THE SCIENCE OF SAFETY

Traumatic times helped propel NASCAR's pursuit of safety advances, as **Andrew Charman** reports

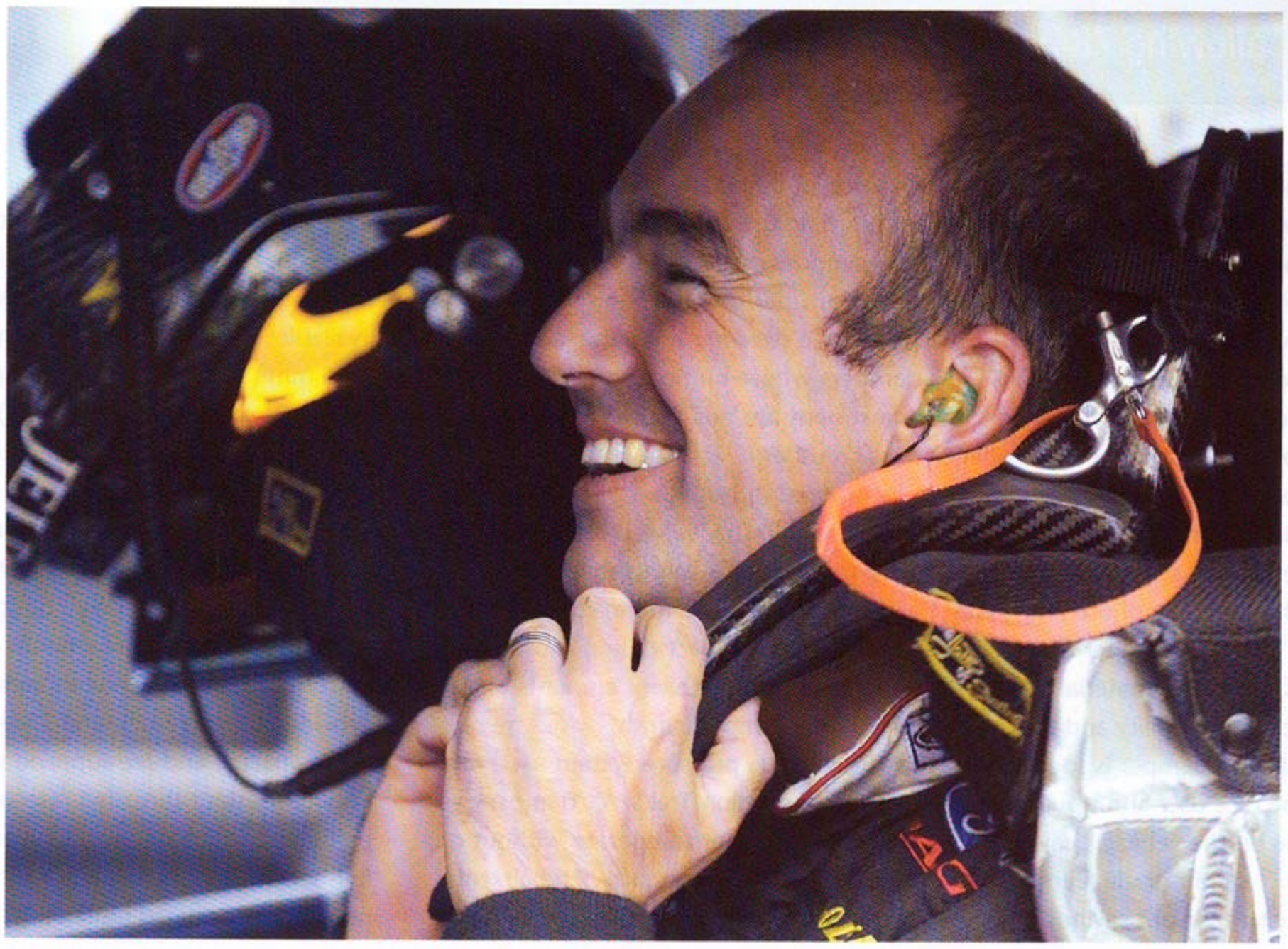
FEBRUARY 18, 2001. On the final lap of NASCAR's blue riband race the Daytona 500, seven-time champion Dale Earnhardt's Chevrolet is tapped into a head-on, but seemingly not heavy, impact with the outside wall of the speedway, before spinning down into the infield.

