WHY AND HOW IRCOBI CAME INTO EXISTENCE

Bertil Aldman
Department of Injury Prevention, Chalmers University of Technology, Sweden

ABSTRACT

This paper shortly reviews the development of restraint systems and the events which brought about the formation of IRCOBI.

THE EARLY DEVELOPMENT OF RESTRAINTS for light aircraft and for road vehicles had much in common. In both cases it is possible to distinguish certain stages at which emphasis was given to protection against similar perils in case of an accident for the occupants of both types of vehicles.

Already at the turn of the century single straps around the lap were used to protect occupants from falling out of their vehicles in both means of transportation. Since that time this has remained one of the basic requirements in later developments of more sophisticated restraint systems.

Once this first requirement was met and it had become possible to prevent total ejection of occupants, the next task was to protect them from violent impacts against interior structures of their own vehicles. The addition of shoulder straps, sometimes called shoulder harness, to the original simple lap strap could constitute proper means to achieve this goal. Under certain conditions such straps could reduce the forward movement of the upper body and thereby modify the occupant kinematics in a desirable way. During this stage of development it became evident that proper location of anchorage points was important for the geometry and thus for the function of the entire restraint.

The third stage in the history of restraint systems development is characterized by emphasis on additional features such as inertia reels, force limiters and pretensioners to enhance the function of the systems. This also includes combining the use of seat belts with structural changes of the vehicle body and its interior such as deformable instrument panels. All this aimed at reaching higher levels of protection for the occupants. This effort was even more pronounced at the introduction of the Federal Motor Vehicle Safety Standard (FMVSS) and of the international program for Experimental Safety Vehicles (ESV). From that time on the seatbelt no longer was the single safety device in road vehicles, but was a component of a safety system which embraced the entire vehicle, its body as well as its interior parts.

THE FORERUNNERS

The outstanding pioneer during the early development stages of safety belts was Hugh De Haven. In the first World War he served as a young cadet with the

Canadian Flying Corps. In combat practice he collided with another plane and both crashed. De Haven had leg fractures and internal abdominal injuries.

During his recovery period he had plenty of time to think about what had happened in the crash. The leg fractures were obviously the result of the structural collapse of his plane at ground impact but what about his internal injuries? He concluded that these were caused by the stiff buckle of his lap belt. This restraint, which had prevented him from being ejected but also had contributed to his injuries, represented the very first stage of seat belt development for military aircraft.

It was not until 18 years later that he recalled his earlier thoughts about vehicle structures and their significance for accidental injury. He felt that nothing had been made in the field of injury prevention. A minor automobile accident, in which he had been involved, triggered him to present his ideas to a special committee for Aviation Medicine and to other groups. There was still little or no interest in injury prevention and the argument was that money would be better used if spent on accident prevention.

From 1938 to 1941 De Haven personally investigated aircraft crashes and falls from 15-50 m and in 1942 he was appointed director of a project called Crash Injury Research (CIR) at Cornell University Medical College and from 1953 the Automobile Crash Injury Research (ACIR). De Haven served as director of ACIR until his retirement in 1954. During these years he published several reports of accident investigations. He also designed and tested restraints with shoulder straps. These were aimed at preventing a secondary impact between the occupant and the interior vehicle structures and represent the second stage of restraint development for airplanes.

In 1949 De Haven and Hasbrook included in their recommendations for a crashworthy airplane that the instrument panel should have an energy absorbing shield on the panel face. This means that they were gradually moving into the third development stage of safety systems, where restraints and vehicle structures function together for the protection of the occupants.

In 1950 De Haven and Griswold developed what they called the CIR-Griswold restraint, which consisted of a combined diagonal and lap strap anchored to the vehicle structures above one shoulder and on both sides of the seat. This continuous strap could slide through a buckle, which locked onto a short strap to adjust the restraint.

This first three point belt could also use an aircraft type, floor mounted inertia reel,. The use of this reel required a pulley or a D-ring at shoulder height to change the direction of the diagonal strap. This CIR-Griswold restraint is reported to have been used in two production airplanes in 1953.

In the early 1950s De Haven and his associates had conceived, designed, and tested almost all of the features which would later be incorporated into automobile safety belts.

THE DEVELOPMENT OF SAFETY BELTS FOR CAR OCCUPANTS

Already at the turn of the century car racing became popular and the drivers soon found the advantage of being strapped into their cars. One of the first single lap belts

was probably used in 1907 by Thomas Flyer in the round the world race from New York to Paris. It was installed to keep his mechanic from falling out of the car. Later on belts with shoulder harness were used for even better protection. After the second World War different types of belts were also sold for use in private cars, some of these seat belts also had upper torso restraints.

