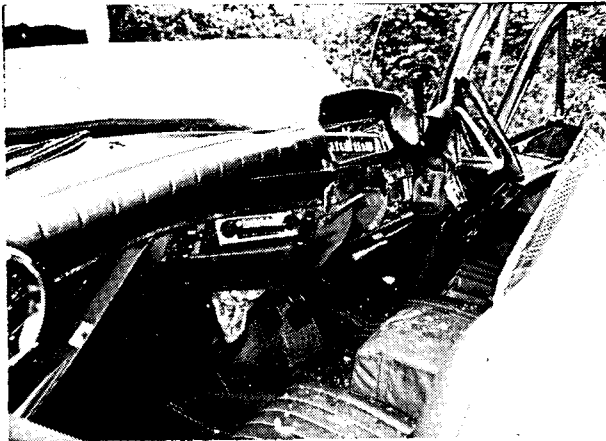


Figure 10b

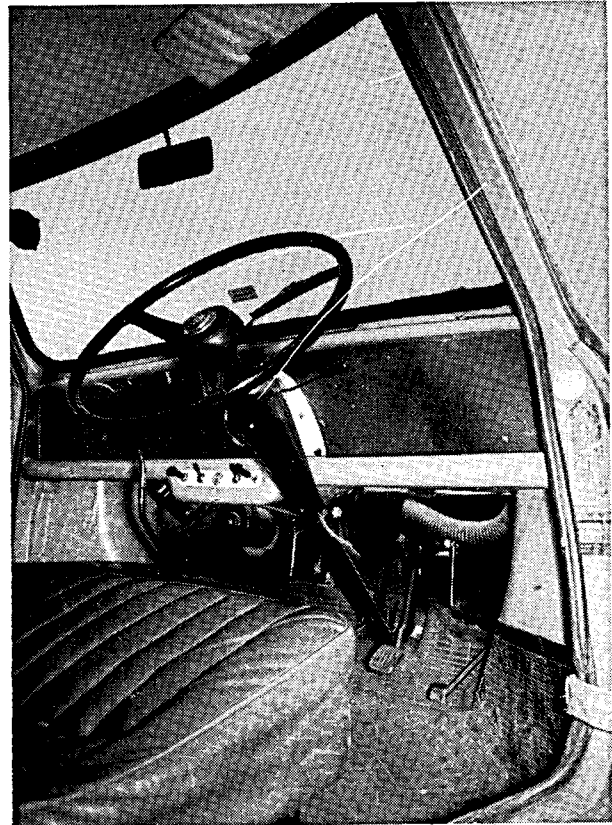
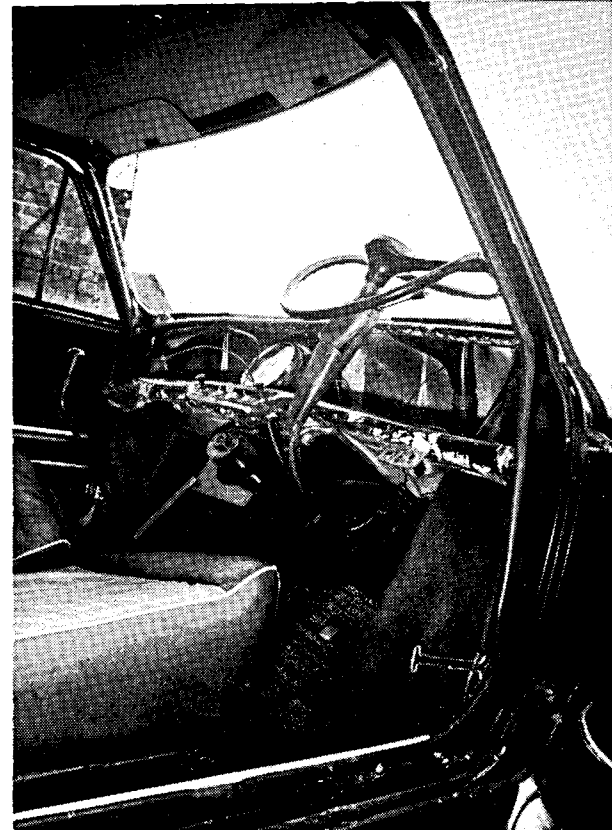


Figure 11a

Figure 11b



requirements for collapsible steering columns - I understand from what was said during the US technical presentation that the Highway Safety Bureau is considering this point. Examples of steering columns of different column angles are given in Figs. 10 and 11.

In a similar way a study has been made of injuries to the knee/thigh complex with the following results. The dynamic load required to produce certain types of fascia damage have been associated with the frequency of skeletal injury.

THE DYNAMIC LOAD REQUIRED TO REPRODUCE CERTAIN TYPES OF FASCIA DAMAGE TOGETHER WITH THE OCCURRENCE OF ASSOCIATED SKELETAL INJURY

Estimated load - kN	Cases with skeletal injury	Cases without skeletal injury
> 6	3	2
< 6	2	3
≤ 5	3	3
> 4	1+1*	2
< 4	0	3
≤ 2	1*	12

*Dislocation of hip without fracture of acetabulum

Figure 12

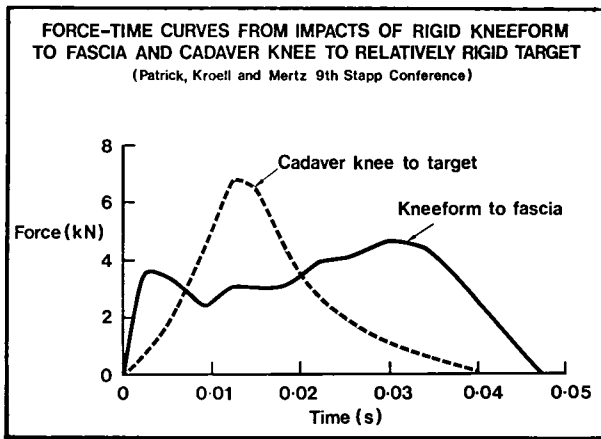


Figure 13

From the 36 cases given in Fig. 12, it can be seen that the limit of the dynamic load on the knee/thigh complex should be something less than 4kN (900 lbs). A typical force time curve for the damage simulation is given in Fig. 13. Also shown is corresponding work by Patrick using a cadaver impacting a relatively rigid target.

Side Impacts

Side impacts are also being investigated and some thought has been given to the mechanism of these impacts with particular reference to intrusion and how the occupants get injured. The distribution of vehicle or object struck in side impacts is given in Fig. 14 and although it is most frequently another car, the greatest degree of intrusion occurs when impacting a fixed objects such as a tree, lamp-standard etc. The importance of side impacts is shown by the fact that although in the national accident figures fatalities of car occupants comprise less than 10% of those seriously injured, in this sample of side impacts it was nearly 20%. Cars striking fixed objects in general cause the most concentrated damage which extends right from the cill to the roof line: a typical example is shown in Fig. 15.

Figure 14

SIDE IMPACTS IN ACCIDENTS

VEHICLE OR OBJECT STRUCK BY CAR	INCIDENTS IN SAMPLE %
Another car	61
Commercial or Public Service vehicle	17
Fixed object	19
Other (motor cycle)	3
ALL	100
Number of incidents in sample	---- 173
Incidents in which at least one occupant of struck car was seriously or fatally injured	---- 115



Figure 15

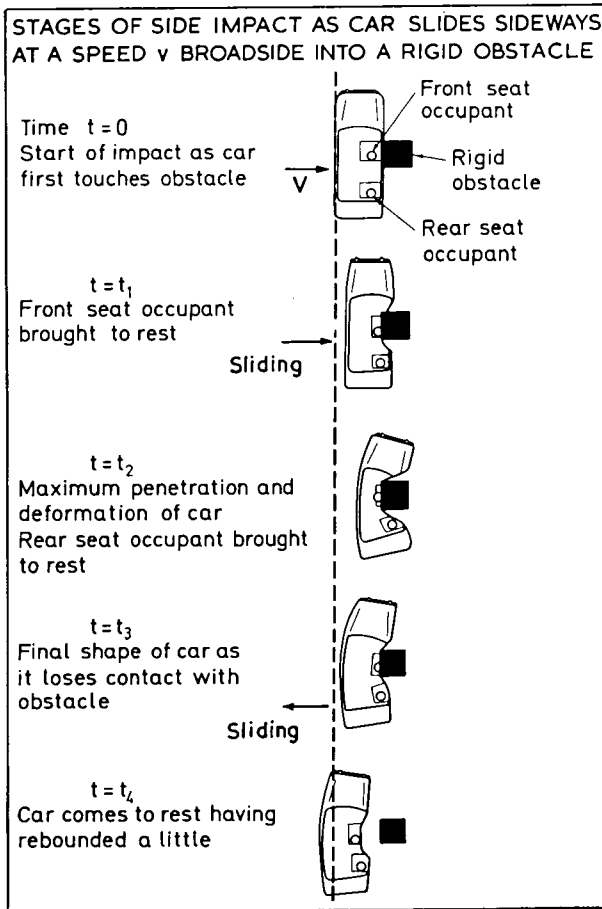
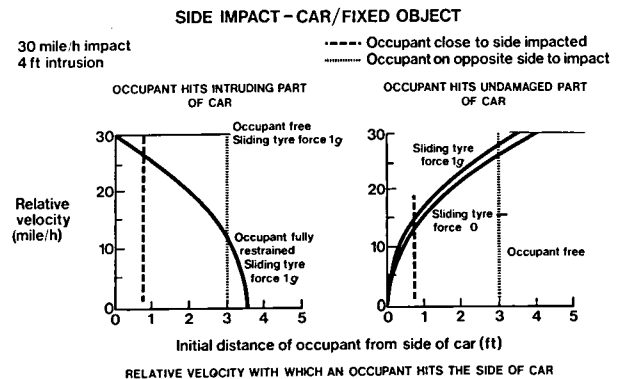


Figure 16

Our analysis of injuries to car occupants in side impacts showed that about 20% were injured by crushing due to the intrusion. As most injuries in side impacts occur to the occupant striking the side or being struck by the side intrusion, it is clear that an important parameter is the relative velocity with which the occupant strikes the side. This is affected by whether he is adjacent to or distant from the side struck. Stages in true side impacts are idealized in Fig. 16; the car is assumed to be sliding broadside into a fixed object. It can be seen that the relative velocity of the occupant against the side will be equal to the impact velocity for a front occupant in the second diagram and further intrusion after this is irrelevant unless it actually crushes the occupant against other occupants or the other side of the car. If the occupant is sitting in a seat away from the point of impact the relative velocity with which he strikes the side is different and is affected by how far he is away from the side being struck. This simple representation has been used to provide a basis for theoretical consideration of the various conditions and the relative velocity of car occupants sitting in different positions has been estimated. Ref.(2), see also Fig. 17.

Figure 17



The general conclusions to be drawn from this analysis is that we have 2 main requirements for protecting car occupants in side impacts. In the first place intrusion in itself is not a bad thing although excessive intrusion is undesirable as a small number of injuries are directly due to being crushed or trapped by the intrusion and that pocketing is less likely to occur with smaller amounts of intrusion. However, perhaps of greater importance are the injuries caused by the occupant striking the interior of the car to protect against this, energy absorbing padding or suitably designed yielding structures should be incorporated on the interior parts of the passenger compartment. Transverse restraint, possibly provided by seats having wrap-round design, would also be advantageous. The possibility of alleviating the side impact problem by modifying the characteristics of the striking vehicle was discussed in ref(2).

The desirable properties of the side interior structures is being studied at the Laboratory by simulation of the side impact damage using special models to measure transverse hip joint and rib cage loads and comparing this with actual injuries sustained in accidents in order to arrive at suitable injury tolerance levels.

In this problem of occupant protection there is a need to continue detailed studies both of accident and injury investigation, such as those carried out at the Road Research Laboratory, to constantly monitor the changes in design that are taking place and to see what effect this is having on the number and degree of injuries sustained.

A short film showing dynamic impact tests in passive seat belts and also the work on side impacts against a rigid pole was shown.

Ref. (1)

R D Lister and J G Wall "*Determination of injury threshold levels of car occupants involved in road accidents*"

SAE Publication No. 700402. Reprinted June 1970 from International Automobile Safety Conference Compendium P-30 by SAE Inc.

Ref. (2)

R D Lister and I D Neilson. "*Protection of car occupants against side impacts*" Proceedings of the Thirteenth Stapp Car Crash Conference held at Boston, Mass., 2-4 December 1969. New York, 1969 (Society of Automotive Engineers, Inc.), pp. 38-60.



SECTION 3

ORGANIZATION OF PANELS FOR DISCUSSIONS OF THE SPECIFICATION

- Part I—** First Specification Discussion Vehicle Ride and Handling
Chairman—Mr. Matthes, Federal Republic of Germany

- Part II—** Second Specification Discussion—Crashworthiness,
Chairman—Mr. Albert Slechter, United States

- Part III—** Third Specification Discussion—Other Accident
Avoidance Factors, Chairman—Mr. Yamada, Japan

ORGANIZATION OF PANELS FOR SPECIFICATION DISCUSSION SESSIONS

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Session 2)	M. Kraft (Chairman)	M. Belke	M. Sassor
Session 3)	M. Matthes (Chairman)	M. Kraft	M. Reidelbach

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Session 3)	M. Osselet (Chairman)	M. Caroff	M. de Lavenne

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Session 3)	M. Okami (Chairman)	M. Mitamura	M. Watanabe

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Session 2)	M. Van der Bruggen
Session 3)	M. Van der Bruggen

Sweden

Session 1)	M. Ekberg
Session 2)	M. Ekberg
Session 3)	M. Ekberg

U.K.

Session 1)	M. Lister (Chairman)	M. Weighell	M. Peck
Session 2)	M. Lister (Chairman)	M. Weighell	M. Peck
Session 3)	M. Lister (Chairman)	M. Weighell	M. Peck

U.S.

Session 1)	M. Di Lorenzo (Chairman)	M. Chandler	M. Slechter
Session 2)	M. Slechter (Chairman)	M. Chandler	M. Di Lorenzo
Session 3)	M. Di Lorenzo (Chairman)	M. Chandler	M. Slechter

section 3 part 1

FIRST SPECIFICATION DISCUSSION VEHICLE RIDE AND HANDLING

*(Braking, Steering, Suspension and
Drive Train)*

MR. MATTHES, *Chairman*

FEDERAL REPUBLIC OF GERMANY

MR. MATTHES (CHAIRMAN): Gentlemen, we'll begin with our first specification discussion session. The topic is vehicle ride and handling. Permit me first to introduce myself. My name is Matthes. I am in the German Automobile Manufacturers Association. I wish to thank the United States delegation for this year's project, for having assigned the job of moderator for this first session to Germany.

As far as the participants are concerned, a paper has been distributed identifying the members of the different panels. As to the documents, we have several paper which you all have and which I propose to mention now in order to get a clear picture of what we are going to discuss.

The first document to be considered is certainly the statement of work for the United States ESV. This is our basic document. That does not mean, gentlemen, that it is the best document necessarily. But we must have a basis for discussion, and I propose that we take this one.

I would mention also that supplementing this statement of work is the second part of the technical presentation made yesterday by Mr. Slechter of the NHTSA.

