The FIA Institute improves the safety of motor sport through analysis, research, testing and development.
Welcome
Professor Sid Watkins, FIA Institute President

I have spent most of my life working to improve motor sport safety and I can think of no greater honour than being elected as the first President of the FIA Institute.

Our aims at the FIA Institute are very clear, to encourage the rapid development of new and improved safety technologies, to facilitate ever higher standards of education and training and to campaign to raise awareness of safety issues amongst all of those involved in our sport.

It is the FIA Institute’s commitment to rapid progress which is perhaps the most satisfying. In our first two years we have already commissioned more than 50 projects, the vast majority of which will have a very significant bearing on the way we go racing and rallying.

A project such as developing a new crash helmet specifically engineered for young drivers up to 16 years old has broken new ground and has done so in record time. After only 18 months, laboratory testing is already underway on a prototype and production on the final version is set to begin by the end of 2007.

Recognising and rewarding excellence in motor sport achievement is also fundamental to our approach.

Our Centre of Excellence programme is set to roll out across established and emerging motor sport markets worldwide and our close liaison with national sporting authorities as well as the key industry players will encourage new safety partnerships to flourish.

Our work has only just started but we could not have made a better beginning. With the help and support of all of those working and competing in international motor sport the FIA Institute will always strive to ensure that safety comes first.

Professor Sid Watkins, FIA Institute President
Introduction
Professor Gérard Saillant, FIA Institute Deputy President

It is perhaps appropriate that the FIA Institute was inaugurated in Paris during the FIA’s centenary celebrations. It demonstrated that whilst recognising motor sport’s history and heritage the FIA was not only thinking of the past but also the future.

Ever since I was invited to become involved in its work, first as a Fellow and now as Deputy President, the FIA Institute has consistently echoed this forward thinking and dynamic vision.

Motor sport will always be a sport with an element of risk. Preventing accidents is not always possible but striving to minimise the consequences of an accident is fundamental to the FIA Institute’s approach. Whether in terms of driver equipment, crash test standards, circuit infrastructure design or the training of officials, the FIA Institute is working to improve all of the elements which together create the system of safety in motor sport.

Medicine and sport have been the twin vocational passions which have defined my professional life. The opportunity to bring these two passions together in the important work of the FIA Institute is one that I greatly value.

Professor Gérard Saillant, FIA Institute Deputy President
What the Drivers Say About the FIA Institute

Michael Schumacher  
Formula One  
“Safety in motor sport has improved hugely since my Formula One debut in 1991. But that does not mean we should stop aiming to raise the standard. There is always room for improvement and the FIA Institute’s work is vital for the continual safety of all drivers.”

Sebastien Loeb  
World Rally  
“The research projects undertaken by the manufacturers in conjunction with the FIA Institute give me a huge amount of confidence in the future safety of rallying. We all know that our sport isn’t without danger but I really think that a lot of work has been done on the cars and on safety in general. Our cars are much stronger, we’re now wearing the HANS device and the security in the stages is better. It is great to know that the FIA Institute is working hard to develop safety in these areas on our behalf.”

Jarno Trulli  
Formula One  
“Safety is such an important aspect in motor sport. Without an organisation like the FIA Institute constantly pushing to develop safety we could not as drivers push as hard as we do on the track. Long may the FIA Institute continue to work for the safety of all of us.”

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Marcus Gronholm  
World Rally  
“Rallying is a special sport which demands a unique set of safety requirements. It is not just about the drivers either. Protecting the public is obviously of paramount importance to the sport’s future while allowing them to enjoy the spectacle. So it is essential that the FIA Institute continues to work behind the scenes to make rallying as safe as possible for all of us.”

Alex Wurz  
Formula One  
“It is good to know that there is an organisation out there devoted solely to improving motor sport safety. As a driver it is especially important that work continues in this area to keep us free from injury and maintain the high standards of this great sport.”

Andy Priaulx  
World Touring Car  
The FIA Institute’s commitment to safety research is the evidence that the FIA is pro-active rather than reactive. It is not waiting to take measures after an accident; on the contrary it tries to foresee the problems and solve them before they happen.”
About the FIA Institute and its Objectives

History

The FIA Institute was established in October 2004 by the FIA and the FIA Foundation. It receives an annual grant from the FIA Foundation to fund research projects and other safety-led activities.

The FIA Foundation itself was formed with monies from the FIA, following the sale of the 100-year commercial rights to the FIA Formula One World Championship. As such, the income from Formula One has not only improved safety in motor sport but also has been used to help raise the standard of public road safety.

Objectives

The objective of the FIA Institute is to promote improvements in the safety of motor sport across all disciplines from junior championships to the top level race series and from closed car to open wheel racing. It does this in a number of ways:

• Promotes research, disseminates the results of research and provides information on the best safety procedures, practices and technologies that can be applied to motor sport safety. This research covers all aspects of motor sport safety including driver equipment, vehicle design, circuit design, spectator protection, rescue facilities, medical facilities and race control.

