



# AUTO+ MEDICAL

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## RACING ENABLED

How disabled drivers are competing at the top level of motor sport



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I am very proud to be writing this introduction for this latest edition of AUTO+ Medical. Our cover feature looks at the new FIA Disability and Accessibility Commission, a very significant and important development by FIA President Jean Todt, in an area affecting motor sport at all levels, from off road to circuits. It's particularly poignant for me to have seen how a young Billy Monger has struggled against all odds to regain a race licence and after an amendment to our regulations, is now back in single seater racing.

I'm sure you will all join me in sending best wishes to three of the longest serving and original founding FIA Medical Commission members: Jean-Jacques Issermann, who will be known only too well by anyone who has ever been involved in extrication training; Robert Scarlot, who has overseen the motor sport medical affairs in Monaco for so long; and Professor Hugh Scully from Canada, who recounts some of the early days in our letters page. They won't disappear from motor sport but are retiring from the Medical Commission.

Congratulations go to Dino Altman from Brazil who is appointed as Vice President of the Medical Commission and also joins the editorial board for this publication. Please let us know your thoughts and opinions, all your comments and submissions are always welcome.

Dr Paul Trafford, Chairman,  
 Editorial Board, AUTO+ Medical

# LETTERS

*In this section, we print the best letters and emails received from readers around the world. We welcome comments on articles as well as suggestions for future content. If you wish to send in a letter or email, please direct it to: [medical@fia.com](mailto:medical@fia.com)*

Dear Editor

It is with great sadness that I step down due to the new age restriction rules from the FIA Medical Commission after nearly 40 years and would like to share with you all how it all started.

I started the Race Physician Team in Canada 50 years ago. Then there were no facilities, medical centre, equipment, nurses, paramedic/ firefighter/rescue personnel, or rescue/ ambulance vehicles. We introduced strategically placed rescue, ambulance and track service vehicles around the circuit to assure rapid response to accidents, and the first special rescue medical car in North America to follow cars on the first lap after a standing start at the same time Jean Jacques Issermann was trying the same concept in France. When Prof Sid Watkins came to Mosport in Canada in 1974 with F1 he was impressed with the medical car concept and introduced it into F1.

I worked with Sid Watkins and Jackie Stewart along with many others around the world in a determined effort to improve medical and rescue services and overall safety in motor sport. On three occasions: Hungary, Mexico and Malaysia I substituted for Sid as "Medical Delegate" on a Friday or Saturday... although Sid never missed a race day in all of the years that he was the Medical Delegate to Formula One.

The first motor sport 'Medical Commission' in

the world was put together in Paris in 1981. Jean-Jacques Issermann (France), Robert Scarlot (Monaco), Professor Nalda (Spain), Dr. Rovelli (Italy), Professor Watkins (Great Britain) and I (Canada) were the founding Members. We elected Sid as the Chairman... and the rest is history!

From 1994-2011, I had the great honour, privilege and opportunity to be the Chairman of the International Council of Motorsport Sciences (ICMS) based in Indianapolis. We invited Sid to join us and be appointed as an Honorary Member of our Board. He attended and contributed to our annual scientific meetings regularly.

At Sid's invitation as the Chairman of the Medical Commission, I made the proposition that the FIA Medical Commission and ICMS hold a joint meeting. This was enthusiastically endorsed, and our first "summit" was held in London in 1991. Subsequently, we have convened joint summits in Miami, Puerto Nuevo and Rome. Discussions are underway for another "summit" in 2019 in Indianapolis.

At the invitation of then FIA President Max Mosley, Professor Sid Watkins created the FIA Institute for Motor Sport Safety and Sustainability in 2004, based in Paris. This was a creative marriage of motor sport-oriented physicians, engineers and officials all dedicated to research and the application to motor sport safety. I was



honoured and pleased to be invited as one of the Founding Members. In 2017, its safety research programmes were taken on by the Global Institute for Motor Sport Safety, the FIA's safety research partner.

In the early 1970s, annual driver mortality in F1 was 1 in 7. Other series were equally dangerous. Many drivers, track personal and spectators were seriously injured or killed during motor sport events.

As a result of the great collaborative efforts the FIA, the ICMS and others, there have been great improvements in motor sport safety over the past forty years.

We have incorporated better driver fitness, effective protective clothing and helmets, highly trained medical / rescue teams, better race medical centres, communication systems, trauma centres, better tub design, fire-proof fuel cells, the HANS

device and head-surround, better brakes, wheel tethers, safer barriers, better circuit design with better run off and safety fence design, and better security... all to the benefit of all motor sport.

I have been honoured to be recognized in Sid Watkins first book "Life in the Fast Lane" along with Sir Jackie Stewart and Lord Stanley, to have been elected to Life Membership in the Canadian Race Drivers' Association and the Vintage Automobile Racing Association of Canada, to have been awarded the John Bassett Award and the John Reid Trophy and be the first physician elected to the Canadian Motorsport Hall of Fame for "outstanding contribution to medical care and safety in motorsport."

Since 2011, I have had the challenge and privilege to be the chairman of the Canadian Motorsport Hall of Fame and President of the Canadian Motorsport Heritage Foundation.

It has been and continues to be a great pleasure and personal satisfaction to be a major "player" in this arena. I have had many invitations around the world to present and discuss the principles of motor sport safety (Australia, England, Mexico, Brazil, Malaysia, Italy, Doha, Istanbul, Vienna, the US and across Canada). I have enjoyed great international friendships with other participants in our motor sport safety ventures.

While I have enjoyed a very successful career as a cardiac surgeon, Professor of Surgery and Health Policy at the University of Toronto, President of all heart specialists in Canada, and all physicians in Ontario and Canada, I have always had a passion for and found great pleasure in motor sport.

I wish all my colleagues well and will undoubtedly miss the FIA Medical Commission but will continue to contribute to the safety of our sport wherever and whenever I can.

*Dr Hugh Scully*

# GLOBAL NEWS



AMR takes over from Holmatro as sponsor of the IndyCar Safety Team

## INDYCAR AGREES DEAL WITH AMERICAN MEDICAL RESPONSE

The IndyCar safety team has agreed a deal with emergency medical transport provider American Medical Response (AMR) to sponsor the championship's safety team. As part of the multi-year deal from 2018, AMR will take over from Holmatro as safety team sponsor and provide ambulances to Indianapolis Motor Speedway, alongside emergency and non-emergency ground medical transportation services. Holmatro will continue as Official

Rescue Tool provider for the championship, having agreed a contract for the next five years. The safety team plays a key role in ensuring that drivers are safely recovered from incidents on track. The dedicated team of 30 that attends each race weekend has an average of 20 years experience in their respective areas. "The IndyCar Safety Team has a world-renowned history of setting the standard for emergency services in motorsports," said Ted Van

Horne, AMR president and CEO. "With our focus on safety and experience providing onsite medical responses at numerous sports venues, there is a natural fit for us to sponsor the safety team." AMR provides medical support for thousands of events across the US. AMR also becomes the official ambulance provider at IMS for the IndyCar Grand Prix, the Indianapolis 500 presented by PennGrade Motor Oil and the Big Machine Vodka 400 at the Brickyard.

## ICMS FOCUSES ON SAFETY AND RESPONSE TIMES

The 29th International Council of Motor Sport Sciences' Annual Congress took place at Indianapolis on 7-8 December 2017, where a range of topics regarding medical and motor sport safety were discussed.

Notable appearances came from legendary team owner Chip Ganassi who spoke about his career, and IndyCar driver Charlie Kimball who discussed his management of diabetes in motor sport.

The FIA presented the latest anti-doping case studies alongside an annual update from Medical Commission member Dr Paul Trafford.

In its third year attending, the Race Track Safety Programme did a presentation on the most efficient and safest procedures for responding to track incidents. There were also practical training sessions, which included extraction procedures and 'live' fire suppression with the latest materials and tools.

A Scientific Session covered a number of topics, including recent research in driver physiology; discussions of concussion caused by improper design of driver compartment safety devices; and an in-depth review of situational sensitivity and crisis management in motor sport. In addition there were lectures from Dr David Ferguson on the physical response to driving a race car, and Dr Julia Daly on concussion considerations when returning to competitive racing.



## BILLY MONGER TAKES PODIUM ON RACING RETURN IN SINGLE SEATERS



Billy Monger scored a podium on his return to racing at the opening round of the British Formula 3 championship.

It is the first time the 18 year-old has raced competitively since his accident in British Formula 4 last year in April at Donington Park, which led to the amputation of both his legs.

After the FIA approved a new rule during the winter that enables disabled drivers to compete in international single-

seater categories, Monger tested a British F3 earlier this year using an adapted system.

The paddle on the steering wheel allows his right hand to accelerate, while using left to upshift and downshift. He then uses his right prosthetic leg to operate the brake pedal.

His presence in the F3 race was confirmed just a week prior to the meeting, when Carlin was given special dispensation to run a fourth car.

Monger qualified in fifth just 0.548s off the pole time on Saturday, then during the race capitalised on contact between Clement Novalak and Krish Mahadik to settle into third place. He then fended off 2017 Ginetta Junior Champion Tom Gamble to take the final podium place.

Following his accident last year, Monger received nearly £850,000 to go towards his rehabilitation through crowdfunding. Although he has only committed to the opening round of this year's British F3 championship, Monger hopes to compete in the remainder of the season.

## NEW DEPUTY PRESIDENT APPOINTED

Dino Altmann, MD, has been appointed Deputy President of the FIA Medical Commission. Altmann is a surgical oncologist, who has worked as an Emergency Physician in motor sport since 1990. He is Chief Medical Officer of the Brazilian Grand Prix and also the Emergency Physician in

charge of the Brazilian Stock Car Championship and of the Brazilian Porsche GT3 Cup. In addition to his role with the FIA Medical Commission, Altmann has joined the editorial board of AUTO+ Medical, the FIA's international journal of motor sport medicine.

## BOTTAS USES EYE DOCTOR TO STAY SHARP

Mercedes F1 driver Valtteri Bottas has been working with an eye doctor to sharpen his hand-eye coordination before each race.

Sport scientist Dr Sherylle Calder, who specialises in eye-hand, -foot and -body coordination, has done track walks with Bottas to help him best prepare for a race weekend.