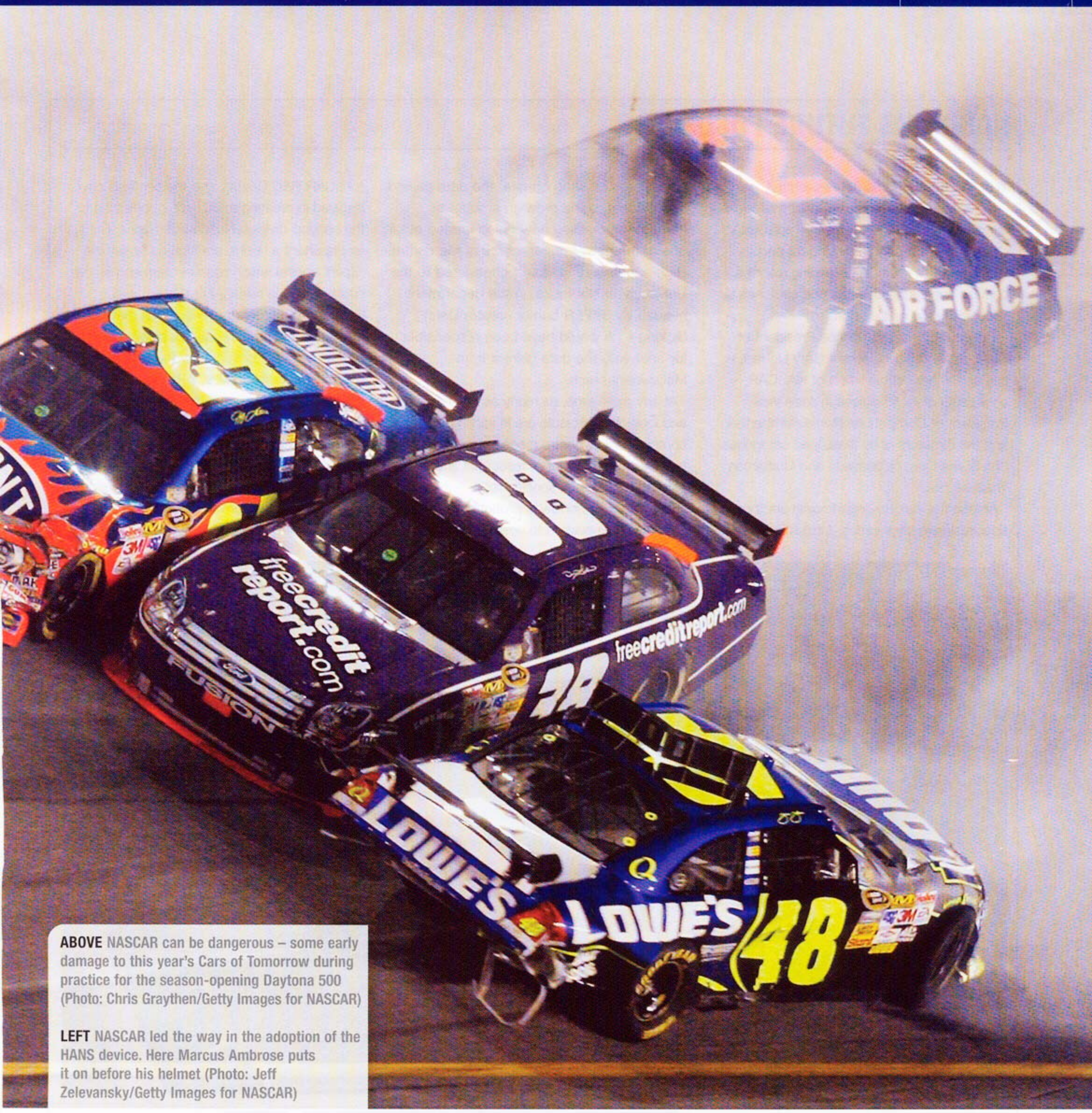
> ' The battle for safety can never be considered won '