• Supports the training of officials, circuit and race personnel in safety procedures, practices and the use of equipment.

• Supports the protection of participants, officials and members of the public at international motor sport events.

• Monitors motor sport safety trends in order to identify research and regulation priorities.

• Manages non-regulatory safety activities such as research, training and medical control.

“The Institute is working to improve all of the elements which together create the system of safety in motor sport.”

Professor Gérard Saillant, FIA Institute Deputy President
Structure of the FIA Institute

- General Assembly
- President
- Executive Committee
- Secretariat
- Karting Research Group
- Medical Training Working Group
- Fellows
- Closed Car Research Group
- Open Cockpit Research Group
- Industry Liaison Group
- Centre of Excellence Network

Fire marshal at the 2004 Monaco Grand Prix.
The Research and Working Groups cover every aspect of motor sport safety.
The progress in open wheel racing has been dramatic. Spectators often stare in amazement when a driver walks away from a heavy crash in an open cockpit race car. This is no miracle but rather the embodiment of years of motor sport safety research and development carried out by the OCRG and its partners and its predecessors.

The OCRG recognises that no matter how much the injury statistics may improve, there is always room for progress. Much of its work is data driven, using the information taken from numerous similar racing incidents, both with and without injury, to define safety objectives and strategies. The modern era of safety was spawned in 1994, following the tragic deaths of F1 drivers Roland Ratzenberger and Ayrton Senna.

It was then that FIA president Max Mosley, already a major activist for safety, intensified his campaign to improve safety standards across all levels of motor sport.

At the time, Mosley called upon the help of Professor Sid Watkins MD, one of the world’s top neurosurgeons, who had been working in Formula One since 1978, when Bernie Ecclestone, then boss of the Formula One Constructors Association, offered him the job to be the championship’s doctor.

Mosley asked Watkins to become chairman of the newly formed Expert Advisory Safety Committee, which initially focused on Formula One safety research and development but later extended its remit to include closed car racing and, more recently, karting. The committee looked at ways to improve safety of the car, the circuit and the drivers’ protective equipment.

So many changes to the circuits, such as larger run-off areas in high-speed corners and reduced g-force corners, have been made that a large number of drivers have been able to walk away from heavy crashes. There are two types of debris fence, circuit fences and temporary fences. The circuit fences are already used extensively, while those used at temporary circuits such as Silverstone and those used at temporary circuits such as Melbourne. This project has led to the creation of a computer modelling system which will be used to develop the ideal debris fence to protect spectators.

High Speed Barriers

Work continues to develop efficient, high energy dissipating barriers. These types of barriers are often constructed using „low cost” second hand or reject types, but to very controlled specifications and are already used extensively in motor racing.

Advanced barriers are being developed which will dissipate more energy in a relative short space, thus ensuring the car and driver survive. Fia regulatory bodies. The effects of these and other new measures on the safety of race events are continually monitored by the Group.

Debris Fence

A project to improve the safety of debris fencing, circuit fences used to prevent debris from hitting spectators at the track. There are two types of debris fences, those used at permanent circuits such as Silverstone and those used at temporary circuits such as Melbourne. These types of barriers are often constructed using “low cost” second hand or reject types, but to very controlled specifications and are already used extensively in motor racing. These types of barriers are often constructed using “low cost” second hand or reject types, but to very controlled specifications and are already used extensively in motor racing.
Development of the Circuit Safety Analysis System (CSAS)

The CSAS is a computer tool which integrates detailed electronic image maps for the circuits with lap profile data from sensors fitted to the cars. Further information, regarding the performance of run-off areas has been collected from real accidents when cars ran off the track. The CSAS tool is used to evaluate and specify the run-off areas. Further information, including data from accidents in Indy and Formula One, often launch in wheel cars, especially those used on Grand Prix circuits.

Car Launching Mechanisms (“Flycars”)

This project aims to fully understand the mechanisms whereby open-wheel cars, especially those used on Grand Prix circuits. The results will look to optimise spinal stability and protection for the driver in rear impact accidents. The CSAS is a computer tool which integrates detailed electronic image maps for the circuits with lap profile data from sensors fitted to the cars. Further information, regarding the performance of run-off areas has been collected from real accidents when cars ran off the track. The CSAS tool is used to evaluate and specify the run-off areas.

F1 Race Control Flag System

This project is examining the development of a system which will replace coloured warning flags during races. Instead, coloured lights will appear on the road side and in the driver cockpit to show the status of the sector he is coming up to.

F1 Wheel Tether Testing

Wheel tethers are used to prevent wheels from flying off the cars but they also have to have enough elasticity to stop the car taking off with the wheel. Through rig testing, tethers have been developed which are able to absorb approximately eight times the energy of 2004 tethers. Testing continues with help from F1 teams, including McLaren and Honda.