She has also created a tailored version of an app called EyeGym, which helps athletes see better and anticipate quicker, to keep the driver sharp.

Objects will jump up and down across a screen, testing the reactions of the user, their memory and spatial awareness. Rugby Union players, for instance, have been using the tool to better train their eyes when attempting to catch a high ball. But Calder

believes it is of even more benefit in a sport like F1.

"If you make a mistake in F1 it is a lot more crucial than in, for instance, a rugby game," said Calder speaking recently to CNN. "We warm up the rest of the body, but about 80 to 90 per-cent of the information that you base a decision on comes from the eyes."

Her work with Bottas is not necessarily sight-related, but is based on improving the visual motor system and decision-making. "We make sure he's ready to perform by getting the visual system fit and ready to respond to anything happening around him."

Previously, Dr Calder has worked with a number of leading sports teams and players, including the All Blacks rugby team and golfer Ernie Els.

## DRIVERS CALL FOR BETTER SAFETY AT BATHURST



**Drivers have called for increased safety at the Mount Panorama circuit, after a heavy crash at the 12 hours of Bathurst this year.**

**The crash, involving drivers Ash Walsh and John Martin, caused the race to be stopped and the result to be declared early.**

**Walsh's Audi was sat broadside to the circuit having made contact with a barrier before Martin arrived in his Mercedes-AMG GT3 at almost full speed. Though Martin tried to swerve left to avoid the Audi, he made heavy contact which saw him momentarily lose consciousness.**

**The pair were taken to the circuit medical centre and Walsh was then transferred to Bathurst Hospital for further checks.**

**"I can't believe we haven't learnt after previous situations there," said Will Davison, 2006 and 2016 Bathurst 1000 winner on Twitter. "Such a scary situation for both parties. Needs to be improved immediately."**

**Martin, who has twice raced in LMP2 at Le Mans, believes in-car marshal warning systems used in the World Endurance Championship could help when approaching unsighted areas.**

**"I think all that sort of stuff like in WEC would be nice, if they implemented that into these sort of cars," Martin told the SpeedCafe website. "In places like that where you can't see, you rely on every little bit of information that you get for any sort of warning."**



## SILVEIRA CAMARGO LEAVES FIA AFTER 15 YEARS

Sandra Silveira Camargo has moved on from the FIA after 15 years with the organization.

She started working for the FIA in March 2003 and worked her way up to become Head of Medical Affairs.

She said: "Leaving the FIA is anything but simple. Not a day has passed without my

enjoying going to work. I have spent here extraordinary years and I have met extraordinary people.

**"Working in an environment where most stakeholders are passionate about what they do is a real privilege. I had the chance to know many of you who are reading this magazine, and I am grateful that you shared with me your enthusiasm for motorsport.**

**"The time has come for me to take a new path and head on new challenges. It will be hard to find such a motivating environment as motorsport, but I will do my best. I will keep precious memories of my years at the FIA. Thank you for helping to make them so stimulating. I wish you all lots of exciting races ahead and great personal achievements."**

## FIA MEDICAL COMMISSION MEMBERS TO RETIRE AFTER OUTSTANDING SAFETY CONTRIBUTIONS

Three members of the FIA's Medical Commission will be retiring as part of the new age limit rule announced at December's FIA General Assembly.

Professor Hugh Scully, Dr Jean-Jacques Issermann, and Dr Robert Scarlot will be retiring from the Commission, having made some outstanding contributions to the FIA in its quest to make motor sport safer for competitors.

Professor Hugh Scully has been in motor sport medicine since 1968 when he was Medical Director for the Canadian Grand Prix at Mosport and subsequently Montreal.

Dr Jean-Jacques Issermann has been involved with the Le Mans circuit since 1950, most

recently taking up the role of honorary vice president at the circuit alongside his FIA duties as special medical delegate. He was responsible for introducing extrication teams and the Kendrick Extraction Device (or K.E.D.) which helps drivers when they are placed on a stretcher and taken away for a medical examination.

Dr Robert Scarlot has been a key member in developing the driver extrication process and is one of the Vice Presidents for the Automobile Club De Monaco.

Despite retiring from the Medical Commission, all remain active in motor sport. An age limit of 75 has been placed on all members of FIA commissions from this year onwards.



## 'TRAINING THE TRAINERS' AT LE MANS

The FIA has hosted an event at the Le Mans racing circuit to train leading Chief Medical Officers (CMOs) to become trainers in their own regions.

Seven experts were invited to the training session, with representatives from Turkey, Hungary, Mexico, Canada, Singapore, Bahrain and Brazil.

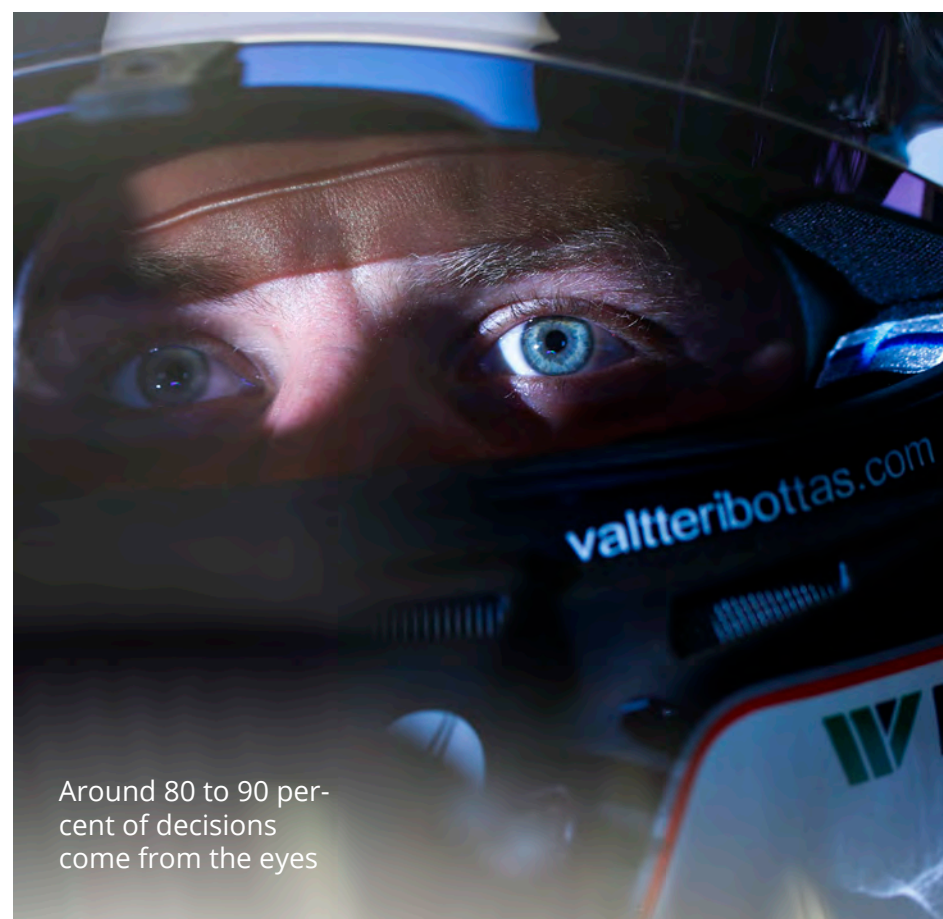
The training was conducted by FIA Medical Delegates and Medical Affairs staff, with additional presentations made by some of the participants. They were invited to the seminar to become FIA trainers of future CMOs and Deputy CMOs in their regions.

"This training is a significant step forward in increasing the quality and professionalism of the medical cover of the FIA World Championships," said Professor Gérard Saillant, FIA Medical Commission President. "The aim is to accredit one CMO from each region who will then be entitled to train all of the new CMOs to the highest standards."

To help with this, the FIA is developing a toolkit to aid training of future medical representatives at motor sport events across the world.

The Le Mans training event, which took place on Friday 26 January, was followed by a two day extrication seminar hosted by the Fédération Française du Sport Automobile (FFSA) and led by extrication expert Dr Jean-Jacques Issermann.

In all, 20 extrication teams were trained from countries across Europe and each team gained practical experience on a number of race cars, including four fitted with the new Halo head protection device.



Around 80 to 90 per-cent of decisions come from the eyes



# FEATURES

## RACING ENABLED

Innovative technologies and a new FIA commission are breaking down the barriers to entry for disabled drivers to compete at the top level of motor sport

Five and a half hours into the 2016 Le Mans 24 hours race, the cameras cut to the garages to show the rather unusual sight of a driver being hoisted into his car with the assistance of his mechanics.

The man in question was Frédéric Sausset and he was about to make history by becoming the first quadruple amputee to compete in the iconic race. Not only did Sausset manage to finish the race, with the help of teammates Christophe Tinseau and Jean-Bernard Bouvet, but he also had the privilege to be on the podium in front of tens of thousands of fans.

It demonstrated one of the unique aspects of motor racing – it is the only sport in the world where disabled athletes compete on the same playing field as all others. Sausset is now a member of a new FIA commission that aims to encourage more disabled racers to do just that.

The FIA Disability and Accessibility Commission is focused on improving accessibility for all in motor sport and ensuring that people with disabilities can compete fairly and safely.

Nathalie McGloin, a paraplegic driver who races in the Porsche Club Championship in the UK, has been named as the Commission's first president and is aiming to remove the barriers faced by disabled drivers in their bid to compete. "The FIA overall has been very aware and on top of the need to set standards for disabled drivers competing in motor sport," says McGloin.

Motor sport has become a major passion in McGloin's life after she was severely injured in a road accident in 1999 when studying for her A-Levels. She was a passenger in the car of a friend when the driver lost control and collided with a tree. She spent a year in hospital and suffered paralysis from the chest down.

Soon after being discharged from hospital she was determined to remain active and took up wheelchair rugby as a hobby, eventually going on to play for Great Britain. It was one of her teammates who introduced her to racing with a track day at Bedford Autodrome.

"I fell in love with the concept of driving your car at any speed that was safe, or any speed that you dare around a racing circuit," says McGloin, "I then took it up as a rather expensive hobby outside of my rugby training and it just kind of blossomed from there really."