Secondly; we have the technical papers which have been submitted by several delegations, and which are available to everyone here in the room. At present we have the following documents:

First; the technical requirements for an ESV which have been prepared by the German Automobile Manufacturers Association, the VDA.

Second; is a discussion paper listing a number of question which have been submitted by the Japanese delegation.

Third; we have the discussion paper which was submitted by the French delegation this morning.

Finally, I want to draw your attention to the extensive work which has been going on in international bodies on our panel discussion subject. I would like particularly to refer to the work of Working Party 29 of the Economic Commission for Europe, and its efforts on braking.

We have the good fortune of having the chairman of both groups, Mr. Poggi, with us this morning as a panel member for the Italian delegation.

The ECE Regulation No. 13 on braking was officially distributed in May 1969 by the United Nations, and has since been applied by several countries. A number of countries are at present making the necessary preparations for applying this regulation.

As far as legal steering and handling is concerned, we have a far more difficult situation as far as specifications are concerned, and the problems in this field were very clearly described by Mr. Slechter yesterday on pages 16 to 20 of his technical presentation.

On the international level, Committee ECE 22 on automobiles at its plenary meeting in December, '69 had a subcommittee ST9, Working Dynamics. Work by this subcommittee has already started but they have discovered that it is very difficult to arrive at really valid, objective, reproducible test conditions.

Gentlemen, I propose to follow a certain sequence in our discussions. First; we will take *braking performance*; after that, *steering*; then *handling*; then *ride performance*, and finally, *engine and power train*.

In order to facilitate our discussions, the United States delegation has kindly agreed to furnish the slides which you saw yesterday. For each particular discussion topic the corresponding slide will appear on the screen so that we can see exactly what we are all talking about.

Braking Performance (Slide No. 6)

MR. PECK (U.K.): I would like to ask a question of the American delegation concerning the skid number and the method of measurement.

I believe I speak for most manufacturers when I say that we all have difficulty evaluating skid numbers on dry surfaces vis-a-vis the recent legislation. I notice on the slide that we are required or it is intended that measurement shall be made to a skid number of 20. Presumably this is equivalent to .2 which is shown for low friction coefficient surfaces.

I wonder how the ASTM trailer test, which involves towing a trailer of specified weight behind a vehicle, and locking the wheels to determine the braking force or the draw bar pull, is going to be

affected on a surface which is as low as .2 coefficient of friction.

I don't believe this is possible with any safety or any accuracy and would recommend that an alternative method be considered for measuring the surface coefficient. Maybe a simple pendulum test with a rubber block as is currently being perfected by Road Research Laboratory in England might be a suitable way of establishing a reference level. Because that's all this really is, reference level of certain adhesion, rather than a rather complex and certainly, I submit, an unsafe method when getting down to such low adhesion levels as are now being considered.

MR. DiLORENZO (U.S.): The ASTM trailer tests were intended for that measurement and we recognize the variability that the trailer imposes. I'll go on to explain the brake efficiency procedure we will use, and by which we hope to eliminate some of this variability.

We would use an ASTM trailer, but we would define the coefficient of friction with the ASTM tire and ESV tire.

MR. MATTHES (CHAIRMAN): I think, gentlemen, that the first question referred to the second group, service brakes, low efficient coefficient surfaces: It is possible by calculations to measure this performance without actually driving the vehicle on the surface, when you know a certain number of design characteristics of the vehicle. For example, if you know the height of the center of gravity and the load distribution you can make a calculation showing whether the vehicle complies with this requirement or not?

MR. DiLORENZO: We hadn't considered that exactly. We would choose to actually test the vehicle. I will explain what we had in mind for that particular requirement.

First, when we wrote the specifications for braking efficiency, we thought it was a relatively simple thing. If for example we had demonstrated performance of a stopping distance of 150 feet on a dry pavement we would use this for our ideal condition, and say that occurred for a coefficient of friction of .7 or .8. We then wet the surface and the coefficient goes down to .4. We then ideally would expect the vehicle to stop at approximately 300 feet. Now 80 percent comes into play by dividing the ideal—in other words the 300 foot distance by .8. This gives some leeway because under adverse loading conditions we would expect something less. From experience we've learned that it's not quite that simple. The coefficient of friction varies significantly with speed, especially on the wetted surface. In fact we have experimental data which shows the coefficient of friction at 60 miles an hour on some pavements would be around

.2 and as the vehicle slows down this coefficient of friction could go up as high as .6. Therefore, you really can't say at what speed you should define a coefficient of friction.

In consideration of this problem we decided to use an alternate approach. We've decided to use the peak μ , μ being the coefficient of friction at each velocity. In fact the procurement for this supplemental program has been started and we plan to use the University of Michigan trailer. We will run the ESV tires on the University of Michigan trailer at various speed on the same pavement that we will test the car on. We will therefore define the friction characteristics of that tire on that surface for speeds from 60 down to 10 or 15 miles an hour.

Characteristically these curves are call μ slip curves. We would then have an empirical family of curves that we can use to compute an ideal stopping distance, by choosing the peak coefficient at each speed.

In other words, as these tires go from zero slip to 100 percent slip, the coefficient rises to some value then drops characteristically. We'd use just the peaks all the way through the range of the velocities and compute an ideal stopping distance. Then taking that data we'd run the car and measure its stopping distance, and compare that number with the ideal stopping distance. We still require that brake efficiency be 80 percent.

MR. LISTER (U.K.): Mr. Chairman, I wonder if I could add to this and I didn't frame this question entirely by myself.

What we are really asking is: Can an established method which is already in use all over the world, be used to substitute as a reference point, reference measurement? The pendulum test to which Mr. Peck referred has been standardized in all respects and is used in correlating work with road materials, therefore it has a wider application even than the one under discussion at the moment.

It is used in Japan, Germany, and other Continental countries. There are quite a number in the United States. What we are pleading for is that a simple method should be applied to measure the road surface. When Mr. DiLorenzo referred to establishing a μ slip curve, he was entering into a very complex field which has involved a lot of people for a long time, and they're still not through with it. It brings into the calculation consideration of the characteristics of the road surface itself, the stones, the wetness, the degree of wetness, temperature, the tire tread compound, its properties and all the rest.

I think that he would be better off if he specified an alternative method which is already available and in use throughout the world.

MR. DiLORENZO (U.S.): Before we embarked on this procedure we made a careful check of the latest work at the University of Michigan and we looked at the data they had statistically generated. It has the accuracies which we are looking for. I'm not completely familiar with this pendulum test. We consulted with the brake manufacturers, the automotive people and our own contractors on the best way to solve this problem and this procedure appears to be the consensus in our office now.

MR. POCCHI (ITALY): I would like to make a few remarks on the subject of service brakes braking efficiency. Mr. Chairman, we have worked together a long time on this problem, and we know that we have very high values already. They are higher than the figures on this table. I don't know what friction figures correspond to the figures up here, but I do think that .78G as an average is very high.

We are speaking of stopping distances, and we've always spoken of braking distances in the past. There is a slightly different. But if we cannot interpret braking distances then we must have an average higher than .78G during braking.

At the present moment brakes are practically always power assisted brakes and this has a considerable influence on the result. When you have an assisted system, the influence of the period necessary to achieve maximum efficiency is such at the maximum deceleration must be much greater than the average.

MR. SLECHTER (U.S.): These figures, which take into account the different conditions of a loaded and an empty vehicle, and the difference between real values and theoretical values can, of course, be criticized and often have been criticized. We've responded to these criticisms. We tried to find a meaningful compromise on the different conditions of friction, the different loads, and we have left to the manufacturer the choice of adapting these criteria to achieve the best performance. Of course, you've got to take into account the ultimate aim of the vehicle.

MR. MATTHES (CHAIRMAN): When you regard braking efficiency, the figure as such does not say anything as long as you do not take into account the pedal force and the effectuation force and the state of loading. When you desire to make a comparison between the ECE regulation and these proposed specifications, you set two important differences. In the ECE regulation we have a pedal force which must not exceed 50 kilos. When you convert these 85 pounds to kilos you arrive at 38.5.

We have in the ECE regulations an actuation force which is a little higher. But, we have here a state of loading of 40 percent rated load. Whereas in the ECE regulation we have specified that the brake test,

the basic brake test, must be made with the vehicle fully loaded and empty. When you try to compare these requirements you find that the ECE regulation is by all means comparable to these requirements.

Well, gentlemen, the first question was regarding the first part, service brakes; are there any other questions regarding the service brakes?

MR. MONTABONE (ITALY): I have two questions. First, referring to the specification sheet in the section on service brakes. Here we're after road tests with coefficients, skid efficiencies and variables between .2 and .8, so that in all these combinations we must have a braking efficiency of 80 percent.

We don't say under what conditions these tests should be made. The car must remain on a straight line, no corrections must be made by normal steering. I think that under these conditions it is difficult to control the car without making any corrections—or it might be a dangerous condition, a dangerous effect. That is my first question.

MR. DiLORENZO (U.S.): With no steering input our requirement is to stay within the 12 foot lane. Of course, all the conditions under these various coefficients of friction and loading are referring to the first paragraph of the specifications, so far as stopping distances, speed, and lane width are concerned.

MR. MONTABONE (ITALY): My second question. You know that with the new tire dimensions which are becoming larger and larger, and with the surfaces which are very varied, the aqua plane phenomena is becoming very important. I would like your reaction to this, please.

MR. DiLORENZO (U.S.): We recognize that the vehicle will, because of its high weight, and braking capabilities require tires in size and capacity larger than our present production. We have chosen, though, not to go into those design parameters. We do not specify design solutions in these specifications, but leave this to our contractors.

MR. MONTABONE (ITALY): Sir, the new tires are increasing in dimensions; and therefore increase the road surface on which the tires are working. This design reduce the specific load on the road and in some conditions when you have water on the highway, you have the problem of hydroplaning.

Why did you not address this important problem in your specification? You know that the hydroplaning phenomena is dependent on the tire characteristics. Why did you ask for only braking performance and not overall tire performance?

MR. DiLORENZO (U.S.): It's certainly inferred here, wet pavement performance has to be taken into account when we specify braking efficiency and the other requirements. I don't think there's the necessity

to go into the tire performance by itself. It's a subsystem, one of many subsystems, that relate to the totality of vehicle performance. The problem is the responsibility of the designer. He has to come up with tires that will be compatible on wet and dry surfaces and so on.

MR. MATTHES (CHAIRMAN): Are there any further questions regarding braking? The whole of this braking subject, M. Belke?

MR. BELKE (GERMANY): It is requested that the braking be carried on without locking. Now, when you haven't a necessary device on the vehicle which avoids this locking, then such a condition will depend on the braking distance.

Now, my question is: how does the Administration carry out these tests in America to ensure that the nonlocking condition isn't the result of a particularly good driver?

MR. DiLORENZO (U.S.): As Mr. Slechter mentioned yesterday, we had a six car program on which we evaluated the state of the art in production vehicles. In the testing of these vehicles we used skilled drivers and even they had to practice to obtain the best vehicle performance. They couldn't do it the first time.

In the specifications, we have advanced the state-of-the-art in braking to the extent, we have almost—almost, I say—required anti-locking systems on these vehicles. Again, we didn't want to design the car to meet our requirements. So the requirements for anti-lock brakes is not specified.

MR. MATTHES (CHAIRMAN): Thank you.

Well, any other questions? Mr. Sesnic?

MR. SESNIC (FRANCE): From Citroen. From the safety point of view we think that the efficiency of the parking brake should be checked with an unloaded as well as a loaded vehicle. This efficiency is linked with the braking devices themselves, and also to the percentage of the total load available on the brakes. Hence, a loaded vehicle doesn't necessarily correspond to the most difficult conditions. Therefore, why are tests only provided for loaded vehicles and not for unloaded vehicles?

MR. DiLORENZO (U.S.): I don't follow his argument that the vehicle unloaded is worse situation.

MR. SESNIC (FRANCE): Well, May I explain?

This depends of course on the total arrangement and design of the vehicle. Normally, the parking brake works on one axle only, and it must work normally on an up or down slope. Now, depending on the arrangement of your parking brake system, it may be that due to the pure reason of friction you cannot hold the vehicle, and you may even be forced

to have a parking brake which does not work on only one axle but on two axles. This is expensive and you don't need this in most cases. Therefore, the question was: How do you cover this state when you have a parking brake on one axle only; the vehicle is empty. This axle is not charged to its full extent, but only partially, and you have the most unfavorable situation, upwards or downwards. How did you cover that?

MR. SLECHTER (U.S.): I think we would certainly admit that we did not take this into account, but assumed that the fully loaded vehicle would be the most unfavorable condition. We certainly should consider this input.

MR. EKBERT (SWEDEN): Mr. Chairman, you stated during the discussion that if you take into account the differences in test methods, the ECE regulations were compatible with the American standards. I think you were referring then to the stopping distance, but, is this also the case with braking distance?

MR. MATTHES (CHAIRMAN): Well, I'm very sorry, but I can't answer your question. It is difficult as far as the safety is concerned, to make a valid comparison.

MR. PECK (ENGLAND): It might help Mr. Ekbert to say that in our opinion the American SAE test is a less severe phase test requirement than the ECE. They are not very compatible. In our opinion it is easier to get through an SAE test than to get through an ECE test.

MR. SLECHTER (U.S.): We would very quickly comment that the Safety Administration in the United States is a rule-making activity, and is working on this problem right now, and I believe recognizes the difference in these two specifications.

MR. MATTHES (CHAIRMAN): If I may add a word, it's always difficult to reproduce in a laboratory procedure the stresses encountered in actual traffic. You can always find conditions where the best test is not applicable. This is especially true in Europe where we have varied driving conditions. The U.S. has big highways, while we have mountainous regions with small and twisting roads. We have long distances which are traversed at different speeds. It has never been quite possible to establish a valid driving cycle. All procedures for tests are auxiliary designs to arrive at a means of comparing vehicles and to exclude those which are illegal—not meeting general specifications.

MR. MONTABONE (ITALY): Sir, we have the American and German specifications. Why don't we standardize all these details. As an example, in the case of service brakes, the Americans require an

efficiency of 80 percent, and you ask for 75 percent. Why isn't there compatibility between the two? I think that since they are practically the same specifications it's only logical that they should have the same values. Might I ask the German delegation to give an explanation on this, please?

DR. BURGHARD (GERMANY): It's extremely difficult to answer this question because the definition is a problematical thing in itself. Theoretically, one should look at the problem of the surfaces of the tires. All these problems should be perhaps removed from the specifications because, before we can actually do this, we've got to find a sort of compromise solution. This means that everybody is going to interpret things in their own fashion. Then all we can do is to come and meet and discuss and try to harmonize our opinions. This is always much more difficult to do than to base considerations on physical facts.

Therefore, I think it important in research to continue our work which deals with the influence of roads and the tires on brakes. For example, the Swiss authorities have carried out research work which is highly satisfactory.

Now perhaps I have answered the question. Is this sufficient as an answer?

MR. MATTHES (CHAIRMAN): Perhaps I might try Mr. Montabone to add something to what Dr. Burghard has said. I am now speaking on behalf of the German delegation.

We have placed this requirement in our specification for the following reason. We discussed at great length in Germany requirements of this type. We had discussions with the authorities and with industry, and we came to a quality degree — this is the degree of the exploitation of the friction — and we have to stick to a certain scope here.