Rear Impacts Seat

Prototype seats are to be developed using data from accidents in Indy Racing League cars in conjunction with Lumbar Spine modelling work carried out by Wayne State University. The results will look to optimise spinal stability and protection for the driver in rear impact accidents.

The Safety Training Working Group (STWG) was created to work with the network of national sporting authorities to help raise the quality of training, particularly in emerging motor sport markets.

The Group has started to do this by developing the Global Best Practice Project, a strategy to create best practice in safety training around the world. The programme has been developed in conjunction with the Confederation of Australian Motor Sport and the UK’s Motor Sport Association. An initial survey of current activities and training procedures of each major national sporting authority (ASN) was followed by the development of a detailed report which set out the criteria for benchmarking best practice.

The aims of the project are to provide recognition to those ASNs meeting these standards, create links between those who meet the standard and others who seek to do so, facilitate a knowledge exchange between ASNs, and encourage an ever higher quality of safety training provision. This will be achieved by creating pan-regional forums for the ASNs to work together. The FIA Institute’s Centre of Excellence programme will establish a network of international facilities at which these forums can take place.

The first STWG pilot for the “training the trainer” programme took place in Caracas, Venezuela in April 2006. It was attended by senior motor sport officials across the fourteen countries of NACAM, representing North America, Central America and Mexico, the largest ASN zone after Europe.

The delegates took that knowledge back to their home countries and educated their own members.

FIA Formula One Race Director Charlie Whiting said: “It is fundamental that the knowledge and experience of countries that hold world-class events is shared. This type of event is especially beneficial to countries with less experience.” Eventually, the STWG will set criteria and standards for an ASN’s involvement in certain types of motor sport. Progress through those standards will be encouraged and grants will be made available to those ASNs which seek to improve standards but require further funding to do so.

It will be recommended that only ASNs and individual safety personnel that have achieved the required standard will be permitted to run major championship events such as Formula One and World Rally. This would incentivise the pursuit of higher safety standards and raise the level of professionalism in motor sport worldwide.

“It is fundamental that the knowledge and experience of countries that hold world-class events is shared.”

Charlie Whiting, FIA Formula One Race Director
The Closed Car Research Group (CCRG) is the first group of its kind to focus solely on safety in closed car motor racing. It was formed when the FIA Institute launched in 2004 and has focused research and development in this area.

The CCRG supervises all research into safety issues relating to closed cockpit racing cars, including GT cars, Touring cars and Rally cars. Its work involves a comprehensive investigation into driver and co-driver safety in a closed car environment, with particular focus on the restraint system, seat, roll cage, head protection and the safety cell structure.

These safety devices vary significantly from those used in open wheel racing and require a different approach. Many closed cars are production based with a number of safety features inbuilt into the chassis. In addition, the cars are fitted with a complete roll cage to reduce intrusion and maintain survival space during impacts and rollovers.

The wheels of closed cars are fully protected by bodywork, thus the potential for wheel ejection is reduced and the principal mechanism of car launching due to wheel contact is eliminated. The driver sits in an upright seating position which requires different belt geometries than the reclined seating position of many single-seater cars.

In addition to the design of the cars, closed car racing brings with it a different set of safety issues compared with open cockpit disciplines. In rallying, for instance, the cars have to deal with extreme terrains and aggressive structures such as trees and walls within close proximity of the race surface. Whereas in circuit racing a lot of safety solutions can be included within the track environment such as kerb and safety barriers. Closed cars also have to ensure protection during very high speed impacts, potentially in excess of 150 mph, a parameter that the majority of production cars are not designed for.

Even so, the cars’ production background means that safety research is even more valuable in this area.

World Touring Car Champion Andy Priaulx, a leading safety activist amongst racing drivers, said: “The safety research on these racing saloons is even more important when we consider that they are closely derived from the standard road cars on sale to the general public. The car manufacturers have a chance to transfer the safety innovations adopted on the racing cars to their normal products.”

Before the launch of the FIA Institute, closed car safety research was primarily handled by the Expert Advisory Safety Committee. This committee, which included amongst its members some of the major safety experts in motor racing, looked after research into all motor sport safety from Formula One to rallying and touring car. However, in 2003 the FIA decided that to maximise the approach different expertise were needed for the two different disciplines in motor sport safety. One group was put together for open cockpit, open wheel racing and another for closed cockpit, closed wheel. This development led to the formation of the FIA Institute the following year.

The CCRG became one of the FIA Institute’s three major working groups at its launch. Its members now include some of the top experts in closed car safety such as FIA World Rally Championship safety delegate Jakub Bartas, Peugeot chief engineer Michel Nandan and Padrina’s David Lapworth.

Closed Car Occupant Safety
This is the main part of the CCRG’s work as it includes most of the areas of investigation in the short- and mid-term goals of developing a safety cell. Primarily aimed at the protection of rally crews, this work will be adapted for all closed cars.

It looks at all areas of the car and how the different safety elements interact. It encompasses the work on the FIA Seat Specification project. Another part of this project is side impact protection which converges with the other tests in this area. It is likely that the side impact work will be rolled out as a seat regulation as well as a car regulation.