As McGloin started to take the sport more seriously she was soon faced with the UK's Association of Racing Drivers Schools test (or ARDS test) to gain a competitive racing licence. She had to pass all of the same parameters as other drivers but in addition she had to complete four hill-climb or sprint events and demonstrate she could exit a car within seven seconds unaided.

"The main challenge for me was getting my head around whether I could actually get out of a racing car with a cage, racing seats, a (six-point) belt and driving position within seven seconds considering I'm paralysed from the chest down. The hill-climb and sprint events were fun to do, but time-consuming and costly."

One of the first changes McGloin hopes to achieve in the commission is to standardise the test worldwide and ensure the requirements are not a barrier to entry.

Matt Speakman is another disabled driver who races in Porsche Carrera Cup Australia, and he endured similar challenges when obtaining his licence to race from the Confederation of Australian Motorsport.

"The hardest thing was actually obtaining a license from CAMS to compete in circuit racing as I am the first paraplegic in Australia

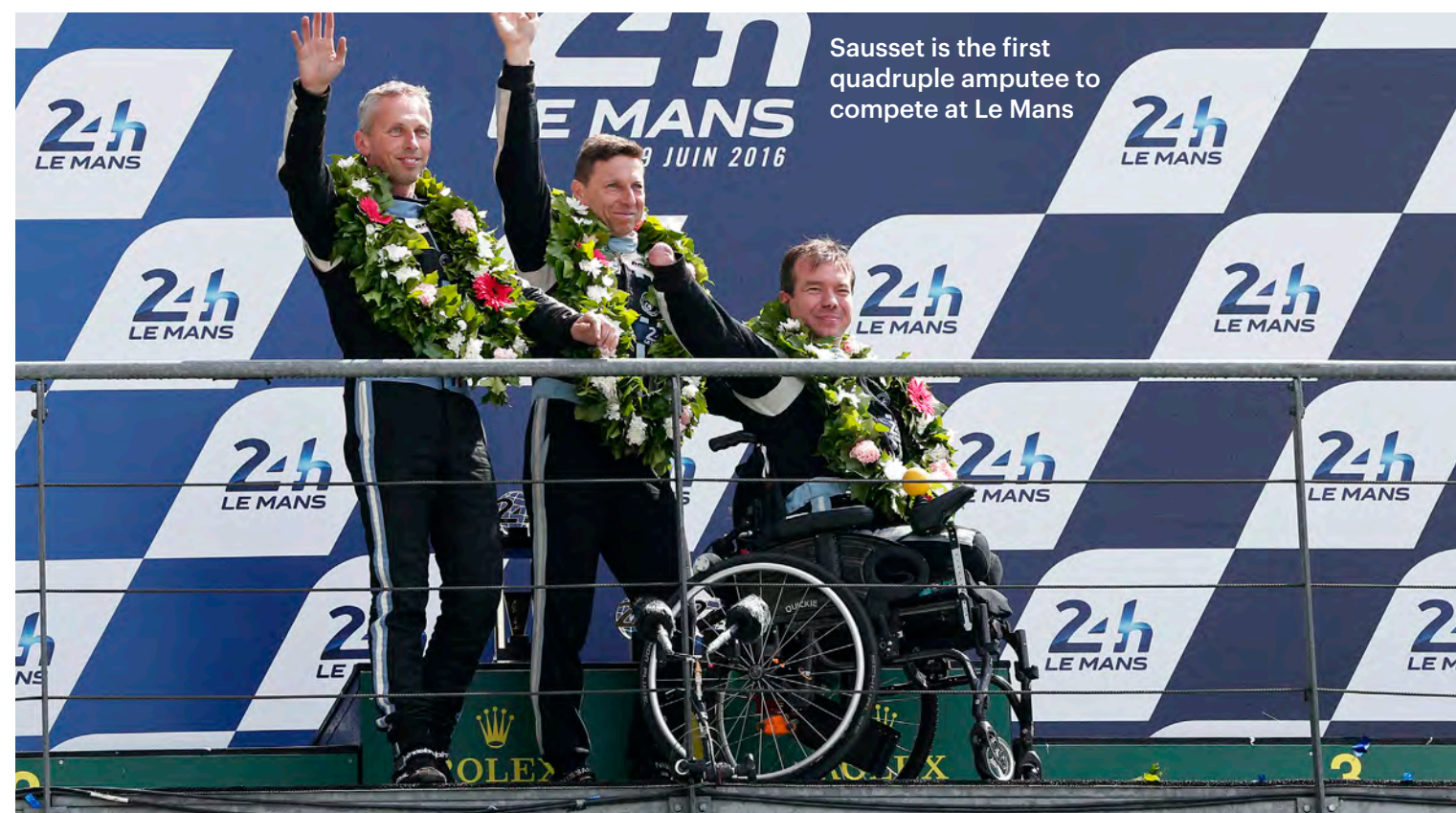


McGloin races in the Porsche Club Championship in the UK

**“ THE MAIN CHALLENGE FOR ME WAS GETTING MY HEAD AROUND WHETHER I COULD ACTUALLY GET OUT OF A RACING CAR IN SEVEN SECONDS ”**

to race," said Speakman to ourridelife.com. "Then in 2011 when I did get the license it was frustrating trying to get a drive and I actually lost a year waiting for the other series organizers to get back to me. So to prove my point I took a 1975 Toyota Celica rally car, converted it into a circuit racer, and in 2012 won the Queensland Improved Production Championship. This performance is what led to Porsche taking me seriously."

At the moment the FIA has a standard but not all championships in individual countries are FIA-certified at club level, as they are governed by National Sporting Authorities (ASNs) such as the UK's Motor Sports Association.





“If we can set up a model that we can pass down to ASNs to implement in their own countries, that would be a big bonus and one of the missions of the commission,” says McGloin. “We have the responsibility to make sure that the ASNs have the knowledge to conduct their tests in a safe but fair way.”

**TECH SUPPORT**

A major factor for the recent emergence of disabled racers in top-level racing is the development of technology. Many of the solutions that Sausset came up with for his Garage 56 entry to Le Mans were innovative in this field.

“My handicap forced me to think, to come up with solutions,” Sausset recently told the

**“ WE NEED TO ENSURE ABSOLUTE PARITY WHEREBY THE TECHNOLOGY ALLOWS US TO COMPETE ON THE SAME LEVEL ”**

FIA. “I can’t bear coming up against a problem I can’t solve. Nothing could be simpler than the things I ‘invented’ like extensions for the pedals. I didn’t know if it would work, but it seemed the simplest solution to come up with; the ‘ejector seat’ so that I could get out of the car in an emergency, the connecting rod instead of the steering wheel.”

The connecting rod is part of the steering

system, which he would attach to his artificial carbon arm and allows the seat to link to the accelerator and brake by a crosspiece that brings the pedals up to his leg stumps.

“The engineers, technicians and mechanics on my crew did everything they could to refine my suggestions and put my ideas into practice.”

McGloin uses similar methods to work around her paralysis, most notably the use of a ‘radial control’, which helps with the transition between operating the brakes and accelerator.

“Because my fingers are affected by my paralysis I don’t have the dexterity to use the paddle shift system,” she says. “I race a PDK Cayman, which is a double-clutch gearbox,

clutch-less car, so the car changes the gears for me. I have a radial control, which allows me to operate the brakes and accelerator.

“It’s not anything that’s wired into the car, it’s just a simple mechanic system. Almost like an extension of the brake and the accelerator into one pedal that sits nicely by the steering wheel. I push forward on the lever towards the dashboard to operate the brake, and I push down towards the feet to operate the accelerator.”

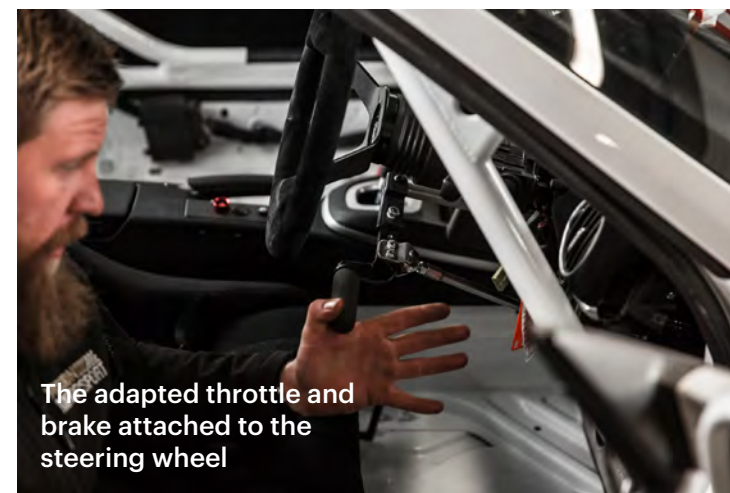
Speakman uses a similar system in his specially modified Porsche Carrera Cup car, however the brake is on a handle rather than combined with the accelerator. This handle pivots off the steering column and connects to the original brake peddle.

This type of technology is now making its way over to single seaters. British driver Billy Monger, who had both legs amputated after an accident in an F3 race at Donington Park in April, is leading the way.

With support from the Motor Sports Association, Monger managed to successfully change an FIA rule that had previously prevented disabled drivers from competing in international single-seater categories. The 18-year-old then tested an adapted British Formula 3 car at Brands Hatch as he continues his comeback.

Despite the development of technology to help disabled drivers, McGloin is determined not to let it go too far as it would be detrimental to create an uneven playing field.

“Recently, a Paralympian long-jumper showed he could jump much further than an able-bodied athlete because of the spring in the technology of the artificial limb,” she said. “In motor sport we need to ensure absolute parity whereby the technology in the car allows us to compete but always on the same level.”



The adapted throttle and brake attached to the steering wheel



McGloin speaking at the FIA Sport Conference in Geneva



The commission hopes to improve the opportunities for disabled racers worldwide



As such, the commission aims to make sure that any adaptations made to cars for disabled drivers are facilitating them to compete in a different way, rather than giving away any sort of advantage over able-bodied competitors.

**CHAMPIONS OF THE CAUSE**

McGloin hopes that with the influx of disabled drivers into the sport it will not be long before we see race winners and champions.