Tests of aircraft restraints using volunteers had been carried out in the United States simulating a diversity of conditions by John P. Stapp, a U.S. Air Force physician, and his associates. Being his own test object Stapp had shown that the human tolerance to decelerative forces was much higher than previously expected.

However, little was known about accident kinematics and the magnitude of the loads in automobile accidents. De Haven had begun to use some simple substitutes for the human body, while Severy and others carried out a comprehensive test program of car-to-car impacts in California using somewhat more human-like dummies.

THE DEVELOPMENT IN EUROPE

In the early 1950s a great number of seat belts of various designs were offered for sale on the market in Sweden as well as in other European countries. Some of the belts were of questionable quality. According to a notice in the Swedish magazine "Motor" in 1956 the SAAB car division had 100 cars equipped with a combined lap and shoulder belt for test purposes. This combination, with the shoulder strap anchored to the top of the B-post and the lap straps to the floor, was never further developed for practical use by the motoring public.

After some preliminary simple simulations of accidents carried out in Sweden by dropping full scale cars form a crane, a governmental research grant was given in 1957 for a more scientific approach to the restraint problem in European type cars. When this research started little or no similar work was carried out in other European countries.

It soon became evident that some kind of standard for testing and assessment of seat belts would be necessary in order to improve the quality of restraints available to the general public. The national road authority in Sweden was charged with the responsibility and published a provisional standard regulation in 1958. This was probably the first standard in the world to require a dynamic test of automobile seat belts.

A group of people was then set up to monitor the results from the ongoing research and the experience from the dynamic testing of seat belts and also to advice the authority about the requirements needed in a new standard to be issued later. Drafting of this new standard began in 1961.

The first results of the Swedish scientific program were published in a doctoral thesis in the spring of 1962 and a new seat belt standard was issued for reviewing and comments by interested parties in the same year. However, some of the early proposals in this document e.g. for tests with a realistic stopping distance as well as tests at different velocities and measurements of forces and elongations in different parts of the belts had to be postponed. The reason for this was mainly lack of test devices and instrumentation at the national testinghouse.

A comprehensive draft of the standard was requested by, and sent to, the Inland Transport Committee of the UN Economic Commission for Europe (ECE) in Geneva. This led to the formation by the Committee of a "Group of Rapporteures" chaired by Sweden and with representatives from the United Kingdom, West-Germany and France. The document proposed prototype testing for approval and routine testing for quality control of production and included among other requirements a test for brittle rupture of metal parts. The proposals led to lengthy discussions on the feasibility of the different requirements.

In 1962 the Council of Ministers of the European Conference of Ministers of Transport (ECMT) adopted a resolution noting: - that practical experience has confirmed the results of scientific studies: namely that safety belts are a vital factor in the prevention of injury; - that the effectiveness of safety belts depends on their design, construction and anchorage; - that safety belts are already in production in most ECMT countries; etc

In an attempt to set uniform standards the Council recommended to member countries that, without making safety belts obligatory, they introduce government-approved standards for the design, construction and anchorage of motor vehicle safety belts and that the standard being prepared by the Inland Transport Committee of ECE could be used for this purpose.

In 1962 American automobile manufacturers provided anchorage points for two front seat belts. In the same year a Working Group of a Technical Committee of the International Standards Organization (ISO) issued a document with a proposal on anchorage points for safety belts. This proposal was then discussed over some years.

In 1963 some types of inertia-reels were tested in Europe and a Subcommittee of another Technical Committee within the ISO discussed proposals for approval of such devices, but the prototypes presented at that time were not considered to be suitable for use in car seat belts. It was not until the later years of the 1960s that approved retractor belts could gradually be introduced in new car models. This period also saw the introduction of pretensioners to reduce slack in the belts and force limiters to keep the maximum load within tolerable limits.

In the late 1950s the two Swedish car manufacturers, Volvo and SAAB, had provided single diagonal belts for the front seats. In the early 1960s three-point belts were gradually introduced as standard equipment for front seats on all models in Sweden. In 1963 Volvo introduced three-point front seat belts as standard also in the U.S. market. Until that time it had not been possible to have three-point belts tested for approval in some states of the U.S.A. In these states the local standards could only accept lap belts and equipment for testing of lap and shoulder belts was therefore not available

A GLOBAL VIEW ON OCCUPANT SAFETY

Already in 1953 Mercedes 180 was designed with features which later led to improved vehicle crashworthiness, a word coined in Australia by John Lane for airplanes in analogy with the term airworthiness. Bela Barenyi of Daimler-Benz realized the need for energy absorption, a principle which was taken a step further into the vehicle`s interior. The use of energy absorbing material on contact surfaces to reduce

the effect of the second impact had been advocated by De Haven for small aircraft in 1949. This represents the beginning of the third development stage in automobile restraint technology.