This is especially relevant in rallying where the cars can hit stationary objects such as trees on the side of the road. The FIA Institute is looking at primary safety measures to stop rally cars from hitting trees in the first place. But in the eventuality that a rally car does hit a tree it is

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Andy Priaulx, World Touring Car Champion

*As of 1st September 2006
The Medical Training Working Group (MTWG) seeks to improve medical education and training for motor sport medics. Its remit is to raise the standards of medical training across all motor racing championships worldwide.

Chaired by Formula One Medical Delegate Gary Hartstein, the Group’s first task has been to create a modular motor sport medicine course that can be used to train trackside medical personnel.

Hartstein has been looking at ways to improve motor sport medicine since he began working full-time in Formula One in 1997 as an assistant to previous medical delegate Professor Sid Watkins. When Hartstein was appointed chief medical delegate at the beginning of the 2005 season he was determined to continue Watkins’ progressive work. He said: "This is the first time that a course has been tailored specifically for motor sport and made accessible for anyone that needs it."

Most trackside doctors are qualified in Advanced Trauma Life Support (ATLS), which is widely regarded as the leading qualification available. However, it is not tailored to dealing with emergencies at trackside and is not considered the ideal course for motor sport medicine. This is because it is a hospital-based course whereas trackside treatment is pre-hospital medicine. As such, training requires a location to put it into a practical context.

With this in mind, the MTWG has sought to create a brand new motor sport medicine course. To do this it has sought input from a vast pool of knowledge amongst its membership. Members have been selected from motor sport markets all over the world to bring the widest amount of experience to the Working Group. They include Sid Watkins, Carl Gwinnutt, David Cranston (all UK), Gérard Saillant, Jean Doby, Jean-Jacques Barman, Alain Chantegret (all France), Ronald Denis (Canada), Dino Altman (Brazil), Nabeel al-Ansari (Bahrain), Masato Kito (Japan) and David Vissenga (Australia).

Between them, the members have created the curriculum for the course, which is set to be rolled out in 2007. Practical training will include trackside simulations that can provide practice for the whole spectrum of intervention personnel from fire crews and marshals through to medical and extrication personnel.

Hartstein said: "Having travelled round the world and spoken to doctors at established circuits with long motor sport history, like Silverstone and Indianapolis, as well as new circuits, like Bahrain and Turkey, I realised that there is a very strong demand for furthering educational training in immediate care in the motor sport environment."

"There is a very strong demand for furthering educational training in the motor sport environment."

Gary Hartstein MD, Formula One Medical Delegate
The Karting Research Group (KRG) was one of the three main research groups formed when the FIA Institute was launched in 2004. It is chaired by Professor Sid Watkins and includes among its members representatives from karting’s governing bodies: Commission Internationale de Karting (CIK-FIA) the United Kingdom’s Motor Sport Association and Germany’s Deutsche Motor Sport Bund.

Before the CIK-FIA was launched in 2005, there was no dedicated committee for safety in karting, although occasional safety studies were commissioned. The speeds of the karts were controlled by a number of measures brought into the sport, which helped to maintain safety levels.

A stricter homologation for tyres was introduced to limit speeds. Safety devices such as side pods and other bodywork were brought in to offer further protection in kart-to-kart collisions. Other potential applications for this performance-related research could be improved. The first formal research was commissioned. The speeds of the karts were controlled by a number of measures brought into the sport, which helped to maintain safety levels.

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1. Industry Liaison Group

The ILG works in two ways. It provides a forum for a detailed dialogue between the industry and the FIA Institute’s research team. And it offers the manufacturers the chance to become partners in the FIA Institute’s various projects. This is necessary to enable the FIA Institute’s working groups to maintain a dialogue with the manufacturers and deliver standards that are appropriate to the market. For instance, there is little point in inventing a new safety measure if it uses exotic materials and is very expensive to produce. The findings of the research must be cost-effective and of the right standard for the manufacturers and vendors that produce and sell the items. The ILG will help to guide those standards.

The FIA Institute has always worked in close collaboration with the safety industry but on a project by project basis. The ILG offers a platform to extend and develop that relationship.

The ILG’s members include the major companies involved in manufacturing safety equipment such as helmets, race suits, HANS devices and safety harnesses. A further benefit of this membership is for the FIA Institute to utilise the resources of the manufacturers and vice versa.

The ILG holds around three meetings a year where members are invited to discuss current projects, areas of potential research and trends in motor sport safety. It also runs a number of workshops which offer a closer examination of individual projects. The first workshops focused on the youth helmet project and a project looking at the introduction of a new FIA seat performance specification.

It is envisioned that by involving the industry it will help facilitate the whole process, from research and development to design and production. This will, in turn, benefit the end user as they will receive an improved and generally cheaper product in less time.

Membership to the ILG is not just open to safety equipment manufacturers but all sections of the motor sport industry with an interest in safety, including circuits, motor racing teams and test houses.