We decided to verify this with mathematical calculation in order to avoid difficulties which were addressed in the first part of our discussion on braking. We can discuss this problem day-in-day-out without coming to any conclusion because the phenomena, the friction phenomena, is a phenomena which up to now has not really been fully clarified. This why we have based our requirements on a theoretical calculation which considers that it is possible to achieve certain data on the car; the center of gravity coefficient, a number of different arrangements of the braking devices, et cetera. In this way, we have been able to arrive at a solution on paper if you like.

I hope this answers the second half of the question.

MR. MONTABONE (ITALY): You in Germany in your administration consider that the American

specifications are too severe? I believe we are confusing a few things here. I agree with you that specifications are specifications, and they are numbers, and you respect them or you don't respect them. The American specifications are for 80 percent, and you say it isn't possible to obtain this figure of 80 percent, but you ask for 75 percent.

MR. MATTHES (CHAIRMAN): Might I add once again, on behalf of the German delegation that we have converted other figures of the American specification. As you see, for example, the original speeds, the departure speeds, in the American specifications, was 60 miles per hour. We have based our assumptions on 100 which of course would increase the test requirements. Obviously, if you convert English units into metric units, well, one's got to adjust oneself a little bit.

I would say, however, the values were more or less the same.

UNIDENTIFIED (ITALY): You referred in your requirements to SAE 843A, whereas a new standard or recommended practice 843B has already been released. Why did you not refer to this second specification?

MR. DiLORENZO (U.S.): These specifications were first written about November, '68. We then went through the six-car program, and released the bid package to industry. The new SAE specifications was issued subsequent to these events.

MR. MATTHES: In your statement of work at the beginning you stated that the state-of-the-art should be taken into account. Does this mean that when in the course of development the procedures and the standards of SAE change your contractors must take into account these changes.

MR. SLECHTER (U.S.): Yes, we must consider the multi-year nature of this program. And we just can't lock into three-year old information.

MR. POCCI (ITALY): Mr. Chairman, I'm sorry to take the floor again. I know we've trying to follow a schedule, but here we have a highly-qualified assembly. We have many pioneering technicians, but I have the impression that the braking problem has been put to simply. The years of work we have expended, when I say we — all here have participated to a considerable extent. These years have shown us that there are enumerable aspects which have to be taken into account. Sometimes we've discovered that you can obtain good performance in one field, but you've got to pay a penalty in another field. For example, fading, the brakes might not clean themselves rapidly, and hence, might not be efficient. If you have good road brakes, you might find that you have bad road testing brakes. It could mean the

distribution of the brakes on the axles. We find that there are sensitive brakes, too sensitive to the effort exerted on the pedal.

There are advantages of brakes which are particularly good for emergency braking and not for other types of braking. Over the years we had to sort out our priorities, if you like. I'm not trying to advocate a specific type of brake. I'm not trying to say how fine the work has been that's been carried out. But what I would say is that the totality of this work is so very, very complex; and what we've got to do is to take all aspects into account. We've got to weigh them one against the other.

One of the things that is most difficult is to be a really good citizen, if you like. We have got to offer something which is really optimal in all conditions for all types of drivers. And this is, I believe, a reflection of the work that we have done up to now, but not a sufficiently good reflection. Perhaps sometimes we've been too severe in one field and not sufficiently severe in another field. We've got to draw our knowledge from the well of knowledge, and we've got to try to find a sort of overall generalized type of safety in this field.

I'm sorry to take so much of your time. Thank you.

MR. MATTHES (CHAIRMAN): Gentlemen, I think that in order to give us sufficient time to discuss the other topics for this morning we must now leave the field of braking performance and take the second slide which concerns the steering characteristics of the vehicle.

Steering

Gentlemen, Mr. Slechter, yesterday explained the reasons why this characteristic was adopted and I think that especially this specification merits some discussions. I note that the Japanese delegation has some question, and I know that the other delegations have made some remarks on it. As far as the German delegation is concerned, their proposal for technical specifications deviates in some respects from the U.S. statement of work.

MR. KONDO (JAPAN): Mr. Kondo's question was concerned with the applicability of the 4000 pound vehicle specification to the 2000 pound vehicle specification.

MR. DiLORENZO (U.S.): Yes. We didn't expect that this specification would be directly applicable to the small car. We understand that the initial slope is certainly a function of the wheel base of the car and that the curve for a small car would have a steeper slope to it.

The car we specified has a 120-inch wheel base. This curve is for that type of car. Therefore, if you embark on this type of specification, you will have to arrive, however you will, at a specification which is compatible to that size vehicle.

MR. MATTHES (CHAIRMAN): When you say "compatible" does this mean compatible with your specification or compatible with the general characteristics of the vehicle itself?

MR. DiLORENZO (U.S.): The general configuration of the vehicle. If you want to go into the shape of this curve, we can do that, or do you want to go on with the discussion?

MR. MATTHES (CHAIRMAN): No. What I meant was that in general as far as European vehicles are concerned there's a certain preference for such steering characteristics, which are a little different from that exhibited by this diagram. Mr. Slechter, yesterday, in his presentation clearly stated that these characteristics were derived from tests which involved six current American production vehicles. There was one English vehicle, but the others were American, big family sedans of the same weight class. These vehicles tend to understeer.

In Europe, we generally prefer a characteristic which is more neutral, towards oversteering. I would refer to the other delegations in explaining this feature, because I think we approach it differently, what is the desirable characteristic of a vehicle in certain critical situations? The American delegation, I think quite rightly, has based their curve on the assumption that the ESV must not deviate too much in its behavior from that which the average American motorist is accustomed to.

When we consider other parts of the world, it may be that the average motorist is accustomed to different vehicle behavior. Does this mean that when other companies embark on ESV projects, they can orient their specifications towards what the motorist in that country is accustomed to?

MR. DiLORENZO (U.S.): I think that that is a very sound approach to your project. Whatever characteristic your public has been accustomed to you should attempt to emulate in your specifications. That's exactly why we selected our approach. Now, we do have research and have gone to our contractor people to determine what the population would do, could accept, could acclimate to in the way of neutral steer, understeer and oversteer. At this time these data are not available to us so we had to choose this mode. But there is certainly a good probability that a future generation car would have different characteristics than this one.

MR. LISTER (ENGLAND): Mr. Chairman, I would like to address something a little more

fundamental. How do we know that we've got the desirable characteristics which will reduce accidents? The handling or steering characteristics which one prefers to get rapid response, understeer at all times, perhaps these are not always the ones that give the minimum number of accidents.

We are trying to study this by examining the accident rates of different types of vehicles with known differing handling responses, and we are trying to measure these responses to see if there's any relation between the accidents, or accident situations and what we think are the handling characteristics.

The problem is to find the right parameters to determine what should be measured and included in the accident situation. This is a very difficult field, and it may well be that the steering responses requested here may have no effect at all on the accident situation.

MR. SLECHTER (U.S.): We completely agree with Mr. Lister statement, but we have to reiterate from our presentation yesterday, that we have oriented the first ESV to crashworthiness as number one priority; recognizing the fact that it is very difficult to establish the link between safety and vehicle handling. We believe that by construction of our own vehicle and the construction of vehicles in the 2000 pound class, and hopefully, the 3,000 pound class to establish the link. Conferences of this kind also will help to arrive at handling characteristics and specifications which we can verify by testing these cars with a large population of drivers. By these means we hope to get a little bit closer to the safety relationship of handling. But I would reiterate, for our 4000 pound ESV we have established crashworthiness as first priority and have specified handling characteristics that the American driving population are most familiar with, that is what we consider good handling characteristics for an American car.

MR. MATTHES (CHAIRMAN): May I ask the American delegation one question. You have referred most of your steering specifications and handling specifications to a lateral acceleration of 0.4G's because you said that up to that limit the tire characteristics, the side force, is approximately linear, and that this is a value which the normal driver does not, in his normal driving, encounter, but which he may well encounter in surprise maneuvers.

On the other hand, your table on handling lateral accelerations, this must be Slide 11, specified lateral accelerations well in excess of that figure of 0.4 with manual control up to .65.

Can you give an explanation for that?

MR. DiLORENZO (U.S.): We have a table in the specifications to reflect this. We evaluated production cars to determine the ultimate lateral accelerations,

and arrived at that table. Certainly there are maneuvers in extreme cases in which the driver will go all the way from some value close to zero lateral acceleration to the full amount the vehicle is capable of attaining. We want to be sure that that maximum amount is not too low.

I have a question I'd like to ask the German delegation concerning this selfsteering behavior. I note it will be run on a track, however a track with one radius. I wonder how you go about attaining this self-steering behavior? How is this going to be demonstrated in a parametric form as the vehicle behavior varies over a reasonable range of vehicle speeds? You have only specified one radii. I can see a vehicle might as you say, self-steer, on a circle of one radii, but how are you assuring yourself that this characteristics doesn't go to an understeer or a neutral steer at some other velocity?

MR. MATTHES (CHAIRMAN): Perhaps I could repeat the question in German. He was saying that in our specifications when we design the self-drive, self-steering, we only have one circle and have only mentioned one radii, and we can obtain a specific speed limit. But it would be interesting, however, to obtain other speeds at other radii. This would be interesting to study. Why haven't we introduced this into our specifications?

MR. KRAFT (GERMANY): We can answer this in a very simple fashion. The test facilities don't exist. Especially for the higher speeds we would require very large facilities that we haven't got. At our factory we just don't have such surfaces available. The vehicles that we produce have been studied, have been tested by our engineers on all possible roads, on all possible curves. We truly have obtained the optimal driving behavior. We could have mention the ISO attempts but we realize that there was just no point in introducing the ISO recommendations into our specifications because those conditions just didn't exist in Germany, and we had insufficient information on the problem.

It has also been proved that the ESV has very good handling characteristics.

MR. DiLORENZO (U.S.): Our experience in this area may be helpful if you decide to follow a similar path. For the large radii demanded by these cars, we didn't in fact pave large surfaces. In one portion of the specification, you need an 800 foot radius circle. We don't have a circle of 360 degrees for that radii. What we did is design a vehicle maneuver that forms a letter J — the English letter "j". We go into a transient and then steady stay for about two seconds to get the data, and this is adequate. I'm just suggesting that you might consider this if you want to

try different speeds. I am sure that you know the cars you produce, however I would like to caution you, that when you go to the crash-worthiness portions of your specification, and you modify your vehicle with added masses, the differences in performance are very significant. In this regard, don't expect the vehicle as you now know it to react the same way after you have modified the structures and so on. They behave quite differently.

MR. MATTHES (CHAIRMAN): This is also shown in your comparative tables. They compare one characteristics which is good for crash survival against another characteristics which influences handling on the road.

MR. SLECHTER (U.S.): That is the type of message we're trying to get across.

MR. KRAFT (GERMANY): Might I add something to what has already been said?

We don't think that one speed is all important to the understeering of the car. We also don't think that the understeer tendency will be the same for all lateral accelerations. When we reach the limit of lateral acceleration, then we will have an oversteering condition so that the car can react in the correct and the necessary fashion. For these reasons we opted for the radius of the circle that we did, and we can determine our gain in this fashion.

In order to add something else to what has just been said, we are fully aware that when you have to add new devices as, for example, for the crash performance, that the axle load will have been changed. But no one is going to take a car that exists today and solve the task by putting the device into this existing car—to just simply add extra steel, extra something else, to an existing car. Even if we were to do this, I believe that European technology is capable of obtaining very good driving behavior with varying loads on the axles. In the European market we have vehicles which are quite varied in the relationship between the front and rear axles loads, but which have very good driving behavior. We can speak of the various differing conceptions which exist in, for example, the BMW and Porche. The ideas are quite different, but nevertheless, we've proven through results that the capacities and characteristics of these cars are excellent. In the long run what Mr. DiLorenzo has just said is just a question of the relationship between the loads on the axles.

MR. MATTHES (CHAIRMAN): Gentlemen, we've got ten minutes left. I will try to summarize the result of the discussion on vehicle handling to this point. I believe it has been shown that it is extremely difficult to express vehicle handling in quantitative terms.

Some delegates have spoken about good vehicle handling, and it has been tacitly recognized that with the present state-of-the-art, it is not possible to evaluate this by exact test specifications which can be objectively measured by everyone and reproduced by everyone.

The normal procedure in Europe at least, is to test the behavior of a vehicle by extensive road testing under all conditions which the vehicle may encounter during its practical life. As I said in the beginning, it is envisioned that test procedures will be evaluated by ISO, the International Standardizing Committee, but it has been found that this will be a long and difficult job. Fortunately, the U.S. delegation has also stated that these specifications on vehicle handling are not to be considered as absolute values to be adhered to but should be used more as guidelines which may be modified according to the particular conditions in the country which develops its ESV.

UNIDENTIFIED (GERMANY): In the American specifications there is a page which deals with handling—lateral acceleration with different tire pressures.

If you have different pressures in the two upper lines you have design values, and then with a manual control you have 0.65 as the lowest value. Then according to German engineering we consider this to be wrong, because in the fourth line, there was a combination of 120 percent front and 80 percent rear pressure. We have a higher value than the original design value. A vehicle is normally designed such that the design value is the optimum value.

MR. DiLORENZO: This I believe can be answered from both experimental data and theoretical considerations. Because our cars understeer, the front tires do not have the tractability they might have with more air pressure. We take design pressures as those the manufacturer gives us, and he arrived at these limits based on a lot of considerations, i.e. ride considerations, noise, vibration, and so on. We find that these tires do perform better at a higher tire pressure and their traction capability goes up. Correspondingly, the rear tires, when you drop the pressure, their traction capability goes down, and you therefore go from a car with understeer to one approaching a neutral steer or somewhere about that. You can therefore achieve the higher lateral acceleration.

MR. MATTHES (CHAIRMAN): American studies on handling attempted to establish safety criteria which are absolutes, and which don't depend on the design of the car. Is it difficult to imagine that research workers in America study European cars in great detail. Because without necessarily speaking of

Experimental Safety Cars, we already have a sufficient choice of cars to examine this in greater detail.

We are rather disappointed that during the examination of the six cars, American cars were used in order to obtain criteria which could conceivably affect us. It is this concern that I would like to express.

MR. DiLORENZO (U.S.): We are simply showing our six car program results in effect. We would like to see you use our test procedures. You don't have to use these numbers.

MR. MATTHES (CHAIRMAN): In other words, summarizing what I said before, in the particular countries which embark on the ESV project you suggest that an approach similar to the U.S. That is, determine the actual state-of-the-art of the vehicles on the road.

MR. DiLORENZO (U.S.): Very definitely. In doing this, we knew that the ESV family sedan would be very much like this year's production cars. We knew we couldn't do any harm in doing this, and we wouldn't jeopardize safety. We couldn't make it any better from a safety standpoint, but certainly we couldn't do any harm.

Suspension and Drive Train

MR. MATTHES (CHAIRMAN): Gentlemen, we have got a few minutes left, and I would like to have the slide #18 on the screen, because here we have some criteria which are not directly related to handling, but which may be useful to us.

The first one is ride performance, and I think here the same stipulation should apply, that is, these figures are not to be considered as absolute limits to adhere to, but only guidelines for the Europeans and the Japanese. Is that correct?