"I think that Billy (Monger) has got a strong chance of doing really well, and I would love nothing more than to see him champion of

the F3 grid," says McGloin. "It's an exciting time for the sport, especially in terms of a young driver who is really able to show what's possible, and I think with the support of the FIA we will get it right so that it is fair, it is safe, and it works."

McGloin's aim is to help improve opportunities for disabled racers worldwide, and if this can bring more of them into the sport and they become successful then it will have a snowball effect

"I think the more we have disabled people competing in motor sport and doing well, the more it's going to advertise to other disabled

**“ IT'S ONLY A MATTER OF TIME BEFORE WE HAVE SOMEONE WIN A CHAMPIONSHIP WHO IS DISABLED ”**

people that this is a sport for you, this is something that is possible. It's only a matter of time before we have someone win a championship with a disability, and I for one can't wait for that day."

The reason McGloin embraced the sport is that once she was in the car, she was just the same as everybody else which was

a liberating experience for someone in a wheelchair. Now she wants as many other disabled people to experience that feeling as possible.

"The whole beauty of why I fell in love with motor sport is that I was on the same level as everybody else when I was out on the circuit. The only difference that I had compared to the able-bodied participants was that when we got back into the pit lane I would get into a wheelchair and push myself into the café whilst they would walk in.

"I think that's why I loved it so much, that kind of parity as able-bodied people being able to do exactly the same thing at exactly the same time."



McGloin competing in the Porsche Club race at Silverstone

# HEADS OF PERFORMANCE

Ford Motor Company and King's College London are exploring the brain as the next frontier of performance in motor sport.

There are 86 million nerve cells within the brain that keep a human being ticking. Every decision and every movement, right or wrong, starts with the brain and dictates our next steps, leaving it susceptible to blame when things don't go to plan, especially behind the wheel.

But the brain remains a relatively untapped basis of research with regards to driver performance. This is why Ford Performance has joined forces with doctors at King's College London and production studio UNIT9 to investigate the effects of driving high-performance race cars on the minds of professional racing drivers.

The hypothesis for 'The Psychology of Performance' study was that a better understanding of a driver's mental capacity could lead to findings in how to better perform and cope in other challenging real-life situations. In collaboration with media technology company OATH and media agency network Mindshare, UNIT9 and King's College London developed a top-of-the-range brain scanner to study the brain performance of a number of Ford's best drivers, including five-time World Rally champion Sébastien Ogier and three-time World Touring Car champion Andy Priaulx.



A professional driver's brain performs up to 40 per-cent better than an average person's

The study reiterated racing drivers' ability to use the maximum capacity of their brain to aid performance on track, and discovered that enforcing mental training techniques can enable all drivers to focus on the task at hand and 'live in the moment' – beneficial when faced with making split-second decisions at breakneck speeds in modern motor sport.

The findings from the experiment were surprisingly conclusive and informative with regards to what it is that makes a racing driver's brain different, according to Dr Elias Mouchlianitis, Neuroscience Researcher at King's College London.

"The first thing that surprised me in the findings was that we could actually see what makes the brain of a driver more efficient, and actually what it is that makes them better at driving. We could see that they are 'always on' - it doesn't matter if it's an easy turn, a difficult turn or a straight, they don't get distracted by external stimuli compared to normal people, whose brain on an easy part of the track would be more distracted. I was quite surprised and quite happy to see that we managed to find the brain signature to what potentially might be one of the cognitive processes that makes someone an exceptional driver."

**MIND OVER MATTER**

Understanding how the brain works requires practice and patience. Working out how to get the best out of yourself mentally requires training but when done correctly, can be invaluable on the track. An advocate of the practice is Priaulx, who has applied mindfulness and meditation techniques for over 17 years.

"I went and studied Silva Mind Method (meditation method), and learnt how to meditate and problem-solve at the alpha brain

The experiment started with data recorded from 12 of Ford's professional drivers, including Ogier and Priaulx, as well as the minds of 36 everyday people driving in a virtual reality simulator using an electroencephalography (EEG) brain scanner. The device was fitted with electrodes that connect to the skull and read the electrical signals from the brain. The initial tests demonstrated how professional drivers' brains perform up to 40 per-cent better than an average person's. The everyday drivers were then encouraged to mentally prepare for the racing simulator using breathing exercises, meditation and a visualisation technique to help describe the track ahead. This mental preparation helped the subjects' focus and performance improve by as much as 50 per-cent compared to a control group who were omitted from the exercises.

frequency level during the off-season [in 1997/1998]. The following season I won every race from pole. I'm just glad a lot of my competitors over the years haven't studied it as much as me because that's what's given me a very successful career. It definitely provides some opportunities for better performances."

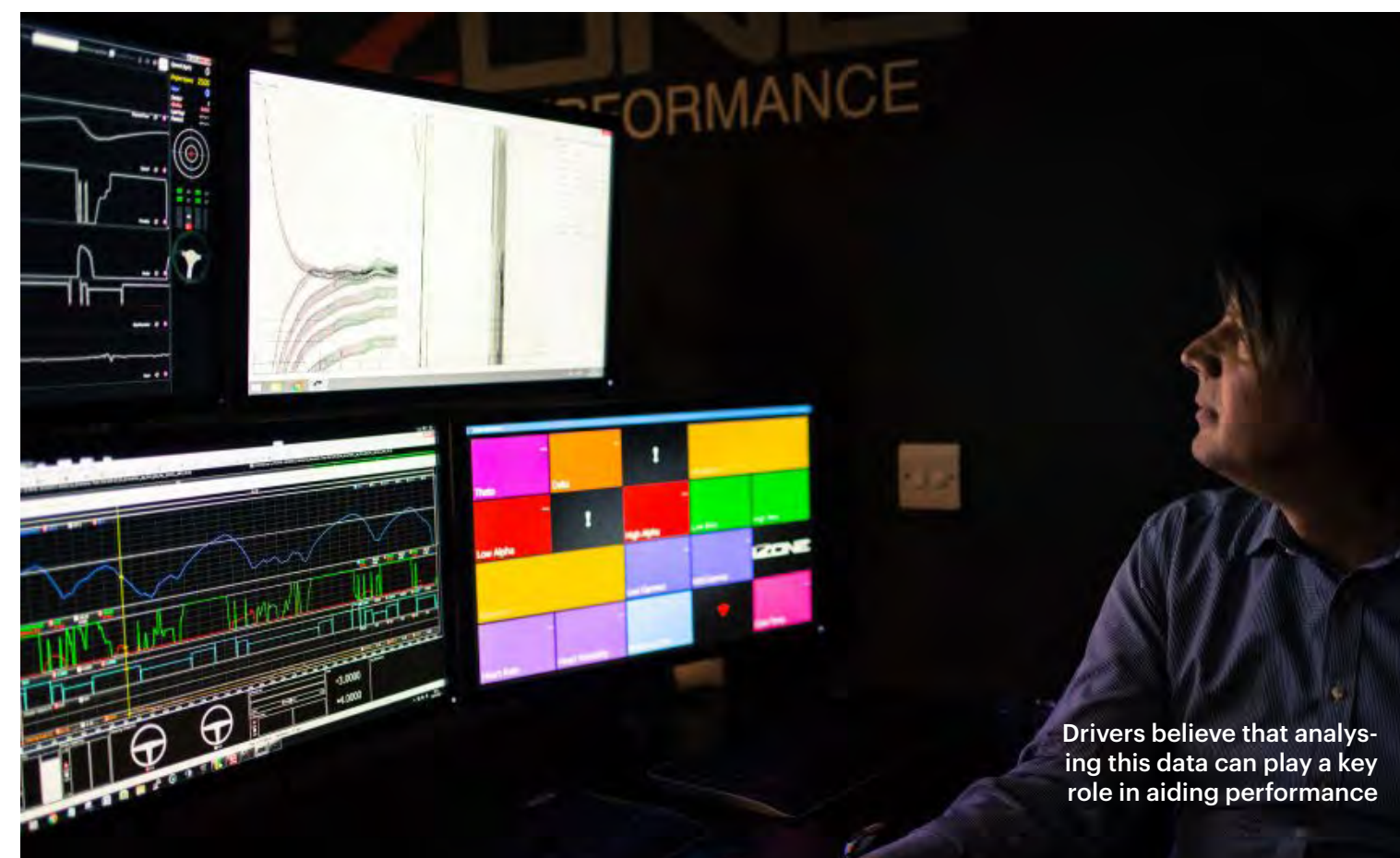
Despite each mental preparation exercise providing some form of benefit to a driver's concentration and focus, it remains an area of research that needs further testing to discover the best practices and how to apply them on the track.

"I think the hardest thing with this situation is finding the right process to achieve that focus on a regular basis, and that's an area that I'm very interested in," said Priaulx. "We know that meditation, creative thinking, and everything about it attracts a more distinctive level of driving – a higher level – but what we

need to do is take this study to the race track and simulate it under pressure during a race weekend, and then have a level of data over the whole year to see when the mistakes came and why, when the laps came that were good, when the laps came that weren't so good, and then maybe we can start understanding a little bit more about the process."

**NEXT STEPS**

Ogier is convinced that this type of brain analysis can play a greater role in aiding driver performance in motor sport. "I think the brain is still something that is not really well known and which there is not a really good understanding of, so there is still a lot of work to do on this subject," he says. "For me it was just an initiation and it would be interesting to work a bit deeper into that because I was just a subject for the research but I didn't really



Drivers believe that analysing this data can play a key role in aiding performance



work to improve myself. I'm convinced that sooner or later we'll see this having a bigger part in racing."

Ogier also believes this research can help with injury, such as concussion. He was in a high-impact accident at Rally Finland last season and was surprised at the lack of information about concussion injuries.

"I discovered that medicine still doesn't control perfectly or is not really able to analyze exactly what happens in the brain when you have an accident. For sure if the research gets better we'll be able to control more precisely, for example how long you need to rest after an impact and what is important to do if you are part of this kind of accident."

Dr Mouchlianitis agrees that further research is required, however adds that the best mental preparation comes down to personal preference, both in motor sport and in real life situations.

"All of these techniques are highly personal; some people are more responsive to

**“THE HARDEST THING WITH THIS IS FINDING THE RIGHT PROCESS TO ACHIEVE FOCUS ON A REGULAR BASIS”**

mindfulness, and others are more responsive to breathing, so they're quite variable. I think if one wants to improve their performance using these techniques, one should explore different techniques to find out what suits them best and then apply them in real life."