2. Every F1 driver wears the HANS device, produced conforming to the FIA 8858 2002 standard.

3. Puma mid-ankle racing boot.

4. Formula One race suit.

5. Sparco racing glove.


7. Arai racing helmet.

Industry Liaison Group

The Industry Liaison Group (ILG), formed in September 2006, is the most recent addition to the FIA Institute’s structure. The Group works as the interface between the FIA Institute’s research and the manufacturers who put the results of that research into the market. It is therefore an essential component in bringing safety to all levels of motor sport.

Case studies: How our research projects make a difference.

The Red Bull Racing RB2 on the grid at the 2006 Italian Grand Prix.
Case Study 1: Young Driver’s Crash Helmet
By Mark Hughes, Grand Prix Editor, Autosport

Among the many FIA Institute projects, one of the most ground-breaking is the development of a young person’s crash helmet. Few people in the industry would have theorised even 10 years ago that a young driver’s helmet should not be just a smaller version of an adult one. But that is one of the discoveries that has been developed by the FIA Institute and its partners, since it launched in 2004.

No doubt this area would have been explored by one of the major safety manufacturers in due course but not with this speed and commitment that the FIA Institute has employed. Indeed, in just under two years it has researched and developed a brand new way of thinking in this area.

Under the guidance of FIA Institute project manager Andrew Mellor, the project aims to introduce a helmet for junior kart racing that is specifically designed for the physique of two youth age groups: seven- to 11- and 12- to 16-year-olds. Already the Snell Memorial Foundation – which has been certifying helmets in the US in a variety of sports since 1957 – is committed to working with the FIA Institute and the FIA in the joint publication of a new FIA youth helmet standard.
The need for such a helmet was first identified by American orthopaedic surgeon Dr. Steve Olvey. They found that smaller versions of adult helmet designs—all of which are currently available on the market—were of inappropriate geometry and mass. Mellor and Olvey, both Fellows of the FIA Institute, collected size and mass data using young volunteer subjects. The FIA used this data to build 3D surface models of the heads and shoulders of young karters. These models were used to create the first prototypes of helmets.

"Although current helmets worn by kids do offer good protection there is room for improvement," points out Mellor. "Young heads are lighter than adults so their helmets should be softer. Also, relative to their bodies, kids’ heads are big but their necks are thinner and weaker so their helmets need to be lighter. Their necks are also shorter so a miniaturised adult helmet tends to rest on their shoulders, creating a gap at the top of the helmet.

The challenge is therefore twofold. Firstly, to ensure the impact loads are travelling through the most appropriate load path and, secondly, to use material and construction that allows full impact protection with a mass that is low enough to give adult levels of protection from neck and spinal injuries."

A typical current youth-sized helmet weighs around 1.6 kg but research has shown this is too heavy for most necks of that age to adequately support in impacts. Although a definitive target weight has yet to be set for the youth helmet, it is expected to be around 1.2 kg even though it must still give adult levels of protection. This 400g reduction represents a huge reduction in the loads imparted to the wearer’s neck during an impact. Despite the significant weight reduction the helmet will still have to pass all of the stringent tests required by Snell and the FIA. These comprise tests involving impact, roll-off, compressive and bending loads.

The mass of the helmet is therefore critical. A delicate balance is required between impact protection and helmet mass. Using stronger shells and thicker liners can improve impact protection, but add mass to the helmet. The greater the mass acting upon the head during an impact, the greater the chances of neck or spinal injuries. The challenge is therefore twofold. Firstly, to ensure the impact loads are travelling through the most appropriate load path and, secondly, to use material and construction that allows full impact protection with a mass that is low enough to give adult levels of protection from neck and spinal injuries.

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Barriers that can protect drivers in high speed incidents are essential in open wheel racing. With short run-off areas at some corners, especially on traditional circuits such as Monza and Spa, a driver can often find himself hurtling towards a barrier at speeds in excess of 200 kph. For this reason the FIA and the FIA Institute have been focused on developing an ingenious solution – a barrier able to protect drivers in high speed impacts, at even the most constricted of circuits.

This special barrier, which can dissipate energy in a way that minimises injury for the driver, has been over six years in the making. It is set to revolutionise circuit safety. This is because it can absorb the energy of a 187 kph impact in just four metres whilst keeping the g-forces on the driver within acceptable limits.

The accident which triggered this particular research was Michael Schumacher’s crash in the 1999 British Grand Prix at Silverstone. The Ferrari driver left the track after a brake failure at Stowe corner at 204 kph and hit the tyre barrier at 107 kph. Incredibly, apart from a broken leg, the seven-times-world champion had no other injury.

However, FIA safety expert Peter Wright later recognised that Schumacher had a lucky escape. By studying data after the race, Wright found that the driver was particularly fortunate not to suffer any head injuries.