MR. DiLORENZO (U.S.): The consumer on the American market has become acclimated to a certain ride in a vehicle, and we want to sell him that car. We recognize the problem of the manufacturer's. We just can't turn out a car that handles like or rides like a Group 7 racer. It has to handle and behave like a passenger car. That's what the public is used to.

MR. MATTHES (CHAIRMAN): Gentlemen, are there any questions on the second section of this slide? The section entitled engine. We shall exclude the first line because we are not holding a meeting on emission standards, and the second line as well, regarding the evaporative losses.

The other three points. Are there any questions on these three points; range, the acceleration of the car, and the lateral acceleration capability, that is, the engine must not stop and behave unduly in lateral

acceleration of 0.5G's. Are there any observations of this requirement?

MR. KRAFT (GERMANY): Apparently we've almost finished this session, but we are speaking of safety and I would like to come back to tire pressure for a minute.

I want to make a very general remark to my American friends. In America, drivers tend to neglect the pressures of tires. I'm speaking from experience as we sell some vehicles in America. When I was in America I drove a Volkswagen, and on two occasions I was not pleased with the handling of our cars. They were Volkswagen, and the people dealing with the cars were VW people, although, of course, Americans.

Now, logically, I went along to a service station to have the pressure of the tires checked, and I was told that of 10 stations, only a very few have monometers. You can obtain air pressure, you know, from the sort of ordinary simple device, but you don't have monometers.

Now I think if we're going to speak of road performances; handling, et cetera, well, conceivably safety would be better served in American traffic if this question of the monometers was examined by the American authorities.

Well, this is my opinion, anyway. Thank you very much.

MR. MATTHES (CHAIRMAN): Gentlemen, this shows that safety is a field which is not only the responsibility of the vehicle designer, he can only do his share up to a certain point, but also the responsibility of the owner, and all the service facilities which he must use during the life of the vehicle.

MR. MATTHES (CHAIRMAN): Gentlemen, I thank the American delegation all present for their questions and discussions. This session is adjourned.

section 3 part 2

SECOND SPECIFICATION DISCUSSION CRASH WORTHINESS

MR. SLECHTER, *Chairman*

UNITED STATES

MR. SLECHTER (CHAIRMAN): This is the Second Specification discussion session of the conference. I'll take a few minutes to make some opening remarks while the projectionist is setting up the few slides which will carry us through this session. I plan to follow the same format that was used this morning to successfully by Mr. Matthes.

Mr. Matthes, I thought, did an outstanding job this morning in keeping a very delicate subject under control. I hope to have 50 percent of his success this afternoon—not 80 percent—as we specified for the braking efficiency.

The important documents that have been submitted and are available to us for this particular discussion are first, the basic document, the U.S. specification for crashworthiness. Second, German specification, which we are pleased to see has accepted the challenge for the small car that the American specification has undertaken for the larger car. We recognize the most difficult task ahead for the 2,000 pound car.

The Japanese delegation has submitted a group of questions pertaining to the U.S. specification. We ask that the Japanese Delegation raise these questions, and any other questions that they may have during the course of this session.

The German delegation also has presented questions on the U.S. specification which we took up with some of their representatives in the U.S., and I believe actually led to the finalizing of their specifications.

We of course heard the Toyota air bag system presentation, which I believe is an important consideration for this particular panel, and of course, the very perceptive presentation by the French on vehicle aggressiveness, which is a subject I think we will be hearing more and more about during this particular session.

If no one has any disagreement with this basic philosophy, I'll call for the slides one at a time from the American technical presentation.

STRUCTURES

MR. SLECHTER (CHAIRMAN): As you recall yesterday we specified crashworthiness in six major segments: The front and rear bumpers, side, roof for roll-over, the interior design, and the restraint system.

I will call for the first basic slide that sets up the requirements for the front and rear bumper structure system—that's slide No. 18.

As you recall from yesterday, this is the basic acceleration versus impact speed requirement for the front and rear of the vehicle. Recognizing that our goal is a 40 to 50 mile per hour front barrier collision, and a similar collision in the rear with a moving barrier.

MR. MAEDA (JAPAN): I am Mr. Maeda, a member of the committee for body structure of the ESV in Japan.

My first questions: In the proposal there's the safety requirement for the structure performance of the body of the car, but at a consistent speed. According to our understanding, the final target of the effort in the field should be the requirement to satisfy the criteria for the passengers. Is it not necessary to satisfy the detailed performance of the body structure provided that the injury criteria will be satisfied? Of course, we understand that it is necessary to satisfy the limit of body damage at low speed.

MR. SLECHTER (CHAIRMAN): I refer the question to Mr. Chandler of the American delegation.

MR. CHANDLER (U.S.): The reason for the specification of the vehicle structure is basically that we are interested in the subject which our French fellow conferees call "vehicle aggressiveness." Not necessarily in the big car, little car collision alone, but the collision between the front end of our vehicle and the side in particular of our vehicle and other vehicles of approximately this same size.

We do believe that if we can make the impact of the striking vehicle less aggressive—to borrow the word from our French fellow conferees—it will also alleviate to some extent the big car or small car problem, which is basically one of difference of masses.

That was the reason for the specification requirement between ten miles per hour impact speed and 30 miles per hour impact speed. That should be on a rising slope. In other words, it does not jump clear up to the maximum value at 11, or 12, or 13 miles per hour.

The value we picked for the upper end of that slope—other words, 30 miles per hour, was a

compromise to allow some of the work that's being done in the United States in which there are serious looks being taken at fixed force devices to play a role in this automobile if our contractors decided to go this route. In other words, the specification does allow what I will refer to as a hybrid system, that could be velocity sensitive at the low speeds, and fixed force at the higher speeds. The value we chose of 30 miles an hour, I would repeat, is simply a compromise value. Obviously the higher that value is, then before you come up to full deceleration, the less aggressive the impact of the vehicle will be.

I might point out that there are a number of possibilities which will satisfy the specification. For instance in the range of 0 to 10 mph we are not specifying a requirement that the response shall be a constant 6 G's, although that would be acceptable. On the other hand, a curve that goes through 0, 0 would also be acceptable as long as it did not exceed 6 G's up to 10 mph. . . . maximum values. Anything below that curve is acceptable.

Now, in addition to the fact that the curve can be extended back to zero, any number, an infinite number of similar curves can be drawn beginning at zero and going up to the 50 mile an hour value that is 40 Gs — or even lower if some designer can do so. This I think would give us the best performance that we have visualized in a frontal impact for this car.

There are several ways in which that velocity sensitivity might be achieved. Once again, we had no desire to limit it to one particular form.

One way you could get up there would be to draw a series of stair steps underneath that curve. In other words, this would be a number of fixed force devices.

I think we all recognize that this approach would use distance. At the lower speeds where you have the lower forces you would knife right through these in a high speed impact with very little resistance, and for this reason that much distance would be used without being very effective.

On the other hand, there is another way to get there that has not been traditionally used in automotive work other than in the shock absorbers. This might be a variable orifice hydraulic system.

If this is used we then find that the resisting force is a function of the impact velocity squared in a barrier collision. It actually is a function of the speed

with which the piston moves in but in a barrier collision this is synonymous with the impact speed.

Now, we didn't want to specify simply a V squared curve which is equivalent to specifying a hydraulic device. Therefore we allowed the exponent which is normally 2 for the variable orifice device to range from 1 to 2. Up to 2.

This allows a number of design approaches to be used while staying under the curve.

May I summarize by saying that we are interested in specifying the vehicle structure, deceleration, whether we have used the right numbers or not. We are interested in specifying it because we want to know how various systems react as a function of velocity and this is especially important in collisions into the side of other cars and in the large car-small car collision.

MR. PECK (U.K.): I would like to ask a question concerning the position where this deceleration or acceleration is intended to be measured. The requirement is for maximum permissible acceleration of the vehicle body structure and the acceleration of the body structure will vary from the front to rear of the vehicle in a frontal impact diminishing generally speaking.

Ought not the position at which this location, this acceleration is to be measured be specified also? Is it intended to be an acceleration of the passenger compartment or literally the maximum acceleration of the whole vehicle structure?

MR. CHANDLER (U.S.): That is also specified; whether or not it is the right place or not, this is the place that we chose when the specification was written. It is given as—and I will read directly from the specification — “The curve depicted in Figure 6 is also the limiting curve for passenger compartment acceleration as measured at two positions on the frame or rigid structure left and right at the longitudinal position of the front seat.”

Now, as the gentleman stated, the acceleration will vary from the front of the vehicle to the back. We definitely didn't want to get into the high frequency ringing accelerations that occur at the front and, by the same token, we did not want to go clear to the rear where the acceleration is minimum and smoothed out. So we specified this position which basically is the passenger compartment position.

be levied for traffic accidents. The federal government, therefore, has this infinite morass that they would have to try to tackle from the federal level. Therefore we didn't consider the idea that you have presented here of raising the fines for damage in accidents of this type. Of course, the fine to the individual in our country is actually higher and higher and higher insurance costs, and that is the reason for our trying to get to a no-damage condition for the 10 mile an hour collision.

MR. EDWARDS (U.S.): We might also add in this regard that the insurance industry in the United States is looking very hard at no-fault insurance which means that in fact for collisions costing certain sums the person at fault actually doesn't pay it. It is an automatic payout so as to reduce the amount of cost involved in an accident, not raise it.

MR. CHANDLER (U.S.): I apparently missed the essence of the first part of that question. I think there is one other thing that I would like to interject. We believe, and we certainly do not have statistics for this except our own and our wives' experiences, but a lot of these low speed accidents may happen in the parking lot, into a post in the yard or the driveway and so on, which I assume would not be covered by any fine that might be levied legally.

DR. REIDELBACK (GERMANY): Just to the last point, an extra remark I would like to make. Just a rapid remark. If somebody drives into a wall, for example, I think he should have to pay for this. But we shouldn't make this a burden on other drivers that is they will have to cover the cost of the person who drove into the wall.

MR. SLECHTER (CHAIRMAN): I agree completely. Obviously the overwhelming cost that we are talking about is not of this type and I certainly do agree. If it were for that reason and for that reason only we would not be doing this kind of thing in our specification.

MR. SLECHTER (CHAIRMAN): I agree completely. Obviously the overwhelming cost that we are talking about is not of this type and I certainly do agree. If it were for that reason and for that reason only we would not be doing this kind of thing.

DR. REIDELBACH (GERMANY): I have a question to put to the French delegation. You have spoken of a mathematical model of aggressive and nonaggressive cars. Have you had any opportunity up to now to compare this mathematical model with the curve which is on the screen at the moment and, if so, to what extent do the results correspond to one another?

MR. CHILLON (FRANCE): I intended to ask to take the floor to discuss this curve. Looking at this

DR. SASSOR (GERMANY): I would like to put two questions to the representatives of the safety authorities and this concerns the requirements for the bumpers.

When we talked about this you mentioned that the light devices in the front and the back shouldn't be damaged in the case of a slight collision. My first question is the following:

Have you carried out cost analyses in order to determine whether with, at a lower cost, you wouldn't be able to obtain the same results? For example, that through higher fines people who are included in such an accident could be encouraged to replace damaged light. And what other aspects were taken into account when you set up these specifications?

MR. CHANDLER (U.S.): Several aspects were taken into account. Certainly the damage to lights and that sort of thing is safety related. However, our basic consideration here was that we can accomplish this without it being detrimental to our major objective which is the safety of the occupant.

It was not so much a safety oriented thing although there are safety features, but, rather, it was economic.

The Insurance Institute of America, which is separate from our organization, has run extensive tests on the amount of damage that is incurred in low speed collisions and, while I am not able to cite the figures here, they are available and the cost of such collisions to the insurance companies and to the public, of course, who pays in the end is — the only word I can think of is astronomical.

MR. SLECHTER (CHAIRMAN): I might add, as part of your first question, you probably recognize that our form of government in the United States, where you have fifty states, all the cities, local governments, municipalities, each of these individual elements of government establish to a large degree such things as what kinds of fines will

curve which is on this slide we have the impression that the values are reasonable, fairly reasonable. Nevertheless, I would like to say that what appears important and what we should require from cars is good performance and behavior rather than a specific acceleration performance.

It appears to me that if a manufacturer produces a car which isn't absolutely perfect during impact, well, I don't think that this car would always be followed totally.

Now, if we really do find a good compromise I think it would be a shame not to build the car even if it doesn't totally correspond to this curve. Therefore the idea of asking people to produce cars which have the possibility of having good behavior in certain tasks, well, I think that this policy is more valid than another policy of acceleration specifications that are stipulated once and for all.

Admittedly we have found such a curve and we usually find that the accelerations obtained are lower. But we are attempting to improve safety and hence to increase this and we don't see why we should be asked never to exceed 40 G up to the condition of impact at 50 miles per hour. If the car has air bags or absorbing safety belts, I think that one could exceed 40 G without the passengers necessarily being wounded severely and if, on the contrary, the passengers are not protected by air bags or by safety belts, well, the second impact accelerations are much higher than those that you see in front of you on the screen at this moment.

Now, I don't really know if I have answered the question quite correctly or not.

DR. REIDELBACH (GERMANY): Well, it isn't as simple as all this, you know. As I understand your answer, it isn't possible to obtain the desired characteristics in one curve and to express them in one curve and hence the answer that you have given me is satisfactory.

MR. CHILLON (FRANCE): No, it isn't exactly what I wanted to say. We can admittedly plot such a curve. We have got one here. But we don't believe that this curve is in one specific domain a really indispensable criteria for the car to be deemed valid. We consider that there are already many difficulties in trying to conciliate a number of aspects.

If we are to impose a way of obtaining results as are imposed here, I don't think it is a very fine or good solution.

Moreover, I would like to address two questions on the slide now shown.

I believe I understood that this acceleration curve which is limited in function of the speed of impact, I think I understood that it should be valid for front and rear impact.

I think it would be useful to point out here that rear impacts generally take place, car against car, more infrequently than head-on shocks or front shocks. Hence cars that are being constructed are weaker at the back than at the front. I think that it would be a good idea to continue standardizing rear impacts in the immobile barrier conditions as done up to now.

When we have a back impact, just as you have a front impact, we carry out the same tests. You find that the severity of the impact doesn't at all correspond with what takes place in 95 percent of the cases. Now, you could practically say 100 percent of cases of rear impact.

Rear impacts beyond 65 kilometers an hour are really exceptional, or at least according to the information that we have available. Therefore we don't deem it necessary to require manufacturers to complicate the construction even more of their cars in order to obtain cars that are stronger at the back.

The requirements don't correspond to what the cars can do nowadays and I really don't think that there is any point in improving this. You require 32 or 50 kilometers an hour with mobile barrier, all right. But to ask for anything severer, no, I really don't think it is necessary.

MR. CHANDLER (U.S.): I certainly agree that our requirements for the rear are very severe. They have been modified by the fact that we use the moving barrier which I believe is understood. In other words, if the 65 kilometers is the speed of the moving vehicle then we have accounted for that, but we are up around 80 with our requirement which is really not a lot beyond what might be reasonable.

But I certainly do agree — in fact, we have discussed this internally as to whether this is too severe a requirement. And, as Mr. Slechter stated yesterday, it was kept in on the basis that in American cars we have room for the energy-absorbing devices and they probably will look very much like the ones we would put on the front. So that was the basis and the reason that we went ahead.