He believes this approach would be useful to anyone focussing on a complex task.

"It doesn't matter whether you are a skilled driver, a writer, a mathematician, a scientist, or whether you're working on a forklift; your ability to be in the zone and focus on what you are doing is a key factor in achieving a high quality performance."

Based on the results of the study, Ford's next

steps into understanding how brain activity can impact driver performance lie with the development of an EEG-enabled racing helmet.

The helmet would be capable of scanning and transmitting electrical signals from a driver's brain with the aim of one day aligning the analysis alongside driver metrics already measured by teams, such as hydration and heart rate. Work on the helmet began following the conclusion of The Psychology of Performance study, and is currently in its prototype stage of development.

For Dr Mouchlianitis, the application of mental preparation techniques both in motor sport and real-life situations is where future investigation lies, with plans in place for further research into brain performance using EEG. "Being able to actually measure what the brain does while someone is driving I think will be very exciting to see, and I think for racing teams, very valuable. But I'm very interested in finding possible interventions with how someone can improve their focus and attention and have translatable improvements in everyday tasks."

**BRAIN TRAINING**

The FIA has registered its own interest in analysing brain performance courtesy of a recently-announced partnership with bio-informatics and technology company, EMOTIV. Revealed by FIA President Jean Todt and EMOTIV CEO Tan Le at the 2018 World Economic Forum Annual Meeting in Davos, Switzerland, the project shows how neurosciences and brain sensing technologies can provide valuable information and measures on the driver's fluctuation of attention at the wheel and help develop more efficient technological innovations to improve road safety.

During the partnership's first official demonstration, 2016 Formula One world champion Nico Rosberg's brainwaves were recorded and monitored thanks to EMOTIV's portable neuroinformatics solutions while using an FIA virtual

reality driving simulator reproducing real-life driving conditions as well as difficulties and obstacles drivers often faced on the road.

The partnership is the latest distracted driver campaign launched to improve global road safety. Research carried out by the UK's Department of Transport found that one in six drivers observed by academics were found to be engaged in a distracting activity, such as talking on a phone or smoking. The study found younger drivers were more likely to be engaged in distracting activities.

In Australia, research into driver distractions has led to campaigns such as Transport for New South Wales' 'Get Your Hand Off It' campaign. Launched in 2016, the campaign was set up to combat the correlation between using a mobile phone behind the wheel and road incidents.

# INSIDE THE RESCUE VEHICLE

*AUTO+ Medical takes a look at the new safety team truck for the British Touring Car Championship*



The British Touring Car Championship has unveiled its all-new state-of-the-art 'TOCA Safety Team' truck ahead of the 2018 season.

The brand new Ford F250, specially imported from the USA for sole use at TOCA events, is equipped with the latest rescue and cutting equipment.

The truck will be deployed to any incident where needed, across all BTCC sessions and those of its supporting series', and is the only

one of its type in Europe. Following similar concepts to those used in IndyCar and NASCAR in the United States, the truck will be manned with a dedicated and fully trained TOCA safety crew and paramedic.

Martin Hunt is the permanent Safety Team Crew Chief of the vehicle, whilst TOCA Medical Director, Dr Paul Trafford, will oversee all operations.

BTCC Series Director, Alan Gow, said: "It

represents an investment of nearly £200,000 by TOCA and its partners, underlining our real and ongoing commitment to the very highest level of safety, rescue and recovery in British motor sport.

"This state-of-the-art rescue vehicle carries the very latest in cutting and rescue equipment and, most importantly, will be manned by the same dedicated crew at all events. Our team has worked with the BTCC

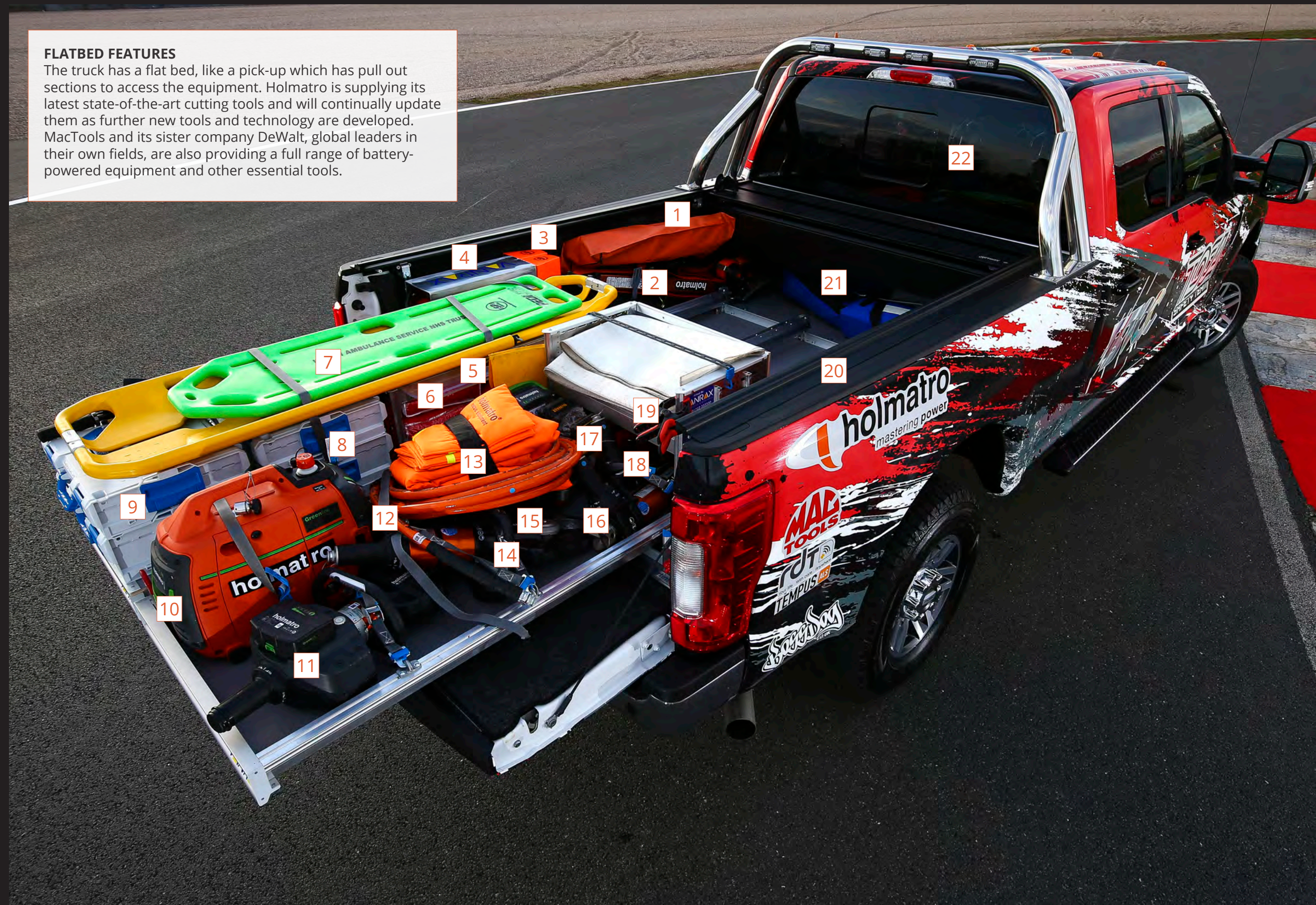
for many years and has enormous experience and expertise, being recently involved in the Billy Monger rescue and the Croft multi-car accident in 2017."

TOCA Medical Director, Dr Paul Trafford, said: "TOCA has always supported the safety initiatives we have made over the years and the 'TOCA Safety Team' rescue truck is going to make a huge difference to our ability to respond to any serious incidents."

- 1 KED
- 2 Holmatro V-Strut stabilisation struts
- 3 Head immobilization blocks
- 4 2 AFFF Fire extinguishers
- 5 Vacuum Extrication Vest, 10 litres of fresh water
- 6 Foam kneeling pads, 2 cotton cellular blankets
- 7 Scoop stretcher and Paediatric spinal board (for use in single-seater extractions)
- 8 Tool boxes containing MAC Tools hand tools and 2 DeWalt 54v Angle Grinders
- 9 Tool boxes containing DeWalt Inspection Camera, Multi-tool (Helmet Saw), Drill and Impact Wrench
- 10 Holmatro SPU 16 BC Battery Pump
- 11 Holmatro self-contained battery Combi Tool GCT 5111 Evo 3
- 12 Holmatro CORE hose
- 13 Holmatro sharp edge protection set
- 14 Holmatro CU 5040 i CL Inclined Cutter
- 15 Holmatro SP 5240 CL Spreader
- 16 Holmatro TR 5340 LP & TR 5370 LP Hydraulic rams
- 17 2 DeWalt 54v Reciprocating saws
- 18 Holmatro HMC 8 U Pedal cutter
- 19 Tarpaulins, various towing and stabilizing straps
- 20 Holmatro Tool Station, Hi-Lift First Responder Jack
- 21 Extrication, self-heating and insulating blankets
- 22 RDT Tempus Pro & Tempus LS, Suction unit and medical bag (inside cab)

**FLATBED FEATURES**

The truck has a flat bed, like a pick-up which has pull out sections to access the equipment. Holmatro is supplying its latest state-of-the-art cutting tools and will continually update them as further new tools and technology are developed. MacTools and its sister company DeWalt, global leaders in their own fields, are also providing a full range of battery-powered equipment and other essential tools.



THE ROAD BACK:

# PETTER SOLBERG

*The World Rallycross star reveals how he returned to the track less than two weeks after having surgery on a broken collar bone following heavy crash*

During the Latvia round of the 2017 World Rallycross Championship, reigning champion Petter Solberg suffered a heavy crash with fellow competitor Janis Baumanis at the Bikernieki track's second corner. The collision saw Baumanis hit the left-rear of the Swedish driver's Volkswagen Polo GTI RX, sending him into a spin and out of the race. Solberg suffered a broken collarbone, two fractured ribs and a bruised lung in the incident. The 43-year-old underwent surgery to repair the collarbone and remarkably returned to the wheel of his WRX car at the next round of the season at the Estering, Germany, just two weeks later, enabling him to pick up enough points to finish third in the final championship standings. He spoke to AUTO+ Medical about the incident and his recovery.