Wright contacted Hubert Gramling, a German engineer and crash-test expert, who had assisted the FIA already in the development of the Head And Neck Support (HANS) system. He asked his colleague to develop a barrier which gives the driver the best chance to survive a high speed crash without any serious head injuries. That conversation led to a six-year sequence of calculation, computer simulation, brainstorming and testing in collaboration with German automotive safety group DEKRA, which would culminate in a leap forward for modern motor sport safety.

First, Gramling developed software to simulate the momentum from a crash at any given speed for different types of barriers. Using this programme he examined the crash data from different types of accidents. He found that some drivers had walked away unharmed from high-speed impacts whilst others were injured in seemingly less severe incidents. For instance, at the Spa-Franchorchamps circuit in 1999, Jacques Villeneuve hit the tyre barrier at 190 kph and his car was brought to a standstill in 400 milliseconds over a distance of just seven metres. Yet he walked away unharmed.

By analysing this data Gramling could develop a model of a barrier which would give the driver the ideal crash momentum.

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Michael Schumacher crashes heavily into the tyre barriers at Silverstone in the 1999 British Grand Prix.

A test car

In front of a tyre wall. However, with a 20mm thick conveyor belt placed in front of the car, which in itself had some elasticity. In this phase the head often hits the steering wheel, where forces need to be reduced. The speed here should not pass five to seven metres per second (m/s). Schumacher for example hit the steering wheel at 5.5 m/s. But had there not been so many rows of tyres at Stowe corner it could have easily been 12 m/s. Any speeds above 8 m/s can be critical for the head.

However, not every circuit has so much space available as the run-off area at Stowe corner. So Gramling came up with a theory that could solve this problem. The idea was to manoeuvre the driver in the first part of the accident inside the car to a position where he can sustain high loads in the latter part of the accident. This is what the tyre wall did in the Schumacher accident and explains the relatively small injury in such a major crash.

The car would also transfer the momentum of the first part of the impact onto the second layer of the barrier. Gramling explains: “It is just the same as what happens in a multi-car pile up. The first car gives its energy to the next one and so on.”

A test was conducted with a 20mm thick conveyor belt placed in front of a tyre wall. However, with an impact speed of 80 kph the belt started to tear. At 100 kph the trolley penetrated the belt. “It was total destruction,” says Gramling. Strengthening the belt did not provide a solution either and, in fact, the barrier became so stiff and heavy it would be impractical for circuit use.

The tests also revealed a problem with the theory. Gramling explains: “The concept of a momentum transfer in two phases could not be made to work without accepting other down sides. What we needed was a consistent deceleration over the whole impact.”

After the tests with the conveyor belts had failed, the FIA received a call from French company TecPro International, which had designed some energy absorbing containers and wanted to work with the FIA on future projects. Gramling saw an opportunity and asked TecPro to donate these elements for testing with a view to future purchase. TecPro agreed.

The TecPro blocks are containers measuring 1.5m long, 1m high and 0.6m deep. Each end is formed like a half circle, enabling them to connect with each other like a jigsaw puzzle. Nylon straps hold them in place.

At the start of the experiment the containers were filled only with poly-urethane foam, a substance known to absorb high energies. Using a trolley with a front nose similar to an open wheel race car, which was specially developed by the FIA Institute, DEKRA commenced the test at its facility in Neumünster. At the first attempt the trolley crashed through the barrier just as it had with the conveyor belts. So to stop penetration, two 2mm steel sheets were placed vertically in the centre of each container with 30cm layers of foam on each side. The overall weight was 140 kg for a container, a feasible amount for two trackside marshals to handle.

The second test, at an airport in Itzehoe, took place with two rows of steel armed blocks. It worked. The trolley crashed into the structure of 127 kg and stopped without any penetration of the barrier material. The driver would have had to sustain only 30g during impact.

As chance would have it, Gramling realised that the data from this test correlated exactly with the data taken from a crash involving Felipe Massa at the Monza Grand Prix in 2002. The Brazilian, who then drove for Sauber, had hit the tyre wall at 137 kph. The TecPro barrier he used at Monza had a 1.2 m gap (shortened to improve efficiency), thus six rows of tyres with poly-urethane inserts and finally a moveable retaining wall. The whole barrier was just four metres deep and the result was stunning. With a deceleration of 55g for the driver, the load was way within acceptable limits.

The accumulated data helped to develop this type of barrier for all kind of corners and run-off areas. As Gramling puts it: “We now know how big the gap between the TecPro blocks and the tyres has to be and how many layers of tyres we need for a given impact speed.”

All bodies well for the future. Gramling says: “With what we know after all these tests we are confident that the barrier we tested at 187 kph can master a 210-220 kph impact in a limited area.” The research has delivered another positive result. The construction of the TecPro blocks has made up of only one line of steel- armed TecPro blocks, followed by a 1.2 m gap (shortened to improve efficiency), then six rows of tyres with poly-urethane inserts and finally a moveable retaining wall. The whole barrier was just four metres deep and the result was stunning. With a deceleration of 55g for the driver, the load was way within acceptable limits.