I certainly have no objection to the statement that that is a severe requirement.

MR. MAEDA (JAPAN): I would like to repeat my question because I don't think Mr. Chandler understood my question well.

Briefly speaking, our opinion is that the requirement of 40 G between 30 to 50 miles per hour will not be necessary if we install a very good restraint system.

MR. CHANDLER (U.S.): This is possible and maybe even probable. Remember, I think that these are maximums that we have specified. If you read the language of the specification it says not to exceed

that value and any value below that curve is not only acceptable but desirable as Mr. Slechter has shown on the board while I was talking. So if this can be reached at 20 Gs, at 25 Gs, wonderful. That I am sure is desirable.

The second comment I would like to make is we specified 60 Gs as a force on the occupant. If you allow for some amplification factor in your restraint system, in other words the deceleration that the occupant will be seeing is somewhat higher than the passenger compartment will see, then we need to drop down some. Remember, that these are maximum values that are given by this curve and any value below it is not only acceptable but desirable, then I think that probably we are saying the same thing.

MR. SLECHTER (CHAIRMAN): Let me add to this and maybe I can help you, Mr. Maeda.

There are two points of interest. Your question I do believe is why worry about specifying the structure performance requirement when in fact if the human being lives in the crash that is really what you are after. I believe that is what your question was.

Well, two important points I believe have been brought out.

If you build a very, very stiff front end in your car it becomes a weapon. So from the total system that we are talking about in all the accidents on the road you must consider both the occupants in the safety car that you are trying to protect and the occupants in the car that it may strike. That is point number one.

Point number two, Mr. Maeda is the fact that by specifying the structural requirement for the front of the car, if indeed you use an air bag system, it may be feasible for you to design the interior of your car so that the air bag would not have to be energized at say 10 miles per hour.

It could be that you might design the interior with padding so that for speeds up to say 20 miles per hour you may not need an air bag. You could therefore prevent an air bag from being deployed by properly designing the front structure in combination with the air bag sensing mechanism and the speed at which the air bag goes off.

We therefore took this approach that from a total—not just one vehicle system standpoint—but from the total accident picture we don't want the ESV to be a new weapon on the marketplace. We want to give the designers more freedom to work with the restraint system.

MR. LISTER (U.K.): Mr. Chairman, I think the problem here is I have some sympathy with Dr. Maeda. I think you are trying to now get three

requirements onto one graph, not two, and, you know, you are making it more complicated.

I cannot understand the justification for the transition between 10 and 30 mile an hour. Because, as Mr. Maeda said, because of the attenuation that one achieves through the seat belt or other restraint system, that transition between 10 and 30 offers no advantage to the occupant or the user.

You are now saying that it offers something to the struck car, but that is a different problem that might be included in the first requirement of zero to 10 mile an hour instead of putting it in as a speed requirement. It may have been in a distance requirement.

I think you are trying to get too much into one curve.

MR. CHANDLER (U.S.): We admit that we didn't know how to draw the curve initially and that we worked a long time with it and that we would not argue vehemently for the values that are on it.

On the other hand, a part of our program does involve the crash of this vehicle into the side of another vehicle. The very subject that was covered by the French delegation this morning.

Whether we have taken the best way to do that job I would not argue, but we are trying to do it, I will argue, and we certainly are open in this particular generation of vehicles, if you will, that we have under way now. We undoubtedly will proceed with this approach.

In the next generation, if something better is available, we certainly would be interested. That is why I have the extreme interest that I have in the presentation that was made this morning by the French.

MR. SLECHTER (CHAIRMAN): Slide 32 on side impact. The American specification has employed the measurement of intrusion at the B pillar and the center of the door, three inches at the pillar, four inches maximum at the door center, and what we consider to be survivable forces on the occupant which, as we stated yesterday, is a subject of much concern to all of us. I think we know less about the human tolerance to injury in the lateral impact than in any other direction.

The German specification I believe, while following the maximum intrusion approach, did modify slightly and if they would like to comment on their specification or if we have any questions about this one, feel free to raise them.

I believe the German specification called for no entrapment of the occupant or no structural damage to the dummy in the test rather than just a minimization of three inches in the side.

MR. CHANDLER (U.S.): May I make one comment on this requirement which I think is plainly stated, but sometimes missed.

The intrusion that we are speaking of is in the interior of the vehicle, not on the exterior. In fact, the more exterior intrusion we can get without exceeding the interior intrusion the better because this is the paradox that Mr. Slechter talked about yesterday. You have very little space and you must if you keep the forces down by absorbing the energy in the side, you must use distance.

At the same time if you allow too much intrusion of the interior surface you are going to injure the occupant.

DR. SASSOR (GERMANY): The ideas that we had when we drafted our specifications were the following: we considered that we had to guarantee a survival space according to defined lateral impact and when I see the two requirements up on the slide and if I understand them correctly, then I think that there is a contradiction here because on the one hand you are asking that the specific intrusion be not exceeded. On the other hand you require that the forces be low so that there be a good chance of survival of the passenger.

Now, if you have a really large car this implies that there is a penetration of three to four inches. This doesn't imply any direct danger of impact or penetration to the passenger because they are a long way away from the edge of the car.

If you have such a wide car and you allow this much intrusion then the impact on the passenger will be reduced and this is why in the specifications in Germany we mention the fact that you have to have a remaining space of survival. Of course, that extra survival space will be smaller in a smaller car than in a larger car.

MR. CHANDLER (U.S.): I agree. The thing that I called a paradox earlier is a contradiction, it is a paradox.

We believe that this is barely possible and our major point here is that we hope to absorb some of the energy in the striking car.

Now, I will repeat the statement of a moment ago. If the doors were thick enough—this isn't necessarily practical, but if the doors were thick enough—say they were two feet thick which is completely out of the range of practicality, but if they were, then you have a major fraction of that door thickness to absorb energy along with the front end of the striking vehicle.

We recognize the severity of that requirement and if you read our statement of work from a legalistic standpoint you will find that we made the decelerations from the side an objective rather than a

requirement. That was done just because of the contradiction that was raised here.

We do not consider this a simple problem. We do not even consider that we have a very high probability of success. But it has to be approached.

Now, with regard to whether three inches is too little or too much, the number doesn't have a terrific amount of validity. It was a number that we picked. We went back to the strongbox passenger compartment philosophy and tried to take the energy out, a portion of it, in the striking vehicle.

DR. REIDELBACH (GERMANY): Now, obviously, there is a shortcoming in our knowledge. For example, knowledge on the acceptable load that can be borne by the human body from the side. Well, as we don't know this very well, we have to examine actual accidents, accidents in detail. We see that to a large extent, a large intrusion, three to four inches, doesn't necessarily imply that the accident is going to be lethal.

Many accidents can be analyzed and you will see that despite a greater intrusion the occupants are not only not killed but are not even severely injured. From this point of view, therefore, I think that these requirements should be re-examined.

MR. CHANDLER (U.S.): I would say the U.S. certainly accepts your comment. We, of course, as far as the building of our cars is concerned are well along in design and, because of the competitive nature of the contracts, we are not proposing to make any basic structural requirement changes along the way; as you can obviously recognize this kind of a program as you get into the hardware phase it is very difficult to turn off the design and direct it in another way when you have a schedule to meet.

But your comment is well taken and we are going to do more thinking on it. In fact, we are continually worrying this problem, not only in ESV but in the other research programs of our administration.

UNIDENTIFIED (FRANCE): I would like to say that if indeed we did manage to produce such a car corresponding to such performances it would be fine. But, well, honestly, I fear that once you impose the energy of the impacts, and you know this data, and you impose the maximum deformation and then you declare that the accelerations are limited, well, after all, this is required you mustn't, of course, kill the passengers.

Well, under such conditions one is forced to deform the interior panel without deforming the exterior panel. I see no other solution. And then I think we are going indeed to be forced to produce cars as Mr. Chandler suggested, with very thick doors.

I think that this will be the result of such considerations: very thick doors.

MR. CHANDLER (U.S.): This is certainly one approach. I think there may be one thing that we are missing here and that is that the interior surface, as we will see it, is the inside of the padding. What we can't take outside we must take inside or we will not meet whatever is required for lateral impact. We don't think that our number for lateral impact is the last word by any means.

So when we think of these thick doors, and this is a large car, we are thinking of considerable padding on the interior of the car.

DR. BRENKEN (GERMANY): We in Germany have in our specifications devoted much time and conversations to this point before we decided to follow the constructive suggestions of the American specifications — or rather not to follow the actual values of three and four inches, but to state that it must be possible to take the dummy out without the dummy being subjected to any damage. In the crash test, then, the dummy mustn't be injured in any way.

These requirements were introduced because we wished to give the manufacturers as much flexibility and freedom as possible and we think that this type of specification is better than a constructive but limited requirement as the American is.

We must also remember that the doors, as has already been mentioned, are made thicker, the doors will be much heavier and with other improvements, just the front and the back improvements, that the car will be so much heavier afterwards that it will automatically entail other disadvantages. Hence, as I have already said, we wanted to leave as much freedom to the manufacturers as possible.

MR. SLECHTER (CHAIRMAN): I think we should move on to the next part of the discussion and if we have some time we might come back to this if there is more discussion.

I would like to go now to the Slide 33 which is the roll-over specification, and, again, we specified an intrusion limitation in the roof for the roll-over and offered two means of testing in our American specification. One, by dropping the car on its roof from a specified height and the second a reproducible roll-over which we thank the Daimler-Benz people for. We saw their films of this technique about a year or a year and a half ago.

Are there any comments on this particular specification?

MR. MAEDA (JAPAN): So far as the amount of body deformation is concerned, that is to say three inches for roll-over test and including head-on collisions, this requirement is generally very hard,

very difficult to satisfy by a smaller sized vehicles.

In a practical sense, the important matter is to limit intrusion at the dome which will have a great influence on the survival space of passengers. For roll-over test more than three inches deformations of a roof around the A pillar should be permitted and also I would like to include the head-on collision deformations.

For head-on collisions, the deformations at the floor pan should be more than three inches.

UNIDENTIFIED: May I react to that? Would you recommend then that the intrusion limit let's say for the front collision be specified in some other way? That is with reference to the dummy or the occupant himself?

We have had recommendations I think from the German delegation about not entrapping in any way the feet or the dummy. Is that what you had in mind? Rather than a severe limit of three inches?

MR. MAEDA (JAPAN): Yes. If the requirement was the same as the German proposal that is the best solution, I think.

MR. CHANDLER (U.S.): Certainly the intrusion requirements are severe. Our own automotive manufacturers have questioned the values that we have specified. We are continually reviewing these requirements in an effort to refine and improve them, however as Mr. Slechter stated yesterday this is the purpose of this program.

The matter of roll-over is extremely complicated. We don't have a test that simulates it. You are likely to have decelerations occurring at the same time you go over and whether the A pillar has a lot more room or not under that kind of situation I think is questionable. But the trouble is that we do not have data, actual accident data, to really know how to specify that size. Certainly we would not disagree with the comments I have heard.

We will have a moment of truth, if you will, in about a year from now when we start testing and our ideas may change quite a bit when we see the results of these tests.

We have decided to go for the strongbox passenger compartment which has been enunciated in the past and that same comment applies to the roof.

MR. SLECHTER (CHAIRMAN): I also would state, Mr. Maeda, that in all cases I think where we talk about intrusion as being our basic requirement for the vehicle, we have taken the strongbox approach. I think in this case your comment is very valid about the forces on the occupant being certainly the thing that takes precedence. If your design tradeoffs are performed in such a way that you are always looking for minimum forces on the occupant

and it leads more intrusion than three inches, I think you are certainly taking the right step. But we had to take what we felt was the most practical approach for the first attempt at the roll-over problem, by specifying the strongbox approach.

MR. MATTHES (GERMANY): I think one other reason why some of the delegates stressed the importance of this roll-over or roof requirement and especially that of the intrusion is the problem of visibility which is not directly connected with occupant protection but which is one of the most important elements of primary safety. Here I think we have one point where we have to make a decisional sort of trade-off between the two elements. As far as we in Germany are concerned, we say that of what good is it if a man survives a crash which he would never experience if he had good visibility. What counts is an active element of safety and this should not be taken too lightly.

Thank you.

MR. SLECHTER (CHAIRMAN): I think that is very eloquently stated, yes.

Other comments on the roll-over specification?

If not we will move on to Slide 34.

Interior Design

In this case our specification was both qualitative and quantitative. With regard to the knobs and protrusions normally found in the car we are doing everything we can in our specification and in our design to make those knobs and protrusions harmless to the occupant when a crash occurs.

I believe the German specification — correct me if I am wrong — limited the protrusions to those below the seat reference point. Is that correct?

MR. MATTHES (GERMANY): Mr. Chairman, as far as the interior design specification is concerned, we also aim for an interior design which has the least possible danger of occupant injury.

We have, furthermore, stated that all parts which are contactable by occupants which are restrained by active restraint systems must be designed in such a way as not to cause any injury.

Furthermore, when the vehicle is equipped with passive restraint systems the interior surfaces must be designed so that the impact speeds for occupant acceleration are below the threshold of admissible limits. In this regard we are completely in line with your specification.

MR. SLECHTER (CHAIRMAN): Are there any comments or questions on the interior design of this specification?

MR. MAEDA (JAPAN): In the case of vertical

acceleration, it seems very difficult for us to satisfy the injury criteria of passengers. If we install the padding around the passenger's head sometimes it will interfere with the sidewalls and would not be a practical solution I think.

If we have any good idea, could you kindly inform us?

MR. SLECHTER (CHAIRMAN): I would refer you to the period of time between June and December of this year for the good ideas.

As you know, from the presentation yesterday, the two contractors will complete their final design in June. Until that time we really, because of the competition, we can't divulge very much information. Of course, as soon as they are both irrevocably into the fabrication stage we will begin to freely expose design ideas and so forth.

MR. CHANDLER (U.S.): I commented a while ago on the fact that we made the lateral acceleration an objective. We also made the vertical acceleration an objective in the legal sense of the contract wording. I didn't mention it then because I didn't want to get another thought in the middle of the lateral problem. But this is also true for the vertical acceleration. It is not a requirement. It is something we would like to have and we recognize the difficulty in doing it when we wrote the statement of work.

MR. SLECHTER (CHAIRMAN): Any other comments on the interior design specification?

If not we will move on to the last specification in crashworthiness which is the occupant restraint system.

Restraint Systems

As a member of the Department of Transportation I do this with fear and trepidation.

The American specification requires a passive restraint system. The American manufacturers will provide designs that have restraint systems that require no action by the occupants.

I believe the German specification went along with the spirit of the passive restraint system. Rather than say the wrong thing, I believe it would be appropriate for the Germans to comment on their specification in restraint system area.

MR. KRAFT (GERMANY): In Germany, after a very basic discussion on the American specifications we came to the conclusion that the requirements are exaggerated and that the people concerned would just think it ridiculous that they be asked to carry out such tasks. There are so many types of accidents which could be covered, should be covered with such a passive restraint system and there are other

requirements, for example, the lateral windows must be opened for any roll-over test, et cetera.