**AUTO+ Medical: What happened during your crash in the 2017 Latvia RX round?**

**Petter Solberg:** Coming into the first corner Loeb touched me a little bit on the back end and I got sideways on the way into the next corner, and the other driver [Baumanis] touched me in the back corner and smashed me around. It just happened so quickly – it felt like I was on a roulette wheel. And then I just felt a massive amount of pain; that feeling straight away was quite special.

**A+M: Did you know immediately that you were hurt?**

**PS:** Yes for sure. I was screaming like hell, and then I understood that it was something with the shoulder, with the collarbone and also down to my back, and that was obviously the two ribs. The collarbone was 4cm over each other on the picture [x-ray]. The pain to get out of the car was tremendous – it's hard to explain. As soon as they touched me to lift me out of the car or remove my helmet the pain went straight into the collarbone. It was almost at the point where they had to cut the roof for me to get out and I was thinking: 'bloody hell, they can't

Solberg had to wear a Kevlar piece for his shoulder to stop further damage



Two weeks after his operation Solberg was back for the final round in Germany

do that', and then I just came out, I couldn't stand on my feet properly because of the pain. I think it's the worst ever accident I have had in all my career.

**A+M: What treatment did you receive immediately after the accident?**

**PS:** Well, first of all the Latvian hospital was not very good. The guy who helped me the most was the FIA doctor Jean Duby, but he couldn't come into the hospital to speak English, and they

[hospital staff] didn't know exactly what happened to me so they were just throwing me from bench to bench.

So I took a private plane back home straight to the hospital in Sweden and I had three doctors around me. Two had said 'no, you can't drive, it's impossible with your ribs, lung and collarbone', but another said 'well maybe it's possible'. I brought that doctor with me [to Germany] because he was positive - his name is Dr Klas-Göran Gravander, and he has a lot of

experience of working in speedway, where collarbone injuries are common. Then I had an operation one week after [the crash], putting in the plates and bolts and everything into the collarbone.

**A+M: How did you manage your recovery process following the operation?**

**“I COULDN'T STAND ON MY FEET PROPERLY BECAUSE OF THE PAIN. I THINK IT'S THE WORST EVER ACCIDENT THAT I HAVE HAD IN MY CAREER”**

**PS:** I woke up on Tuesday morning [after the operation] and I had a motorhome outside the hospital to jump straight into and lie down and drive straight over to Germany, so I didn't have to move around so much. At the end of the treatment I had a machine with me to use on the shoulders and the ribs to heal it faster. It was an infrared system to get the blood circulation going.

I got moulded a Kevlar piece for my shoulder and padding so I could put it on the seatbelt for the next race so nothing happened basically to damage the collarbone. But the treatment was just to take the motorhome [to Germany], relax and take the tablets that I was allowed to take because of the anti-doping regulations.



Despite the Kevlar brace, Solberg broke another rib during a heat race in Germany



I didn't take anything else other than paracetamol every eight hours, because I know when I came into Germany if I drive, I could be randomly dope tested, so we were very careful exactly with everything that I did both from the doctor's side and my own side, so everything was correct to rules.

**A+M:** You made your return to the car at the World RX round at the Estering, Germany, just two weeks after the initial accident. How did you feel when you first got back in the car?

**PS:** Well, it was only pain. First of all I had to show the FIA guys that I could go in and out from the car to show that it was no problem before the race. So they came for the inspection, it was very professional in how they did it and I think it was the right thing to do.

I was a little bit scared to be hit in the back into the first corner, so I tried to avoid any fights or anything at all. I was really tired between every heat; I'd go straight to bed, sleep, relax, and then go out in the car again. I didn't do any interviews or anything, I just tried to get through that race as quick as possible.

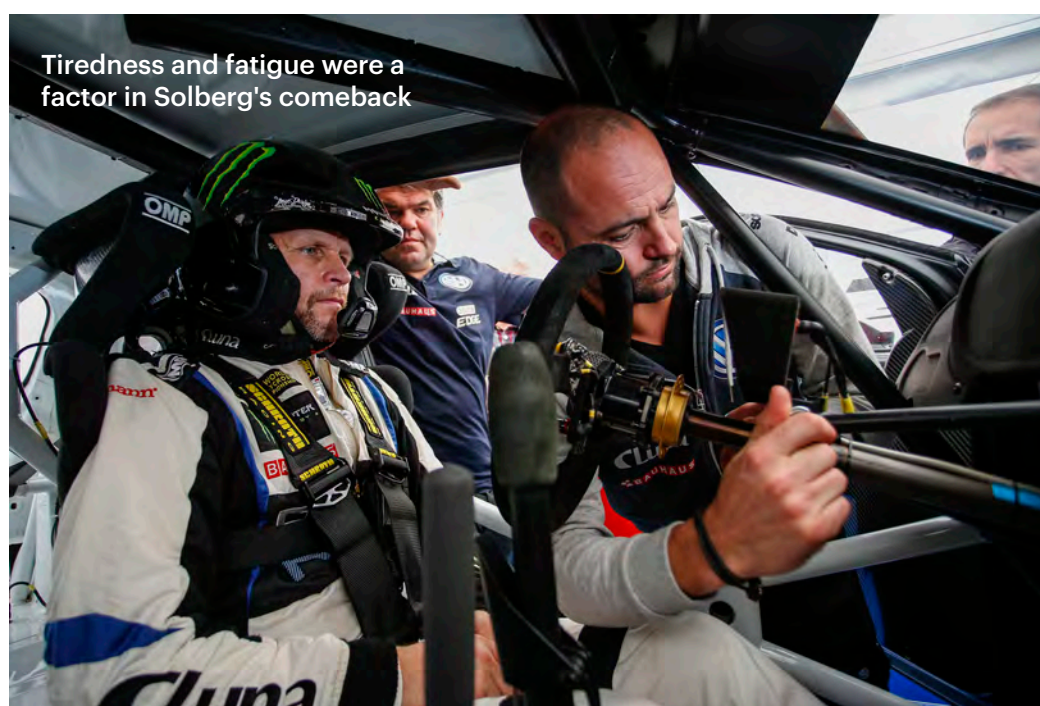
**A+M:** You broke another rib in your first heat in Germany, how did that happen?

**PS:** Yes, because one was cracked and then I broke it completely because I hit a gravel bank, so it was moving like hell. We taped the whole stomach, all around my back and everything to try and get the support, but it didn't help with that, and then I just continued driving again. I still won that heat, and the whole thing ended up like a crazy story because I was the fastest qualifier after four heats.

Before the final I was so tired, so I did a lot



Solberg finished third overall in 2017 thanks to his swift recovery



Tiredness and fatigue were a factor in Solberg's comeback



Despite his injuries, Solberg was still the fastest qualifier of the weekend

**“I WAS REALLY TIRED BETWEEN EVERY HEAT; I'D GO STRAIGHT TO BED, SLEEP, RELAX, AND THEN GO OUT IN THE CAR AGAIN”**

of mistakes because of the pain and the tiredness, so even after being first into the first corner, I was pushed a little bit by [Mattias] Ekström and then I came out in fourth. But at the end of the day that gave me the [third place] medal for the championship.

**A+M:** What advice would you give to drivers suffering similar injuries in the future?

**PS:** I think the only thing is that you need good people around you who are perfectionists, and doctors who understand that you have to drive, and then to have the right people around you to believe in what you're doing. So many people told me not to do it, but it's all up to you and how much pain you can handle without doing anything with bad medicine to hide it. That 14 days are going into the memory book for myself. It's more a test of how much do you want to do things, and you see that everything is possible if you want to.

**A+M:** What feedback do you have for the paramedics and doctors who treated you throughout the recovery process?

**PS:** I am so happy with them. Everything works perfectly. My arm is perfect from the collarbone, and my ribs are perfect. I still have something with the lung, but we've been treating it so I'm sure it'll be ok.



Less than five hours into the 2012 Le Mans 24hr race, Anthony Davidson's Toyota TS030 hybrid LMP1 car attempted to overtake one of the AF Corse Ferrari 458s, but collided with the rear left suspension. The Toyota slewed sideways and took off. After a combined end-over-end roll, the car landed and slid head-on into the tyre barriers. Davidson extracted himself, but only made it onto the side pod before realising he had injured his spine, and decided not to move further. It transpired that he had crushed vertebrae T11 and T12, just above the interface between the thoracic and lumbar sections of the spine.

While it was not clear which of the series of impacts had caused the damage, the vertical landing or the frontal impact, the FIA was already alerted to a problem in LMP cars by the Guillaume Moreau head-on crash in an LMP2 car, at the Le Mans Test the same year. He too had injured his T12 vertebra in a purely frontal impact.

Spinal injuries are very difficult to research using anthropomorphic dummies (Hybrid III and THOR) and Hi-Ge sleds, as the dummies were not developed for such research and the representation of the spine is not particularly biofidelic; the rigid mechanism used prevents flexure other than for adjusting seating posture.

The FIA, through the FIA Institute, approached the Toyota Motor Company (TMC) via its motor sport arm in Cologne, seeking cooperation to research the cause of spinal injuries in frontal impacts, using TMC's sophisticated Finite Element (FE) model of the human body: Total Human Model For Safety (THUMS).

In early April last year, Toyota presented a paper to the Society of Automotive Engineers (SAE) World Congress, which describes the

work carried out by TMC in this cooperation (SAE Paper: 2017-01-1432: Analysis of Driver Kinematics and Lower Thoracic Spine Injury in World Endurance Championship Race Cars during Frontal Impacts. Authors: Tadasuke Katsuhara, Yoshiki Takahira, Shigeki Hayashi, Yuichi Kitagawa, Tsuyoshi Yasuki).

Over 6,500 spinal injuries occur in car crashes annually in the United States, according to the National Spinal Cord Injury Statistical Center (NSCISC), and a tendency for these to occur in frontal impacts is reported. In motor sport the overall injury rate is much lower, but Dr Terry Trammell et al have reported that in IndyCar, a high proportion of injuries are spinal injuries, particularly in frontal and rear impacts into the relatively stiff walls around high-speed ovals.