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Case Study 3: New FIA Seat Standard
By Mark Hughes, Grand Prix Editor, Autosport

The driver’s seat is a core component in a closed cockpit race car. Not only does it provide the main connection between the driver’s body and the car but it also provides the last line of protection should an accident occur. This is why an important part of the work conducted by the FIA Institute’s Closed Car Research Group (CCRG) has focused on developing and improving seat design.

By developing improved seat designs, the FIA Institute can promote enhanced safety for all drivers in closed car disciplines. Given the potential benefits of safer seats, the FIA Institute has commenced a project to develop a new seat specification which may, subsequently, be published as an FIA Standard.

Although focused initially on rally seats, the technologies established by this project will transfer to other race series. The ultimate aim is to create a new seat specification which will provide closed cars with similar levels of protection to Formula One and Indy Cars.

Some of the research, both engineering and medical, may also be relevant for road cars. Wright says: “This project will establish a best practice for design and installation. The FIA will then legislate the standard with a formal regulation.”

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Marcus Grönholm, in the Ford Focus RS
2006 World Rally Bly, Comay, Sweden.
sitting inside a strong roll cage so says Wright. “In a closed car you are“Every car built in the future will be fitted directly to closed cockpit cars.”

The need for improved seats became increasingly apparent following the introduction of the Head And Neck Support (HANS) device into motor racing. Wright says: “We’ve achieved a lot of improvements to the cockpit environment for open cars and successfully integrated HANS with many series. What became very apparent when we formed the CORG was that we needed to reinvestigate the seat and cockpit for closed cars.”

Unfortunately, most of the open wheel safety research cannot be transferred to the closed cockpit cars.

*The whole environment is different,* says Wright. “In a closed car you are sitting inside a strong roll cage so there are more things for you to hit. Also, the seats are discrete rather than built into the monocoque as for open cars. The way they are mounted, particularly for different sizes of driver, and the strength of those mountings becomes very important. There are a lot of areas of driver and seat integration that need to be addressed."

Rallying, specifically, brings further safety considerations arising from keeping two occupants in the car and the different types of terrain the car has to negotiate over the course of the season.

The general aim for any vehicle safety system is to ensure the occupant’s rate of deceleration does not exceed those levels that may inflict injuries and that all the available space is used efficiently to minimise the peak loadings.

Dr John Melvin, a fellow of the FIA Institute, has been leading research in this field for four decades, his work informing many of the standards for the American car industry. Using the huge amount of data made available from motor sport accidents during the last few years, particularly in NASCAR, Melvin has been able to refine his understanding of human injury toleration in impacts.

NASCAR has conducted a vast amount of research in this area, especially following the death of star driver Dale Earnhardt. This gave the CORG a starting point for its own research.

Wright says: “We worked closely with John Melvin in the US and we have commissioned the Delphi test facility in the US for our sled testing. We took our start from the NASCAR research and adapted it for the type of cars and circuits used outside the US.”

It became clear during Melvin’s research that much of the established data on human tolerance to injury was not quite accurate and that injury tolerance levels were somewhat higher than previously believed. This means that the forces and accelerations, imparted by a safety system, can be made more aggressive to make an accident more survivable.

During an accident, the car stops very quickly with a deceleration measured in terms of g-loadings. In simplified terms, the occupant continues to move at the speed the car was travelling immediately before impact until the torso is either restrained by the safety harness or impacts with part of the car’s interior. Following the restraint of the torso, the internal organs may continue to move within the body thus causing internal injuries. Controlling the relationship between these motions, in order to minimise the risk of injury, is fundamental to this research and a key part of the seat project.

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The Centre of Excellence programme recognises and rewards excellence in safety at circuit facilities around the world.

The Centre of Excellence programme forms the cornerstone of the FIA Institute’s aim to encourage and incentivise excellence in all aspects of motor sport safety. The award recognises and rewards excellence at circuits around the world.

Each Centre of Excellence exemplifies the high standards expected by the FIA Institute in terms of medical, marshal and race control safety. They also display a commitment to innovation and the development of new safety technology.

In return, each Centre of Excellence is utilised to host events under the auspices of the FIA Institute. The first recipient of the award, the Paul Ricard circuit, is to host the first FIA Safety Summit in January 2007. This will become an annual event, building on the success of the joint safety symposium between the FIA Institute and the International Council of Motorsport Sciences (ICMS), held in Rome in 2006.

The centres also act as hubs for best practice in various motor sport regions around the world. In order to become an FIA Institute Centre of Excellence, a circuit must first go through a nomination application process. Each nomination is assessed by a jury, made up of leading international experts in the field of motor sport safety as well as officials and competitors.

The Paul Ricard High Tech Test Track, in Le Castellet, southern France, was chosen to be the first recipient of the FIA Institute Centre of Excellence Award.
the FIA Institute Centre of Excellence award. At least two other circuits in different continents, which have been put forward for nomination, are under consideration for the award.