Now, these requirements come from a very well known safety standard. I personally would say that at the present moment they are well, ridiculous. This is why in the German specifications we have left open the possibility of having active safety measures, safety restraint devices. The aim that we are following here is to encourage further developments in the field of active safety devices in the experimental safety car project.

You see, what we don't want is for the experts to come along and say, look, in the future, we are only going to have passive restraint systems, and therefore, what is the point of devoting any work to active restraint systems. We believe that all in all we still have not exceeded, the period when active restraint systems are necessary.

MR. SLECHTER (CHAIRMAN): I think we could probably have a meeting on the air bag restraint system rule at this point in time, but I don't believe we should do that here.

We accept the fact that you are working the passive restraint problem, but are going to continue thinking about active restraints. We recognize your position in this area.

We, in America, are hopefully going to demonstrate that at 50 miles per hour, the passive restraint system will work in the ESV design. I think we have to move on in that spirit.

MR. EDWARDS (U.S.): We can say that we have great hopes for its success in the family sedan category of automobile, and we do recognize the difficulties that are faced in achieving this kind of a goal in the smaller-sized car. No question about it.

MR. KRAFT (GERMANY): I found it rather typical that Mr. Slechter said that in America you have great hopes for the air bag in the case of a 50 mile accident.

What is typical here is that you are thinking of the linear crash, and undoubtedly we have achieved a level of air bag technology which offers considerable advantages. But I was speaking expressly of the overall specifications where we mention side impact and rollover tests. For all these general tests we still believe that the active restraint systems with its capabilities is more important at the present time.

MR. SLECHTER (CHAIRMAN): Are there other comments concerning the restraint system specification?

I would then accept any items or questions that you have on crashworthiness. Any reflections on presentations that you have heard in the past two days?

DR. SASSOR (GERMANY): Mr. Chairman, I think that all of us have welcomed this opportunity to have an exchange of views here today.

As far as I know, similar conversations take place in America whenever there are objections to such problems. I think we have underscored here that any form of uniformity of safety requirements would be desirable, and would be welcomed.

Professor Patrick from the Wayne State University, Detroit, approximately a year ago, travelled round the world and spoke of safety requirements in the case of accidents. Extracts of his opinions were printed in a report, and I would like to quote what he said that when he visited the governments and the automobile manufacturers, he had the request constantly repeated that there should be uniformity in the safety requirements. He had the impression that the American authorities would agree providing, however, that the other countries follow and accept the American laws.

Well, basically this sounds rather pessimistic. Perhaps it was intentionally provocative, if you like, or, could I put this as a question to the governmental representatives from America.

What is the possibility of American Authorities discussing new laws or standards in an European forum to attempt to reach a compromise?

MR. SLECHTER (CHAIRMAN): I would comment that the authorities that are here today, are not the authorities in the Department of Transportation who are directly involved with the setting of rules, and the writing of standards.

Therefore, to amplify on your comment, I think it is extremely important that researchers in our country and in your countries, all of your countries, have frequent opportunities such as this, and I believe the Experimental Safety Vehicle Program will be a catalyst for that kind of discussion. So that we, as researchers, can come to more common terms with specifications relating to safety.

I, personally, cannot comment or guess an opinion as to the Department's attitude toward a dialogue. I don't know exactly the kind you are speaking of, although you might allude to the possibility of some formal dialogue, some meetings to be established for this particular purpose.

I really couldn't say, from my standpoint, as a researcher in the Administration. I think Mr. Edwards might prefer to comment.

MR. EDWARDS (U.S.): Of course, in broad terms, the Department is always open for discussion. There is no question about that.

Insofar as the formal processes of rule-making are concerned, there are very definite steps that allow

anyone supplying vehicles for the American market, who is concerned about a particular rule-making activity, to petition for redress. And these actions, in many instances, have been done.

So, while I cannot here, any more than Mr. Slechter, identify a formal establishment of some new kind of organizational structure to handle this increased dialogue that you indicated you desired, I think certainly within the current frame of reference, a reasonable response is available.

To come back to your earlier comment about Professor Patrick, I would like to add that another researcher, highly regarded in the United States, Dr. Robert Hess, who is the head of the Highway Safety Research Institute at the University of Michigan, in his welcome and keynote address at the Fourteenth Stapp Car Crash Conference, said a lot of things about the air bag, and I am going to extract the good things.

And I quote: "A landmark ruling was made just a few weeks ago, which, if implemented fully, will undoubtedly be as important in the area of injury reduction as all of the private and public actions taken to date in that field, and potentially will have a level of impact on our life as significant as any other public decision of this decade."

This implies a lot of things, and not the least of which is the fact that we really are approaching the problem seriously, and meaningfully, and we believe that the approach is a good one. I think it is fair to say that the Department intends to pursue that direction.

MR. SLECHTER (CHAIRMAN): Does anyone else have comments or closing remarks they would like to make about crashworthiness?

Or other subjects, for that matter?

MR. KRAFT (GERMANY): Might I come back once again to the question of acceleration curves of the American ESV?

Could we have the slides again, please?

We have already discussed this curve, and we have seen that the acceleration was limited in order to limit the aggressiveness of the car, vis-a-vis the partner.

Now, if you do limit these figures, undoubtedly the value 40 G for an impact speed of 30 miles per hour for a vehicle of two tons is much too high. I would say that the value should be reduced by 50 percent.

If we think that the partner car is, let's say, only one ton in weight, and that deformations on the two-ton vehicle are brought about, then there is a power of approximately 80 tons.

It is obvious that a two-ton vehicle would deform in front with a power of 80 tons.

Now, this is an unacceptable value for a small vehicle, because the smaller vehicle would have to have a rigid structure that would be deformed at 80 G's which is also too high a value for the occupants. It appears that the larger vehicle should have a lower acceleration curve.

I would like to go into more detail here.

Where the vehicle mass and deformation is concerned, we have considered them as being homogenous, undoubtedly they are not. Therefore I think that the measurements of the acceleration on the undeformed structure of a vehicle is not sufficient in order to assess the aggressiveness. You are not going to measure the back part of the car, when there is a considerable mass concentrated in the front part of the car, for example, the motor block.

Now, if the front of the car enters into contact with the other car, which is usually the case, and when the motor block is extremely rigid and you cannot deform it or distort it, then when the front of the car is deformed, there will be a fantastic power exerted at this point. It cannot be measured, admittedly, but they are extremely high.

This implies that the vehicle which enters into the motor block of the other car, well then, you don't need to measure another acceleration.

Now a good idea here would be instead of using the criteria of acceleration, to use the impact power and to limit the impact power. In other words, there are SAE standard possibilities here. You have a fixed barrier and you conduct tests and you stipulate requirements similar to this curve. You could say, for example, with 40 G value, you should not exceed more than 80 tons during the distortion period.

For example, one should not be able to measure more than 40 tons for large vehicles, and we would have the same limit for small vehicles.

This would imply that when the two vehicles have a head-on crash, that the front part of the vehicle would be distorted. Then I would also advocate, if we are discussing standards, that the smaller vehicle should have higher powers than the larger vehicle, because after all they are smaller.

Well, I don't quite know whether I have been very clear, but I think that this was what I wanted to say.

MR. SLECHTER (CHAIRMAN): Very interesting concept that you have put forth.

I would comment on the very earliest part of your question, or your comment about the 40 G, 30 mile-per-hour point, and I will turn it over to Mr. Chandler, who perspired more than anyone else in the United States, over where that corner should be for this particular specification. He has the back-

ground on what was obviously a compromise in the specification.

MR. CHANDLER (U.S.): Well, taking the points that I got down, at least, that 40 Gs is too high at 30 miles an hour, I certainly agree. We hope it will be much lower than that into a rigid barrier.

I would like to cover a point that probably hasn't been clear, although it has been mentioned several times, but it is from a little different aspect.

We are not building one car, but actually three cars. We are in a competitive situation, our contractors are in a competitive situation, and they are free to lower the acceleration at 30 to the extent that they can, and they are free to make tradeoffs that they believe are most appropriate for this situation. We certainly hope that it will be lower than 40 Gs at 30 miles an hour.

That corner, as Mr. Slechter referred to it, was a compromise basically to allow hybrid systems, some of which were under development and still are. What we would like to really know, is which one performs best across the spectrum of accidents that are likely to occur, and in the traffic that we have.

We repeat, our specification, that line, does not, in any way, claim that it will solve all of our problems. We did use the values that we believed were the maximums we should allow when we took these many conflicting requirements into account.

Now, with regard to the point that it is not a solution for aggressiveness, I definitely would agree. It is a step, we hope, in the direction of a solution for aggressiveness.

I am not at liberty to comment on the designs we have, because of the competitive nature of the contracts. I won't be in a position until after the first of next year. However, I can assure you that the matter of the engine has been considered, and we have taken care of. It is an excellent point, and that is one of the problems that has to come up when you get up in the 50 mile-per-hour impact range.

Now the other point that I would like to make with regard to the ascending portion of that curve, and we would be happy if it ascended all the way out to 50 miles per hour, is that we are hoping for a system that will, when it strikes a rigid object, will be rigid, and when it strikes a soft object, it will be soft. In other words, to some extent adjust itself, it will sense and know what it has hit and react accordingly.

We in no way by that statement ought to imply that we have a 100 percent solution. The solution that I am referring to is reported in our Phase I Reports and also in the evaluation of our Phase I Reports which was done by Battelle Memorial Institute. That information is available now without compromising any contractor's approach to this problem.

We hope that we are going to be able to show some advantages and we hope somebody else is going to pick it up and take it even further if it works. And I will be happy to give you these references, anybody that would like to have them.

MR. SLECHTER (CHAIRMAN): Are there any other comments on the subject of crashworthiness?

UNIDENTIFIED (FRANCE): I would like to come back to the problem of the limitation of deceleration at 40 G. I highly appreciated what the German delegation said when they spoke of effort, but I would like to say the following: the curve is given for a test which is carried out on a front wall. Hence this interests the totality of the structure.

Now, we fear that we have limited the number of Gs in this type of impact because in a real accident you are only touching a very small part of the structure. In a majority of accidents there is a sort of staggered effect and very often the rigidity is not great enough and the G level is very low and the survival space can be reduced to zero.

Now, we are well informed on this and we know the reaction of the car and the wall with a very flexible front end. It would correspond to the requirements on the screen. We have seen what has happened in the case of actual accidents and we realize that today's cars are not the best cars from the point of view of the protection of the occupant.

MR. SLECHTER (CHAIRMAN): If there are no further comments I don't believe there is a need to try to summarize in detail each and every point that we have just discussed. I believe it was very important for us to have this two hours discussion. I hope there is better understanding in each delegation as to what our logic and philosophy was in establishing the specifications and we certainly appreciate the approaches that you are taking in setting up your specifications.

section 3 part 3

THIRD SPECIFICATION DISCUSSION OTHER ACCIDENT AVOIDANCE FACTORS (VISIBILITY, LIGHTING, CONTROLS, DISPLAYS)

MR. YAMADA, *Chairman*

JAPAN

MR. EDWARDS (U.S.): Our next item on the agenda is our third specification discussion session, which will be chaired by Mr. Yamada of the Japanese delegation. If Mr. Yamada and a few of his associates will come to the dais please, and proceed?

Visibility

MR. YAMADA (CHAIRMAN): Thank you, gentlemen. I would like to move into the visibility section of this technical discussion.

I am from Japan. My name is Yamada. I am the Chairman of the ESV committee in the Japanese AMA. I have with me two assistants, one from Mitsubishi, Mr. Mitamura, and the other from JARI, the Japan Automobile Research Institute, Mr. Okami.

Our discussion will be divided into three parts. One is for front vision, the second is for rear vision and the third deals with a periscopic type device. Each part will require about ten or fifteen minutes; we should be finished in about thirty minutes.

I would like to immediately go into front visibility, i.e., forward visibility from a car.

So far, we have papers submitted by the German delegates, questionnaires from Japan, and the German and U.S. specifications.

Mr. Mitamura would like to submit a question to U.S. delegates.

MR. MITAMURA (JAPAN): I would like to inquire about front and rear visibility as specified in U.S. specification. We have made some preliminary investigations and, as a result, we have some models about which we wish to question the American delegation.

Question number one is about visibility to the front. As you know, the U.S. specification requires a minimum elevation angle of 17 degrees measured from a plane tangent to the top of the 99th percentile SAE eyellipse.

We suppose this requirement is chiefly aimed so that a driver can recognize the traffic signal from a point as close by as possible. But, as a matter of fact, it is very difficult for us to meet this requirement and retain crashworthiness of the body structure. Therefore, we think there should be some compromise between visibility and crashworthiness. Perhaps the seventeen degrees should be reduced to somewhere between 10 degrees and 15 degrees. Additional technical effort should be directed toward obtaining suitable header location and cross-sectional area which is important in resisting side impact and roll over.

Question number two is about the lower angle of frontal vision. That is 8 degrees measured from a plane tangent to the bottom of the 99th percentile SAE eyellipse.

One problem in obtaining 8 degrees down angle is the steering wheel location when the steering wheel is located according to conventional driving position. The upper portion of the wheel comes above the 8 degree line. We don't think it is safer to change the position of the steering wheel below this line, thus sacrificing the conventional driving position.

Another problem is the height of the engine hood in the case of a front engine car, especially as related to pedestrian safety during an accident. As is well known, the behavior of the engine hood plays an important role when a pedestrian is struck by a vehicle and thrown on to the engine hood according to a front trajectory. A part of the impact energy can be absorbed through deforming the hood. With the front vision down angle at 8 degrees and the engine hood below this line, the mutual clearance between the engine, itself, and the hood is limited to a minimum and the shock-absorbing effect available to the pedestrian around the engine compartment is considerably sacrificed or reduced.

Such being the case, additional technical compromises should be considered between visibility and pedestrian safety and between visibility and steering wheel location. We think the 8 degree specification is

a little severe, and if it is revised to 6 degrees many of the above mentioned problems can be solved.

We would like to have some opinions from the American delegation. Thank you.

MR. DiLORENZO (U.S.): The up angle of 17 degrees was the number arrived at by our visibility people early in this game of studying visibility specifications.

Clearly there is a trade-off between visibility and crashworthiness and we have since realized, after initiating these contracts last July, that this is indeed a real problem and have instructed our contractors to trade off accordingly.

In other words, if they find that this is excessive, we will consider less than 17 degrees.

The lower, 8 degree angle, is also now considered a goal we would like to achieve. We realize again that it does mean major production modifications as far as our cars go in the States.

The engine components are located in a position where 8 degrees is infringing on the volume of space available for the engine and to achieve this requires considerable modification.

And, as far as our own program goes, to do all this means more development money in that area. We have already stated in the last day or so our priorities won't allow us to do that.

As far as your steering wheel problem goes, I can't really remark in depth about that. I think perhaps it might have to do with the total envelope of the car.

I don't recall — and, Mr. Roth, you might wish to remark on that — I don't recall that we have run into that problem. Have we?

MR. ROTH (U.S.-A.M.F.): No.

MR. YAMADA (CHAIRMAN): Thank you.

Any other comments or questions from the floor?