With the difficulties experienced when using dummies for spinal injury research, driver kinematic models such as MADYMO have been employed in simulations. While useful in studying the kinematics and loadings they do not possess the detail necessary to evaluate the stresses and strains on individual bones or organs that allow injury severity to be assessed. TMC has created the industry standard FE model of the human body, THUMS, in a joint development between Toyota Central R&D Labs Inc. and Toyota Motor Corporation, over a period of more than 20 years. THUMS is used widely by the automobile industry in its many versions.

**“ IN INDYCAR, A HIGH PROPORTION OF INJURIES ARE SPINAL, PARTICULARLY IN FRONTAL AND REAR IMPACT INTO STIFF WALLS ”**



THUMS Version 4 was employed in the WEC research, scaled to driver size and incorporated into an FE model of the cockpit, including:

- Seat and head surround
- Harness
- Helmet
- HANS
- Steering wheel
- Pedals

The total number of elements in the model was 2.2 million.

As LMP1 cars employ two or three drivers for each event, a small and a large driver were modeled, along with their seat mouldings. The seating positions of the drivers, and most importantly their initial spine geometries were established by MRI scanning Anthony Davidson and Alex Wurz (Driver A and Driver B), whilst they sat in their seats in their correct driving positions.

**Table: 1.** Comparison between Driver A, Driver B, and 50% THUMS human model.

	THUMS Version 4 AM50	Driver A	Driver B
Height [cm]	177	160	185
Weight [kg]	74	55	80

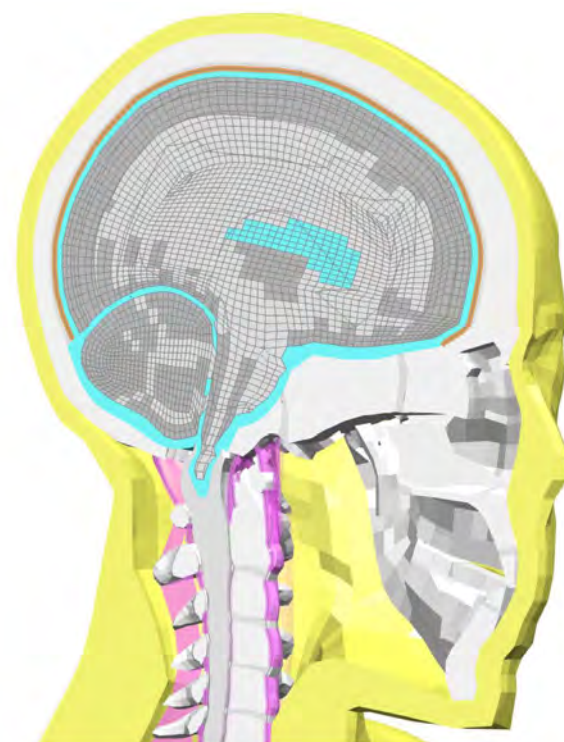
In the initial study, a number of deceleration pulses were evaluated, combining vertical and longitudinal components. For the work covered by the SAE paper, the SFI Specification 38.1 pulse is used, peaking at 70g longitudinal deceleration after around 50ms, this pulse is used as a certification pulse for testing most top-end driver safety equipment, and thus is judged to be survivable without serious injuries, providing the approved equipment is fitted correctly.

THUMS can analyse the impact of internal organs such as lungs, heart and liver



A single run of the simulation, which lasts around 150ms in real time, takes about 24hrs of computational time. The output of the model includes the motion of each component of the skeleton and the organs, the forces and pressures and, particularly relevant to spinal injury, the axial force and bending moment of the spine. The cross-sectional area and section modulus of the cortical bone of each vertebra were calculated for each of the two drivers, and thus the actual force and bending moment components of the spine stress could be calculated, and finally the spine stress of each individual vertebra. Based on biomechanical research on bone fractures, it was postulated that bone fracture occurred when the ultimate strain of the shell element of the cortical bone exceeded 3%.

The harness, HANS, and seat provide the reacting forces to restrain the body masses. The forces in the system and how they are applied to the body are also input to the THUMS model.



THUMS version 3 added detailed modelling of the brain

**“OVER 6,500 SPINAL INJURIES OCCUR IN CAR CRASHES EVERY DAY ACCORDING TO THE NSCISC”**

The base parameters for initial runs were:

**Table: 2.** Cockpit and restraint geometry for initial runs, Driver A and Driver B.

Case No.	1	2
Driver	Driver A	Driver B
i) Shoulder belt angle	-20 deg	-20 deg
ii) Seat back angle	35 deg	35 deg
iii) Crotch belt anchor position	Rearward	Rearward
iv) Shape of leg hump	Decline (40 deg)	Decline (40 deg)
v) Seat pad thickness	60 mm	None
vi) Seat pad stiffness	0.3 MPa	None

The main difference between the two drivers seating positions is the foam seat insert. With a prescribed eye height and pedal position, Davidson had to stretch himself out, by straightening his body and raising his backside.

The results indicated T11 and 12 fractures on Driver A, giving confidence that they

correlated with Davidson’s actual injuries. Of concern were the results for the large driver, which suffered fractures of T11, T12, L1, L2 and L3. The simulations graphically showed why these injuries were occurring and the mechanisms that caused them. Time histories of the motion of the head chest and pelvis, in three dimensions, show that there is almost no motion for the first 30ms (peak g at 50ms) and reach their most forward position at around 70ms. Maximum excursions for Driver A in each of the three axes were:

**Table: 3.** Maximum excursion of head, chest and pelvis of Driver A.

	x-axis	y-axis	z-axis
Head	250mm	10mm	110mm
Chest	150mm	20mm	100mm
Pelvis	100mm	5mm	-25mm

The head of Driver B moves forward slightly further than Driver A.



The pelvis is restrained in the x-direction by the seat ramp and rearward mounted crotch belts, the ramp causing the pelvis to rise. The chest moves forward and downward, causing the spine to flex, reacting against the relatively unmoving pelvis to add the compression force. The combined flexure and compression concentrates the stress on the anterior (forward) part of the vertebrae around the area of maximum flexure – the interface between the thoracic and lumbar spines. Forward movement of the shoulders under the shoulder belts creates tension loads in the belts, the resultant of which is a downward force almost directly along the spine. This creates the compression force that ultimately does the damage to the lower spine. When the spine is straight (upper

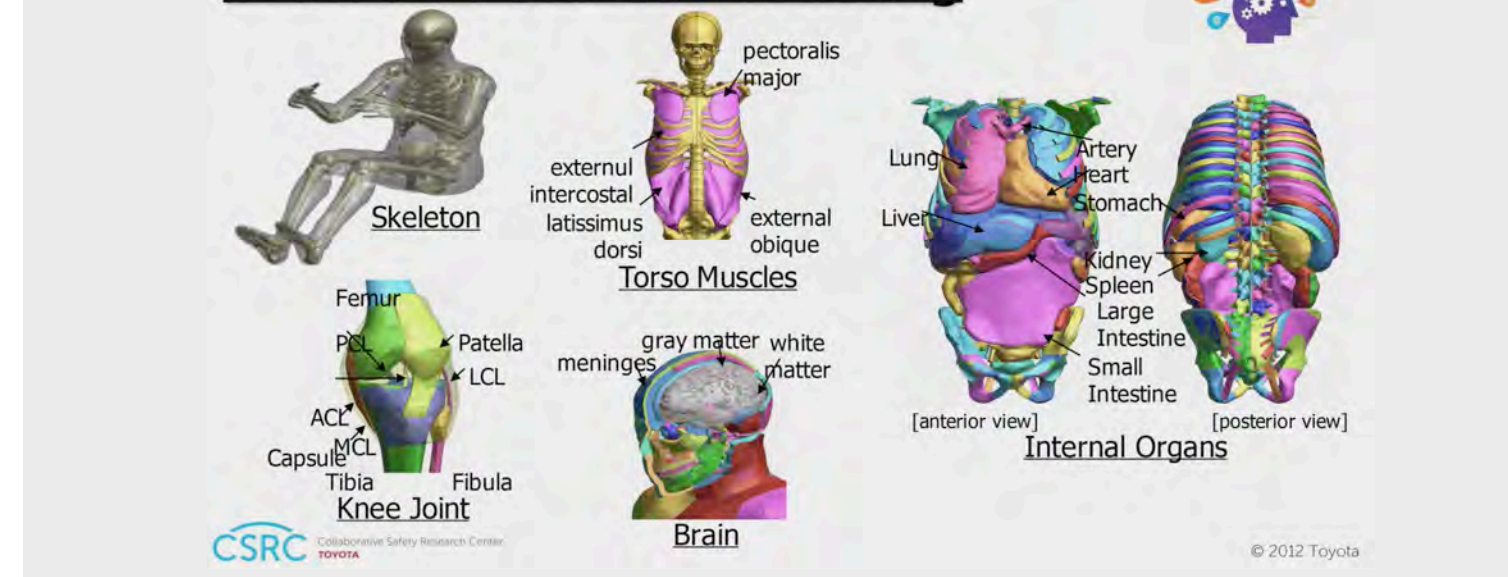
**“THIS WORK REACHED A SATISFACTORY CONCLUSION AND DEEPENED THE UNDERSTANDING OF SPINAL INJURY IN MOTOR SPORT”**

thoracic) it is able to withstand the compression without damage.

Driver B was susceptible to greater compression and bending loads. The partial reason for this is his greater mass.