April 4, 2008. Rookie Michael McDowell suffers a failure on his Toyota Camry during qualifying for the race at Texas Motor Speedway. The car turns hard right into the outside wall and rebounds to slide upside-down along the track followed by a dramatic series of eight barrel rolls, coming to rest totally wrecked.

In the accident at Daytona Earnhardt received fatal injuries. Seven years on, McDowell walked away from what looked a far heavier crash. Following a medical check up, he switched to a backup car and completed the 500-mile race two days later. And while perhaps a direct comparison between the two accidents is unfair, the shock waves that followed the death of one of NASCAR's greatest stars on that dark day at Daytona led directly to the safety measures that were crucial to protecting McDowell from serious injury. The barrier he hit, the head restraint he was wearing, and even the car he was driving came from a safety drive accelerated by NASCAR in the wake of Earnhardt's death.

NASCAR has always been a category of high velocity and consequently large accidents – its races are held on banked tracks where speeds can routinely touch 200 mph, and where





ABOVE NASCAR can be dangerous – some early damage to this year's Cars of Tomorrow during practice for the season-opening Daytona 500 (Photo: Chris Graythen/Getty Images for NASCAR)

LEFT NASCAR led the way in the adoption of the HANS device. Here Marcus Ambrose puts it on before his helmet (Photo: Jeff Zelevansky/Getty Images for NASCAR)

a mistake usually produces a hard impact with a concrete wall. There had of course been injuries and deaths before, culminating in a traumatic year in 2000 when both Adam Petty and Kenny Irwin died on the same corner of the New Hampshire track within three months of each other and Tony Roper also met his death. But the loss of Earnhardt, NASCAR's most bankable name, shocked the sport into serious action, and one of the first apparent results was the opening in 2003 of a new Research & Development Centre in NASCAR's spiritual home, Concord, near Charlotte in North Carolina.

Yet the R&D Centre was already several years old – NASCAR had decided to set up such a facility in 1996, to take charge of firstly improving safety but also keeping competing costs down and improving the quality of racing. Previously achieving these three aims had mainly been placed in the hands of the teams, working on initiatives jointly created by NASCAR and the then three competing manufacturers.

The NASCAR R&D Centre opened in Concord in 2000 and in January 2003 moved into the current $10 million facility (the biggest single spend in NASCAR's 10-year $50 million investment in those three core aims), beginning to develop a new, safer race car. The Car of Tomorrow (COT) debuted in NASCAR's top category, the Sprint Cup, a year ago, became mandatory for every race from this season, and will spawn a version for the second-division Nationwide series by 2010.

In recent coverage of the COT its safety aspects have perhaps been slightly obscured behind other factors such as the cost-cutting resulting from building fewer cars, or the complications of adapting to a new aerodynamic package.

There is little doubt, however, that the COT ▸

NASCAR'S FUTURE FOCUS

THE CURRENT NASCAR Research & Development Centre is a $10 million bespoke facility stretching across 16 acres adjacent to Concord Airport and employing 52 people. While safety research is its leading role, the centre's remit is much wider and stretches far beyond the top of the sport.