MR. SLECHTER (U.S.): Just to add to that briefly. We recognize from your presentation the other day on pedestrian safety that the Japanese delegation is probably a little bit ahead of the American delegation in research in pedestrian safety and, as well, has a bigger problem in pedestrian safety in their country. Therefore, we would certainly be in favor of your trade-off between improving pedestrian safety by working with the hood line and trading that off against the best visibility that you can achieve in the down angle.

We are certainly in favor of your approach.

MR. DiLORENZO (U.S.): This is actually a question to the gentlemen who posed the question. From some of your previous studies it appeared that this type of a hood profile would in fact provide a more favorable trajectory for the impacted pedestrian, at least above a certain size. I am not clear now

on why you are saying this shape is actually reducing pedestrian safety.

MR. MITAMURA (JAPAN): Well, the problem here is of course the location of the hood height itself and how far the engine hood can be deformed so as to have an absorbing effect. In a conventional production design, if the 8 degree angle is applied, we cannot leave much space between the engine hood and the engine itself. And so one of the problems is achieving the lower front vision down angle without reducing the absorbing distance to the minimum. It is one of the problems we have now. We still do not know for certain the relationship between the deformation of the bending compartment hood and the safety of the pedestrian after he is struck.

MR. YAMADA (CHAIRMAN): So that is where we are, and we have by no means nearly completed our research.

Mr. Watanabe, who presented the film of the pedestrian the other day, please.

MR. WATANABE (JAPAN): I have some explanation about the pedestrian in addition to Mr. Mitamura's.

In the film we showed you on the first day we had about 150 millimeters of deflection. On the actual design, I think, it is not necessary to have so much distance, but some amount of engine hood plastic deformation will be necessary. We must have some amount of clearance between the engine and the hood. This decreases the lower angle a little bit. And, that film was restricted to trajectory control, a relation between trajectory control and the front shape.

We have not acquired any data, but the Japan Automobile Research Institute recommended the bumper height. The bumper height is between 14 and 17 inches from the ground. This is not for controlling the pedestrian, but to minimize the injury to the lower leg. In this area the impact point upon the lower leg is between the two joints of the bone, therefore if the bone is broken, it is very simple and very easy to cure.

MR. YAMADA (CHAIRMAN): Thank you. Any comments? Anybody?

Anything for the front view? Rear visibility?
Mr. Matthes?

MR. MATTHES (GERMANY): Mr. Chairman, where the difficulties which have been discussed are concerned, that is, those which result from the upper angle of 17 degrees, we believe that these problems are true for the American statement of work as well.

Under the U.S. specification, it is true that the internal rear mirror may not be any lower than the level determined by this angle of 17 degrees. We

think that as a result of this situation we must compromise because if you have a rear mirror that is too high the driver is forced, if he wants to look back, to lift his head up. This diverts his attention away from the front which is not good. In the German specifications we decided that the bottom edge of the rear view mirror could be lowered somewhat; we feel that the 99th percentile eyellipse is such that the rear mirror can sit lower. I think that I would like to ask the Americans to make a comment on this and the possibility of lowering the rear mirror.

MR. DiLORENZO (U.S.): The 17 degree angle and the problem we have had with it, we talked about earlier. When that was brought to our attention, it was also made clear to us that the human eye can probably rotate 15 degrees vertically without too much difficulty; beyond that you do have to tilt your head and certainly a driver gets weary doing that. As a result drivers will probably not use their mirror and we are worse off than before. So this, again, is another reason why, perhaps, we should lower the angle a bit. But, we do want to keep the mirror out of the forward field of view and maintain the bottom of the mirror at such an angle, whatever the angle may turn out to be. Like you say, probably 15 degrees would be an upper limit.

MR. SLECHTER (U.S.): To add to that, Mr. Matthes, our approach when we set up the specification was obviously, that we picked an arbitrary number after studying the problem for some time, recognizing that the lower edge of the mirror in many of the cars on the road today is at zero or 1 or 2 degrees above the horizontal. What we were really after was a substantial improvement in the reduction of forward view caused by the mirror location.

So, the attempt was to get it beyond the 17 degree angle. Although we recognize it to be a very hopeful attempt, we also recognize that there is obviously a trade-off with the human's capability and willingness to use the mirror when you get it up that high. It is a trade off situation.

MR. MATTHES (GERMANY): Mr. Chairman, might I point out something: the fact that, on the basis of available texts, we can see there is no connection, or little connection, between the danger of accidents and the rear visibility.

The requirements in the American statement of work for rear visibility are such that sometimes it will be necessary, or could be necessary, to provide for structures which would be very different from those of today. Sometimes for example you might even need to build in devices such as periscopes.

Now, do you think that these requirements are really justified on the basis of the accidents and the accident knowledge that you have today?

MR. DiLORENZO (U.S.): I regret I don't have the figures before me on the accidents caused by the lack of rear vision, but I certainly feel that the effort expended by a driver in heavy traffic in trying to see to his side and the rear must certainly take into account his total efforts and might reflect, could reflect, on his ability to drive in total.

We had in our bureau, a number of cars available to us to try at various times and one of them did have a periscope, I will say that in trying that car I found there was a tremendous advantage in heavy traffic because it was so much easier. And I would say that anyone exposed to this type of driving for long periods of time would notice a significant reduction in driving effort.

MR. CLAVEL (FRANCE): Clavel from Citroen. You said that you were searching for a space between the hood and the engine itself, this with the aim of absorbing energy. If I correctly understood, this is the case of the impact against a pedestrian who is projected onto the hood with the view of avoiding skull fracture when the pedestrian strikes the hood.

Tests that we have carried out have led us to believe that the danger of a skull fracture does not occur on striking the hood, but, rather, the danger is striking the wind-screen when the windscreen is too vertical.

The second danger occurs when the pedestrian falls from the hood onto the ground.

Therefore, we do not see the need for a design which has a space between the hood and the upper part of the engine or the air filter and such devices.

MR. WATANABE (JAPAN): I have some comments and questions. The questioner, I think, is correct because most fatal injuries on the human skull occur during the final stage of impact upon the pavement and, according to our measured data, impact forces of the skull on the engine hood do not exceed 80 to 150 G's. So, the necessity for the energy-absorbing characteristics of engine hood depends on the injury criteria.

We don't have some concrete value, a recommended value for the injury, but it seems that the critical G level lies between 80 or 100, I suppose. The energy-absorbing level, required of the engine hood can be attained. It is not so difficult, I guess, but it depends on the design. As for the impact on the windscreen, I think that is important. The windscreen is designed of energy-absorbing material chiefly for the purpose of protecting the front seat

occupants, but it is also recommended to protect the pedestrian.

I do not think that this is a satisfactory answer to the question, but it is my comment.

MR. YAMADA (CHAIRMAN): Thank you. I think Mr. Clavel's question was perhaps mistranslated slightly, but he does agree with you that absorbing energy between the hood and engine is desirable, but he states that the hood is not a major source of the impact. He just wanted to make a point in relation to the frontal down angle visibility requirement.

MR. CLAVEL (FRANCE): Thank you, Mr. Yamada. Personally we have opted for a choice. When choosing between the space that you have mentioned between the hood and the motor and the need to lower the level of the hood, that is using a hood which slopes to the front, we consider that the second aspect is the more important. It is necessary to have as low a hood as possible. This offers good aerodynamic characteristics and thus it is very important for road-holding and handling. This is why we chose this type of hood.

UNIDENTIFIED (ITALY): According to what I have been able to understand, the forward visibility angles that we have already mentioned, 8 degrees down and 17 degrees up, were considered excessive. This was the opinion of the Japanese colleague and other people who had already spoken.

Well, I don't think that any conclusion has been drawn from these remarks, and this is why I would like to put a very clear question. How can we resolve this question?

Mr. Leroy can say that the data that he has already received indicate that the requirements may be too excessive. If we are to come to a valid compromise between visibility requirements and other more specific safety requirements we must do so. I think that we could work on a valid compromise. For example, 6 degrees down and 15 degrees up.

MR. SLECHTER (U.S.): I don't believe that it would be possible in this meeting to come to a firm compromise position and say that 6 degrees down and 15 degrees up are the final numbers that the American delegation would consider to be acceptable, certainly for our own ESV program.

We would expect that the other delegations would take the guidance provided by our specification, 8 degrees down, 17 degrees up, recognizing the obvious trade-offs that have already been discussed and working from that as a framework, arrive at the optimum numbers.

That is exactly what our contractors are doing at this moment. We want it made clear that 8 degrees down and 17 degrees up are guideline numbers from

which to depart in design. And I don't believe we can arrive at final numbers today.

MR. OSSELET (FRANCE): Mr. Chairman, Osselet from France. We have spoken a lot about lowering the level of the rear mirror and I don't think that this would necessarily be a good idea because, apparently, front visibility is after all much more important than rear visibility. Therefore, we should really accord accident priority to front visibility.

What we need of course is to improve rear visibility while reducing front visibility as little as possible. This is why all the rules and regulations which lead to a lowering of the rear mirror are not justified. Indeed, we would be tempted to impose minimum levels. Minimum levels, minimum heights. I ask the American delegation the following question:

If you get a considerable improvement of the rear visibility, don't you think that this would be rather dangerous?

It may appear rather paradoxical, but I have had the opportunity of noting that when you want to use the rear mirror a lot, well, you quite simply forget and neglect what is happening in front of you.

Psychological studies have been carried out on this problem and we have noted that the more one is obsessed, if you like, with rear visibility, rear vision, the more likely one is to crash into a car in front because he has forgotten to look in front.

MR. SLECHTER (U.S.): The point you make is a valid one, at least in degree. How much rear vision distracts from forward vision is, I think, a very qualitative subject.

We certainly would agree, in principle, that the forward visibility is more important than rear visibility taken one against the other and relating them to safety. To what degree, 80-20, 90-10, 60-40, we are not prepared to say.

What we are prepared to say, however, is that we would like to get substantial improvements in forward visibility while at the same time, not make rear visibility any worse and, hopefully, improve rear visibility.

The specifications which we will discuss in a few moments on rear visibility will indicate that we are going for an improvement in the visibility angle to the rear.

So I can only say yes, I agree with your comment. I don't know of the psychological studies you speak of but I can just say intuitively it would seem to me to probably trend in that direction.

MR. YAMADA (CHAIRMAN): We have a little bit more time for the visibility and, the chairman would like to ask anyone who is a specialist on the periscopic type rearview mirror to describe what

horizontal and vertical angles are possible in relation to the many comments from the floor and provide an example of the design if that can be done. Can the delegates from the U.S. give a few minutes' discussion on this?

MR. SLECHTER (U.S.): It is no secret that in the proposals by our contractors at least two proposed a periscope in their design. These contractors are still actively working toward incorporating a periscope in their cars.

I said yesterday that the details of design must remain confidential, so to speak, until approximately June of this year at which time we will be able to release substantial information.

I believe this is a good example, a very good example of the kind of subject matter and design information which we feel this international ESV relationship can cause to flow from one country to another.

We don't want to see Japan, Germany, France, England and so forth independently having to do research in periscopic rear vision if we have cars which have periscopes installed.

So we look forward to the time when we get one or more cars with periscopic rear vision so that all of us in this room can take a look at what the advantages and disadvantages are.

MR. BELKE (GERMANY): Gentlemen, a few years ago the Federal Republic of Germany carried out studies at the University of Berlin on the possibility of ensuring sufficient rear vision.

In these studies, carried out by Professor Augustine, it concluded that, if you use periscopes the rear vision conditions are not necessarily any better.

Admittedly the studies were theoretical. They are printed. Unfortunately I don't have the number of the report but I can give you that at a later date.

Now, in practice it does not appear that anyone has used the results. However, if you are interested, I could supply you with this article.

MR. YAMADA (CHAIRMAN): That article sounds very informative and anyone who wishes a copy please contact Mr. Belke of MOT, Germany.

Thank you very much.

Well, if there are no additional questions on visibility, particularly field-of-view, we would like to go on to lighting,—the headlamps and rear lamps.

Lighting

Anyone who wants to start the lighting questions?

I think our German representative has quite a number of questions.

MR. MATTHES (GERMANY): Mr. Chairman, the list we drew up corresponds to desires expressed

before the conference, that is, a survey of the points of discussion that we were going to deal with. We don't intend to discuss all the points on the list.

Where lighting is concerned, I have first of all a rather ticklish remark. On the first day of the meeting the American delegation showed a picture of a prototype car and there were lighting devices indicated on the car, I must say quite frankly that the size and the design of the lights as they were shown on the slide were rather disappointing. In fact, I thought that the lights would be larger.

Secondly, I would basically underscore that in Europe, in almost all countries, we have regulations on lighting devices, both for the mounting on the car and for testing. And thanks to years of work we have been able to standardize and to make these lights uniform. Therefore all types of lights, headlights, sidelights, brake lights, et cetera, all these lights correspond to international test methods.

Now, rules, regulations, as to the insertion of the lights will soon be assigned. I think it is a matter of course, I would like the Americans to confirm this, that the European countries or firms that work with ESV projects should and must be able to base their work on these regulations just as you in America base your considerations on SAE regulations.

MR. SLECHTER (U.S.): I would comment about the American specification. I think it is obvious to anyone who reads the specification on forward lighting that we have left a lot of room for individual thinking, effort and design. About all we have really specified is the maximum candlepower of 150,000 candlepower, and have left the details of any design, detailed design, to the contractors.

We obviously did not want to specify dimensions of lights and so forth because we were looking for each contractor to do his own research and come up with some new concepts, hopefully, that we could examine on three different cars.

Just yesterday, in my conversation with you, Mr. Matthes, it came to my attention that these international specifications are available. I think it would be very important for our contractors to have that information and I would ask if it is possible for this information to be made available to us.

MR. MATTHES (GERMANY): Mr. Chairman, if nobody else wishes to take the floor, I would like to indicate one point which is included in the American specifications. For headlights it is stipulated that systems with a headlight with a dip, like a high and low beam, that the manual and automatic switching must be studied.

Are there problems in America with automatic switching from highbeam to dipped headlight, and

are these problems well known? In Germany they have been studied and it appears that with automatic switching, that is to say when the two cars approaching one another are equipped with this automatic device, there are a number of difficulties because one car always has brighter lights than the other and this slight difference is sufficient to dip the headlight of the second car. And then the first car, you see, not receiving very much light from the oncoming second car, just carries on without the headlights being dipped automatically.

Have you had these problems in the United States?

MR. DiLORENZO (U.S.): Yes, we have, and our lighting research people have commented to us about it.

I think the answer to your comment is very similar to the one that Mr. Slechter gave a minute ago. The intent of that statement in the specification was only to encourage the contractors to look at the multiple beam systems and such things as automatic switching.

In other words, we have now a two-beam system. We want to look at the possibility of three beams and so on. It is just to encourage their innovation.

MR. MATTHES (GERMANY): I understood the answer in the following fashion. The use of such automatic devices isn't an absolute requirement. It is an aim of the studies but it isn't absolute requirement. Is this correct, sir?

MR. DiLORENZO (U.S.): That is true.

MR. CLAVEL (FRANCE): Citroen. Might I ask the American delegation why it has limited the lighting to 150,000 candle power.

MR. DiLORENZO (U.S.): Our present production vehicles have approximately 75,000 candlepower and the direction in which our rule-making is going will be to raise that. But they have found that something around 200,000 candlepower is perhaps too great for the headlights. I believe they base some of their conclusions, at least, on some of the problems you people in Europe have uncovered.