The development of countermeasures focused on three key features that it was considered contributed to the high bending

## THUMS Detailed Modeling



and compression loads:

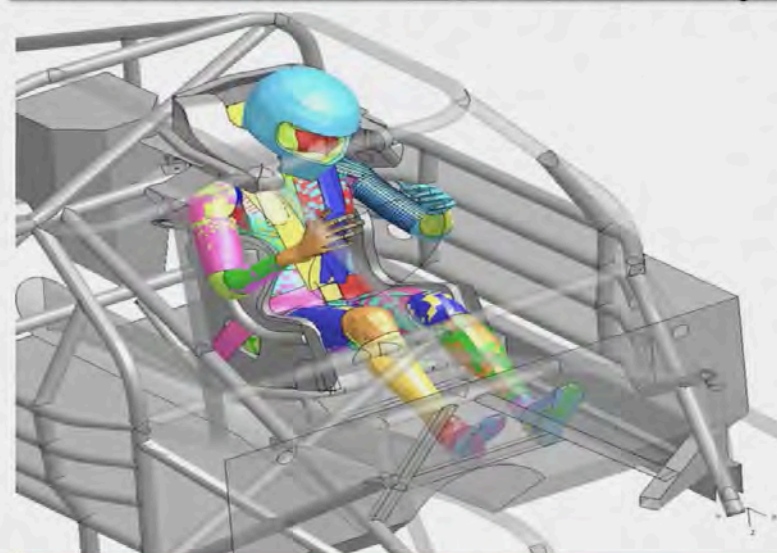
- Pelvis restraint
- Seatback angle
- Shoulder belt geometry

Allowing the pelvis more forward motion, reducing the forward motion of the torso,

and reducing the downward component of the shoulder belt loads should reduce the likelihood of spinal injury.

A series of cases were developed (Table 4), concentrating on Driver A, but with Driver B assessed at the end once a solution for Driver

## NASCAR® THUMS Application



Toyota conducted a safety research study with NASCAR® investigating driver injury and mechanism in stock car racing.

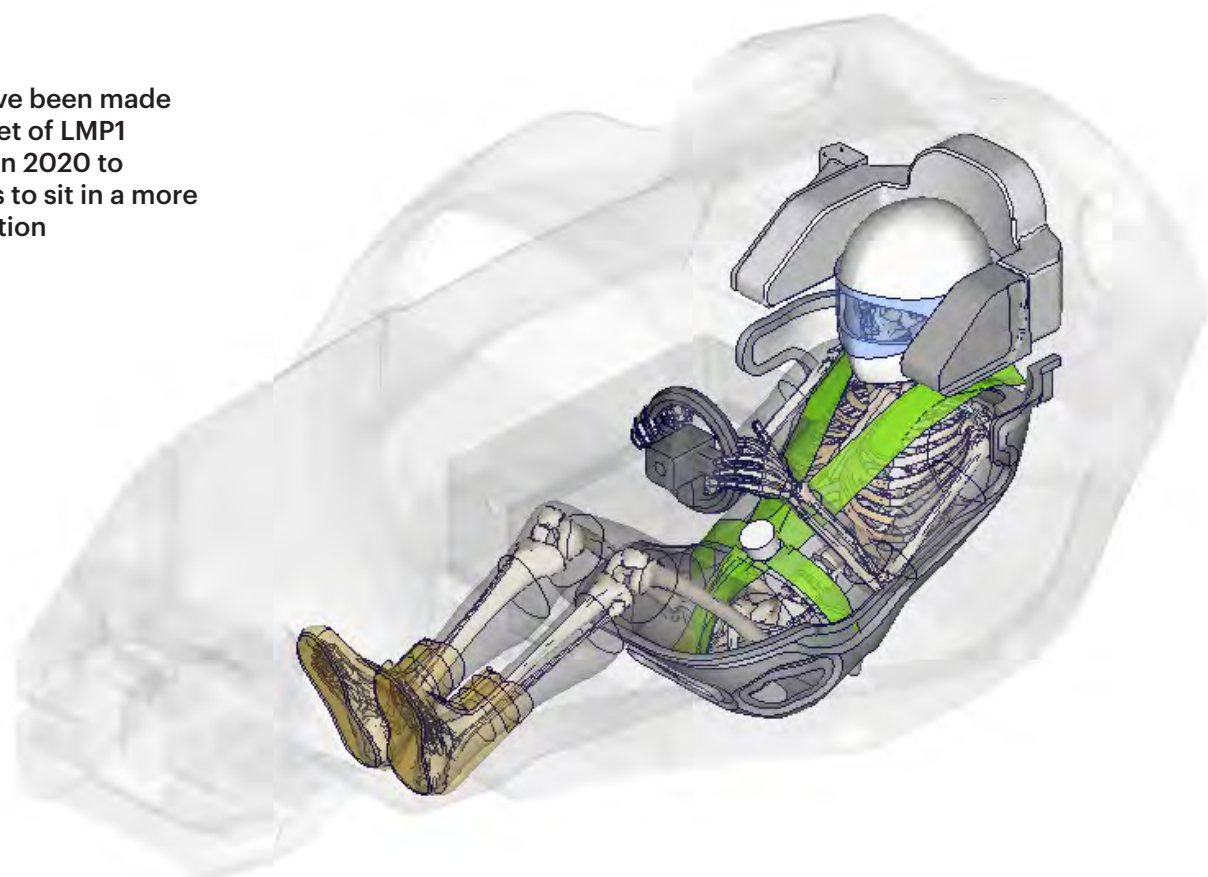
(Rib fractures were observed under certain conditions)

The Study resulted in some recommendations for modifying the cockpit/seat structure to help reduce injury risk.

**Table: 4:** Number of bony fractures and maximum value of T12 stress for all cases.

Case No.	1	2	3	4	5	6	7	8	9	10
Driver	Driver A	Driver B	Driver B	Driver B	Driver B	Driver B	Driver B	Driver B	Driver B	Driver A
i) Shoulder belt angle	-20 deg	-20 deg	0 deg	-20 deg	0 deg	0 deg	0 deg	0 deg	0 deg	0 deg
ii) Seat back angle	35 deg	35 deg	35 deg	55 deg	35 deg	55 deg	55 deg	55 deg	55 deg	55 deg
iii) Crotch belt anchor position	Rearward	Rearward	Rearward	Rearward	Rearward	Rearward	Forward	Forward	Forward	Forward
iv) Shape of leg hump	Decline (40 deg)	Decline (40 deg)	Decline (40 deg)	Decline (40 deg)	Decline (40 deg)	Flat (0 deg)	Flat (0 deg)	Decline (40 deg)	Decline (40 deg)	Decline (40 deg)
v) Seat pad thickness	60 mm	None	None	None	76.2 mm	76.2 mm	76.2 mm	76.2 mm	76.2 mm	76.2 mm
vi) Seat pad stiffness	0.3 MPa	None	None	None	0.3 MPa	0.3 MPa	0.3 MPa	0.3 MPa	0.2 MPa	0.2 MPa
Chest deflection rate	5 %	6 %	6 %	5 %	10 %	12 %	18 %	15 %	16 %	15 %
Number of spine fracture	2	5	5	5	4	3	2	1	0	0
Pelvis fracture	None	None	None	None	None	Pelvis fracture	Pelvis fracture	None	None	None
Maximum spine stress	60.0 MPa	85.6 MPa	77.6 MPa	72.3 MPa	68.7 MPa	68.4 MPa	49.3 MPa	41.4 MPa	40.9 MPa	32.6 MPa

Changes have been made in the next set of LMP1 regulations in 2020 to allow drivers to sit in a more upright position



A had been achieved.

The optimum set-up, Cases 9 and 10, with horizontal shoulder belt mounting; 55° seatback angle; forward crotch belt mounting; and the seat ramp retained, but with a thick, soft cushion to allow movement, generated no spine fractures in either Driver A or Driver B.

Maximum spine stress was reduced by 32% for Driver A and 62% for Driver B. Note that in Cases 6 and 7, where the seat ramp has been flattened to horizontal, all the restraint of the pelvis is provided by the crotch belts, and results in fracture of the pelvis.

These modifications to the seating and restraint geometry of an LMP1 driver require raising the roof of a closed car to allow for the more upright seating position. Planned for 2017 as part of a major LMP1 regulation package, they have now been delayed to

2020 for cost-cutting reasons at the behest of the remaining manufacturers.

This work reached a satisfactory conclusion and deepened the understanding of spinal injury mechanisms in motor sport, particularly in frontal impacts with reclined seating positions. It'll be some years before it can be seen statistically whether the countermeasures prevent such injuries, but perhaps the greatest value of such cooperative work lies outside motorsport, whilst highlighting how the sport can make a significant contribution to road car safety. Toyota has spent two decades developing the industry standard for an FE model of the human body for vehicle safety research; it has been widely adopted by the industry and research labs and is replacing the anthropomorphic dummies for R&D, if not yet certification.

It is of enormous benefit to motor sport safety to be able to use this simulation model; in return, motor sport provides specific and highly detailed cases of accidents and resulting injuries. The vehicle and driver are instrumented, and there is often video footage of the accident, sometimes even high-speed video of the driver dynamics. Detailed medical data concerning the injuries is usually available and the driver nearly always cooperates in any post accident investigation, maybe involving MRI scans.

All combined, these cases present an opportunity to validate THUMS analysis and will inevitably contribute to the further development of THUMS. The accelerations

and forces generated by motor sport impacts are at the upper limit of survival and generate extreme conditions for the simulation. The cooperation between TMC and the Global Institute, which has succeeded the FIA Institute, will continue in order to widen the knowledge of spinal injury causes across all forms of motor sport.

**“TOYOTA HAS SPENT TWO DECADES DEVELOPING AN INDUSTRY STANDARD FE MODEL OF THE HUMAN BODY FOR SAFETY RESEARCH”**



In IndyCar, a high proportion of injuries are spinal injuries due to impacts into the relatively stiff walls around high-speed ovals.

# + CALL FOR SUBMISSIONS

*Every issue of AUTO+ Medical contains a scientific research paper that looks at the various medical issues that surround motor sport.*

**All submissions are welcome so if you have a study that you feel would be suitable for publication in future issues of AUTO+ Medical, please send it to:**  
**medical@fia.com**

**For each submission please include a summary of the research and all necessary contact information.**

**The editorial board will evaluate each submission before it is accepted for use in the magazine.**

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**Dr Robert Seal**  
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**Dr Matthew Mac Partlin**  
(Assistant Chief Medical Officer, Australian GP)

**Dr Pedro Esteban**  
(FIA Medical Delegate, World Rallycross Championship)

**Dr Jean Duby**  
(FIA Medical Delegate, World Rally Championship)

**Dr Kelvin Chew**  
(Chief Medical Officer, Singapore GP)

**Dr Dino Altmann**  
(Deputy President, FIA Medical Commission)