Paul Ricard was selected because of its high safety standards and its continual developments in this field. It boasts a number of unique safety features. For instance, the circuit has 25 acres of run-off areas, made from a special type of asphalt rather than the gravel beds used at other circuits.

Gravel traps have been replaced by three types of asphalt surface. The first, on the outside of the track and painted blue, is more abrasive than the track itself. The second, painted red, continues on from the first and is ultra-abrasive. The third type is a white asphalt surface, which is thought to be more effective at slowing the cars than the grass layers used at other circuits. The surfaces are varying blends of asphalt and tungsten, designed specifically to internally slow down and stop the race car.

Another unique feature is the replacement of flag marshals with a system of lights. Activated by transponders on the cars, this system reacts quicker for the drivers and rescue teams. Thirty-three traffic lights strategically placed around the circuit inform drivers instantly of potential hazards on the track.

The bonus of this system is that the track marshals can be used in other areas such as helping with the rescue teams. Paul Ricard employs a number of permanent marshals and has available between five and 20 rescue teams depending on the number of cars using the track. Each team consist of two track trained safety marshals with experience in rescue techniques.

The medical centre at Paul Ricard is particularly advanced. Facilities include a medical helicopter landing pad, with its own fully equipped resuscitation ambulance, a two-bed observation ward with full medical equipment, full life-support facilities with two emergency sections and a serious burns unit with appropriate baths.

It employs nine permanent staff, including a chief medical officer, an anaesthetist nurse and a number of trained firemen.

The medical facility is also used as a training centre for track and road emergencies. It has a state of the art SimMan Dummy, a mannequin which can simulate 2,500 injuries and be operated on. There are only a few of its type in France with the others used for army training, in universities and at hospitals.

FIA Institute President Professor Sid Watkins is particularly impressed with the circuit. He says: “Paul Ricard has proved itself to be one of the safest tracks in the world and its medical facilities are second to none.”

Paul Ricard has already hosted international training forums for the FIA Institute with a particular focus on extraction training. This programme is set to continue as the Centre of Excellence programme expands internationally and a network of “hubs” for the training of medical and safety personnel is created.

Watkins says: “Our Centre of Excellence Programme is set to roll out across established and emerging motor sport markets worldwide. The close liaison with national sporting authorities as well as the key industry players will encourage new safety partnerships to flourish.”

The Centre of Excellence award is the first phase of a wider excellence programme that the FIA Institute plans to roll out. The programme will eventually involve awards for Excellence in other areas of safety. For instance, new safety developments, new technologies and even individuals will be rewarded for excellence in their specific field. With such incentives, the FIA Institute hopes to increase innovation and excellence in safety in a way that will improve motor sport, technology and practice.

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Professor Sid Watkins, FIA Institute President
The FIA Institute: Putting Safety First.

David Lapworth
Engineering Director, Prodrive and Member of the Closed Cockpit Research Group:

“Prodrive has been more than happy to assist the FIA Institute on a number of research projects which have sought to develop and improve safety in motor sport. The FIA Institute has hugely accelerated research and progress in this area since it was formed and it is important that the industry supports its work.”

Mario Colatti
Brand & Marketing Director, Sparco S.p.A.:

“The FIA Institute for Motor Sport Safety is playing a fundamental role as an independent body which actively promotes the development of safer products for the whole community involved in motor sport.”

Martina Kindt Cohen
CEO, Bell Helmets Europe:

“I think that the FIA Institute is a great improvement for all of us involved in safety. It has been the driving force behind many groundbreaking new technologies. Never has safety made such quantum leaps since the FIA Institute made it its priority.”

Michael Krehl
Project Manager Crash Tests, DEKRA Automobil GmbH:

“The cooperation between the DEKRA Crash Test Center and the FIA Institute for Motor Sport Safety has been very professional, effective and forward-looking. I think the many tests we have worked on together will result in more safety for the drivers and the attendants at racing events.”

Jost Capito
Director of Ford Team RS:

“As a manufacturer entered in the FIA World Rally Championship, Ford places the highest priorities on safety. It is good to know that an organisation like the FIA Institute is working on motor sport safety day in and day out. Between us we will strive to make rallying and other motor sports as safe as they can be.”

Hal Fenner
President, Board of Directors, Snell Memorial Foundation:

“As President of the Snell Memorial Foundation I have had the opportunity to work with the FIA Institute during the past few years. Not only has the Institute been very cooperative but it has been a huge help in the design and innovation of improved head protection for all drivers from karting to Formula One.”

Mark Stiles
CEO, HANS Performance Products:

“Having an open discourse with the FIA Institute over the past few years has made it easier for us to ensure that racers get the best possible performance from their HANS Device. The FIA Institute’s expert researchers have created specifications that have challenged us to construct pragmatic solutions to enhance racer safety in subtle but important ways. This contribution has been invaluable.”

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The FIA Institute improves the safety of motor sport through analysis, research, testing and development.