So we in the ESV program chose a value of candlepower something below this which we thought would be a significant increment over our present production.

MR. BELKE (GERMANY): Mr. Chairman, gentlemen: where the remarks of the American delegation are concerned I would entirely agree with them. The front light power must be limited for reasons of safety. We consider that 150,000 candlepower is quite sufficient. We entirely agree with the Americans.

MR. OSSELET (FRANCE): Mr. Chairman, Osselet of France. I don't think that this is either the time

or the place to enter into a debate as to the optimum value of candlepower. The only thing that we have noted during tests which we carried out in France is that, contrary to what we have believed and this concerns physical laws, the distance at which people require headlights to be dipped has little relationship to intensity. There isn't a linear function at all between the intensity and the distance. Therefore we don't think that the intensity is all that important.

Admittedly studies are still being carried out and we might be able to prove that we could increase the intensity and exceed 150,000 candlepower, but admittedly we have got to supply you with more information on this score.

Thank you very much, Mr. Chairman.

UNIDENTIFIED: We have been speaking a lot about the intensity of headlights, but what we should do is to obtain more efficient dipped headlights than those that exist today rather than studying headlights themselves.

We think that the systems that exist throughout the world for dipped headlights offer limited possibilities despite the improvements that we can still add to these dipped headlights. Therefore we consider it necessary to carry out more detailed research on polarized lights. This is the only way that we will be able to improve the night lighting facilities of a car.

MR. SLECHTER (U.S.): The United States certainly would like to see much more research in polarized headlighting. I think we all recognize the problem of implementation. One day we may have polarized headlighting throughout the world. We are certainly very interested in the subject of polarized headlighting. We have even written a statement in this contract that it be investigated. We recognize the problem is much too great, though, for this kind of program. That is, within the scope of our 18-month program, our contractors cannot go into much detail in polarized lighting. But we agree.

MR. MATTHES (GERMANY): Mr. Chairman, it struck me that in the section about rear lighting that an important apparatus is not mentioned in this specification. The back light, the reflex reflector. Is this an omission? Is it a mistake or have you done this on purpose?

In Europe we consider this to be extremely important. It is important to recognize cars, for example, when one of the tail lights has failed.

MR. SLECHTER (U.S.): If you would like we could call it an omission to some degree. But we are looking for guidance. We would like to have information from you, and we do have the reflector requirement, as has just been pointed out to me; there is coverage on this particular subject in the

motor vehicle safety standards themselves which, of course, the contract requires.

UNIDENTIFIED (JAPAN): I have one thing to be clarified here in the ESV specifications. That is the rear lighting and signaling system. The design shall provide for separation of functions for the brake, signaling and running lights. I want to know the definition of running light. It is a new word here, isn't it?

MR. DiLORENZO (U.S.): Running lights are the lights on the four corners of the car that remain on all the time the headlights are on.

UNIDENTIFIED (JAPAN): We have more time so I would like to ask another minor question. The U.S. specification requires that stop lamps are to remain on. Stop lamps must remain on for a stopped signal. What I would like to have clarified is the condition of remaining on, how long the stop lamps should be lighted.

MR. DiLORENZO (U.S.): The attempt there is to provide a vehicle, let's say that stops for a traffic signal, with some visible indication that it is there and lower the possibilities of its being run into. To do this we would like to have the lights go on when the ignition key is on.

UNIDENTIFIED (JAPAN): Is there any specification on the illumination or color of this stop lamp?

MR. DiLORENZO (U.S.): No, we haven't specified the colors of the rear lighting at all. We, again, leave this to the innovation of the contractor. The intensity of the bulb would be the same as the brake light.

UNIDENTIFIED (JAPAN): Well, I think what he meant was the intensity and color at time of stopping.

MR. DiLORENZO (U.S.): This light should be the same intensity as the brake light, about 85 candlepower. The color, I say again, we have left up to the contractor in these specifications. It has been generally interpreted by our contractors that the same bulb, that is the stoplight, the normal stoplight, would be used to perform this function. Only you would somehow provide a mechanism that would allow that bulb to remain on without the foot on the brake pedal, for those traffic conditions where you are at a standstill but you do not have your foot on the brake pedal.

MR. YAMADA (CHAIRMAN): Thank you. In that case, if I may comment, is there any confusion to the following driver when he sees a stationary vehicle or a moving vehicle with the driver stepping on the brake pedal?

The reason I ask is that in Japan we now have a regulation that a small parking lamp must be on when you park a car for a certain period of time on

the road. Either one light on or both lights on or something like that. It is just parking lights. Very dim lights. But we have to do that. It is not so bright, but still you can distinguish them from distance.

MR. SLECHTER (U.S.): It was not our intention to serve that particular function with this specification. It was only our intention to better illuminate and signal to oncoming drivers that, indeed, a vehicle is in either a deceleration condition or stopped condition.

In the United States we have many situations where on slight inclines at traffic lights, that is just one example, the car is stopped but the driver does not have his foot on the brake.

MR. MATTHES (GERMANY): Mr. Chairman, in the section defrost and defogging, in the American specifications they ask that the vehicle have an electrically-heated back window. Why must it be heated electrically? Would it also be possible to use other means of heating the rear window?

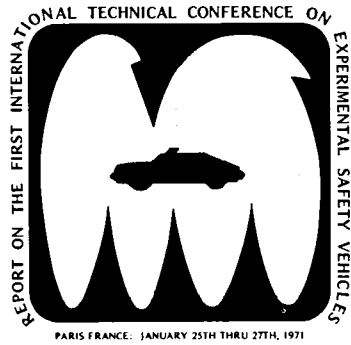
MR. DiLORENZO (U.S.): We have two interpretations which we hope are valid for that statement in the specification. We have required an electrically-heated back window. The obvious one would be, of course, to place the filaments in the glass itself and then heat that way. The other would be to use a fan while electrically heating the air as it enters the fan and then blowing the warm air over the window.

MR. MATTHES (GERMANY): I will repeat my question in English. What I wanted to ask was, why is it specified that the back light must be heated electrically? This is not a performance but a design requirement. In our opinion it is sufficient to specify certain requirements for defrosting and defogging the rear window. How you do this as a designer or contractor, is left to you.

Thank you.

MR. DiLORENZO (U.S.): You might have a very valid point there. Perhaps we have infringed in the area of design. We talked to our people in this area and apparently they felt that the electrical methods would be the most efficient and the fastest. Perhaps they were trying to solve the problem before there was one.

MR. YAMADA (CHAIRMAN): Gentlemen, this concludes the third Specification Discussion Session on Other Accident Avoidance Factors. Thank you all for your excellent participation. This session is adjourned.



SECTION 4

CONCLUDING REMARKS

Dr. Robert Brenner
Chief Scientist
U.S. Department of Transportation
National Highway Traffic
Safety Administration

Monsieur Dreyfus
Directeur des Routes
Ministere de L'Equipement
France

section 4 part 1

Concluding Remarks

ROBERT BRENNER, *Chief Scientist*
U. S. Department of Transportation
National Highway Traffic Safety Administration

Monsieur Fryburg, Mr. Edwards, distinguished delegates, ladies and gentlemen:

I hardly can add much to what has been an outstanding meeting. Much has contributed to its success, starting with the cooperation and superb support of the French Government and the French automobile industry.

Our thanks also go to our gracious host, President d'Ornhjelm of the Chabres Syndicale and to his very able and dedicated assistant, Monsieur Aubin, who has carried the heavy burden of seeing that all of these arrangements have been in order.

I wish to echo my colleague Mr. Edwards in expressing appreciation to the various delegations for the very fine presentations and stimulating discussions. Many good questions have been raised. Why ESV's? Why this or that aspect of our approach? What do we really have in mind?

All of these questions remind me of the story of two psychiatrists who meet each other on their way to work in the morning. One says to the other "Good morning," the other repeats the greeting and they walk on. The second psychiatrist, as he passes, thinks for a minute, and says "Gosh, I wonder what he meant by that."

Gentlemen, there are no mysterious motives back of our ESV program, nor those of the Federal Republic of Germany and the Government of Japan, nor those which hopefully other countries will start presently. Our purpose is to promote the transfer of technology and achieve a quantum jump in vehicle safety. We want to do things that we cannot do within our present processes of rule-making. We also want

to improve our rulemaking processes, particularly in bringing the systems approach to bear.

It would, of course, be presumptuous on our part to suggest that our safety standards should be applied to all the vehicles of the world. But we should at least air our respective views, to let all know what we are doing and to learn what others are doing. We share the common purpose of replacing subjective with objective judgments, of developing quantitative methods for describing such properties as vehicle stability and handling in something more precise than words to the effect that one vehicle has "bad oversteering" while another demonstrates "bad understeering".

Having been here for several days now brings to mind another medical story. It is the end of the day. Coming down the elevator together in a medical building are two doctors — one is a psychiatrist and the other is a general practitioner. The general practitioner is tired, with a somewhat bedraggled appearance, while the psychiatrist is chipper, looking quite fresh, and ready to go out for an evening on the town. The practitioner says to the psychiatrist "How can you sit there hour after hour after hour and listen to patients' difficult problems, and still look so good at the end of the day?" In response, the psychiatrist says, "Who listens?"

Today, at the end of this exciting meeting, all of the delegates and our staff look very chipper, and I am sure this relates to the fine help that we have had. But I can assure you that, not like the psychiatrist, and notwithstanding our fine appearance, we have been listening; and we will continue to listen, to express our viewpoints while we learn those of others. And we will try to get the substance of these deliberations into a publication and get them distributed as rapidly as possible.

And now, in conclusion, I would like to offer this quotation.

"We should not expect ever to employ in practice all the motive power of the combustibles used. The efforts which one would make to attain this result would be even more harmful than useful if they led to the neglect of other important considerations. The economy of fuel is only one of the conditions which should be fulfilled by steam engines; in many cases it is only a secondary consideration. It must often yield the precedence to safety to the solidity and durability of the engine, to the space it must occupy to the cost of its construction, etc."

These words are not those of President Nixon. Neither are they from Secretary Volpe. Nor from Mr.

Toms or myself. No, they don't even come from Ralph Nader.

Instead, they come from the last paragraph of the monumental treatise on the second law of thermodynamics expressed by one of the greatest engineers of all time, the Frenchman Jacques Carnot, who is the father not only of French engineers but also of European, Japanese, American engineers, of all engineers throughout the world. Permit me to finish Carnot's test.

"To be able to appreciate justly in each case the considerations of convenience and economy which present themselves, to be able to recognize the most important from those which are only subordinate, to adjust them all suitably. and finally to reach the best results by the easiest method—such should be the power of the man who is called on to direct and coordinate the labors of his fellow men, and to make them concur in attaining a useful purpose."

I cannot think of a more fitting conclusion for this meeting taking place here in Paris on the ESV than these immortal words of Carnot.

We, the pupils of Carnot, let us work together and place into practice the ideas that he has given to posterity on the social responsibilities of technology.

section 4 part 2

Concluding Remarks

MONSIEUR FRYBOURG

I will not try to sum up the technical information arising from this wide confrontation between eight motor manufacturing countries.

I only intend, by reference to the introductory remarks, to point out how three days of outstanding presentations and comments have led to confirm or modulate the ideas expressed at the beginning of our session.

Doctor Brenner, strict and logical as we know him reminded us at the start that

—optimality is not additive, when one proceeds from sub-systems to a complete system,

—global cost may be smaller than the sum of elementary costs,

—a regulation defining the aims would be simpler and more efficient than a regulation prescribing the means such as the one we have known so far.

We must not forget, anyhow, that if a monolithic solution allows an all-embracing approach, such approach is bound to be very rigid and whenever a technological evolution occurs — quite a probable assumption — the instability of an optimal solution may lead to results much less satisfactory than those one could have attained by means of a progressive approach, as contemplated in Europe.

May I mention one example: the very expensive A.A.S.H.O. tests, designed for a certain type of roadway, lost part of their value when this type of roadway was later given up.

Thanks to their excellent training in mathematics, engineers of the motor industry have been able to master the last conquests of the set theory; however

their theoretical knowledge is greatly enlarged by the permanent training fostered by their contact with reality and the sanction of facts.

The US program deserves praise, amongst other things, for calling attention on the part played by experimentation. As far as collisions are concerned, our theoretical knowledge is still in the infancy stage; experimentation is the only means of achieving an elaborate study likely to meet our ambitions.

The theory of the systems is connected with Descartes.

Experimentation is connected with Claude Bernard.

Would not the matching of systems and experimentation be the best guarantee of a fruitful approach? For what do we care, whether the solution be heuristic or optimum, provided it is good and sanctioned by facts?

Mr. Herla said yesterday that at the present phase of studies, the necessity for fitting one vehicle with the whole of the most advanced safety equipments we can think of to-day did not seem obvious to us.

There is no longer any technical or psychological contradiction between E.S.V. and E.S.S.S. (Experimental Safety Sub-Systems).

Each method has its drawbacks but also its advantages. For the sake of safety it will be advisable to study these problems along different lines.

Indeed our research work will be all the more profitable as its results will be advertised in as many countries as possible.

Far from considering "demonstration" as a show, the commercial aspect of which would conceal a lack of accuracy in the assessment of the solutions advocated, we regard it as a means of supplementing competition for progress with a joint effort of advanced research coming prior to competition.

And so, without disregarding the advantages of support from the general public, we stress the precedence of the test report over the press release.

This ambition is in proportion to the challenge which faces modern societies as a result of industrial development.

It is up to us to meet this requirement properly and to avoid wasting the time of our engineers over financial and ill-founded regulations.

We must take advantage of the expertise of those responsible for the international regulations who have been working for a long time in Geneva.

They gathered a large amount of valuable know-

ledge on many points. In particular, they learned to know what should not be done and the problems arising from border-line cases, which cannot be tackled at the outset. It is most desirable to direct all the efforts displayed in national and international meetings to a single target.

Moreover the dynamism of market economy should not be broken by imposing an undue financial effort on companies. Only the bigger ones could face it, and they are not always the most dynamic.

Low-income consumers should not be required to make the comparatively greatest efforts. That would indeed deprive them of the benefits of mobility provided by cars.

Specifications that would only amount to forbidding small cars would result, in some countries, in a feeling of frustration unbearable by some parts of the population.

Smaller European cars do exist; they are a social necessity which any future regulation must take into account.

They do not necessarily require particular specifications on every point. As part of safety programs, the government will have to specify the few points for which certain requirements will have to depend on bulk and size.

M. Dreyfus said on Monday:

"Research efficiency, mutual information, concerted and adapted regulations, such are the guide-lines I think we might follow. I would be thankful if the eight delegations expressed their feelings on these subjects".

The feelings which have been voiced come up to his expectations.

This three-day session will undoubtedly lead to an increased effort in joint advanced research.

The eight delegations are like so many sub-systems that will build up a new community of the automobile world. Their joint work will result in a new range of safer vehicles.

Let all those who contributed to it be here thanked.

I will close this three-day meeting by extending my thanks to the N.H.T.S.A. members who organized this session.

I would like to mention Dr. Brenner and Mr. Edwards, who has been the competent acting Chairman of this meeting.

To Mr. Toms who leads N.H.T.S.A. and was prevented from joining us, I address a friendly thought.