At the middle of the 1950s the American physician William Haddon, Jr. had begun a long series of studies of road traffic accidents and in 1966 he was appointed the first head of the National Highway Safety Bureau, later known as the National Highway Traffic Safety Administration (NHTSA). The accumulation of experience from field studies and experimental work in both North America and Europe indicated that the benefits of being restrained in an accident could be enhanced by further development of the crashworthiness of vehicles.

In 1968 this led to the publication of the first Federal Motor Vehicle Safety Standards (FMVSS) which established a minimum safety code which all vehicles sold in the U.S. must meet. This influenced car manufacturers all over the world to act along these lines.

In 1969 the U.S. Government initiated the Experimental Safety Vehicles Program and in 1971 sponsored the first ESV Conference. These conferences, in which over the years all automobile producing countries have participated, have contributed to the development of seat belts as a component in a safety system which embraces the entire vehicle.

From this time onward the restraint systems have become more complex as they have to function together with almost all the structures of the car. More information has also been gained on the function and response of the human body at impacts. To enable the inclusion of all this information into the development process of new restraints, more sophisticated tools have become necessary. The progress of mechanical and mathematical models of the human body with more humanlike responses to impact conditions will continue for many years to come. The reason for this is that the evolution of occupant restraints will have to go on and provide even better safety for the great variety of car occupants in all types of accidents.

Also in 1968, the Organization for Economic Cooperation and Development (OECD) decided to set up a research group on Road Safety within the framework of its Road Research Program. Researchers from the following member countries were nominated for this group: Belgium, Canada, France, Italy, The Netherlands, Sweden, Switzerland, United Kingdom and United States. The name of this group and the title of its report was: "Biomechanics of Automobile Accidents". The work was completed in 1969 and five projects of cooperative programs were suggested.

As a first step in the implementation of the program "Human tolerance to Dynamic Impacts", an international survey was made of active research projects in this field. This survey showed that much work was carried out in the United States, but also that an almost equal number of projects were under way elsewhere with Europe in a leading position. To a certain extent, this perhaps explains the prompt response at an inter-governmental level in Europe, to the Federal Motor Vehicle Safety Standards in the United States.

AN INTERNATIONAL RESEARCH COMMITTEE IS ORGANIZED

During the international survey, it became evident that two of the five programs proposed by the OECD research group, one on "Accident Kinematics" and one on "Human Tolerance to Dynamic Impacts", were to a great extent complementary and partly overlapping. Following some preliminary discussions i Stockholm, a small group of active researchers met in Lyon, France, in September 1971 to discuss the feasibility of combining the two programs into one dealing with the entire field of "Impact Biomechanics". The group was concerned with the lack of knowledge in this field and realized that the problem of transport safety is an international one.

The combination of the two original research programs, for which France and Sweden had accepted responsibility, into one much broader joint program made it seem quite logical to the representatives of these two countries to create an international research committee for the implementation of this new endeavor. It also seemed obvious that the members of this committee should be chosen according to personal merits rather than as representatives of certain nations.

As the group would have to meet at regular intervals and probably quite frequently, it was decided to try and find most of the members in Europe. Members from America and Australia would also be called to the meetings but would mainly be expected to keep contact by mail. The change of the original program as reported in the "Biomechanics of Automobile Accidents" was made in close contact with the OECD Road Research Secretariat, which was very instrumental in organizing in 1971 this new committee known as IRCOBI.

One of the main aims of IRCOBI would be to improve the dissemination of information in a very specific field, it was decided that this should be done by efforts to stimulate the participation of young researchers in meetings. One great obstacle seemed to be the fact that the main event in this field, the annual Stapp Car Crash Conference, was for economic reasons out of reach for many young European researchers. A reduplication of the Stapp Conference in Europe did not seem to be a good idea. The question then arose if the problems facing researchers in America and Europe were identical. In one or two respects there were obvious differences.The proportion of unprotected road users was greater outside the United States and the size of automobiles differed so much that the American ESV program had two projects, one for American size cars and one for smaller ones.

In discussions along these lines, the IRCOBI Steering Committee came to the conclusion that it would be desirable to arrange an international conference in Europe to review knowledge on human tolerances to impact conditions, as revealed by accident investigations, experimental work and experience from current protective devices.

The first of what should later become annual conferences with these aims was held in Amsterdam in 1973. It proved to be an appropriate frame for exchange of information in this field. Researchers from Europe and other continents have taken an interest in participating in these meetings regularly. They have contributed in making these annual IRCOBI Conferences to an important forum for the dissemination of information in the field of the Biomechanics of Impact.