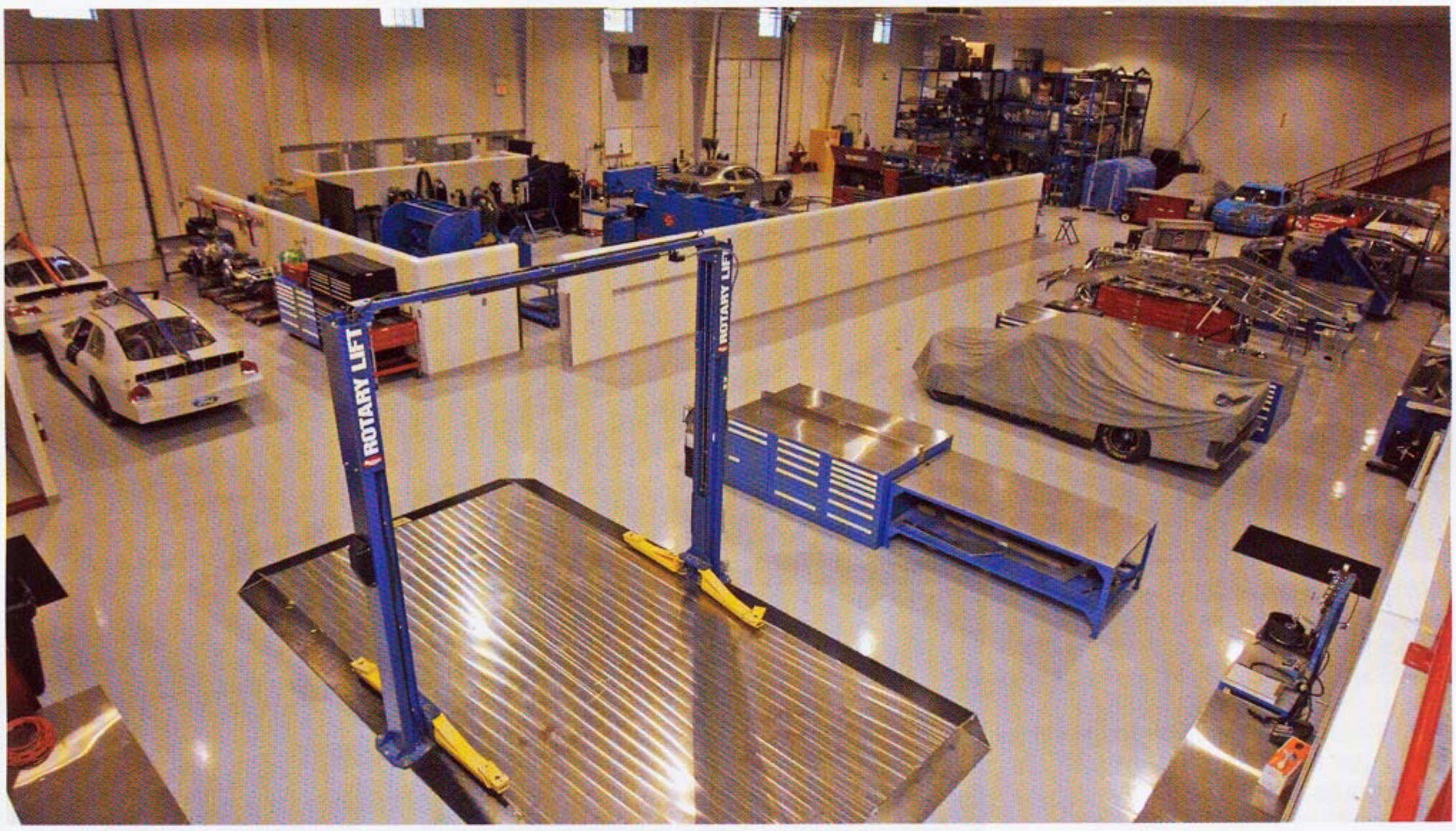
The centre, headed by Vice President of Research and Development Gary Nelson, is effectively the technical hub of NASCAR – occupants of its 53 offices include Vice President of Competition Robin Pemberton and the directors of all three lead categories (the Sprint Cup, Nationwide and Craftsman Truck series).

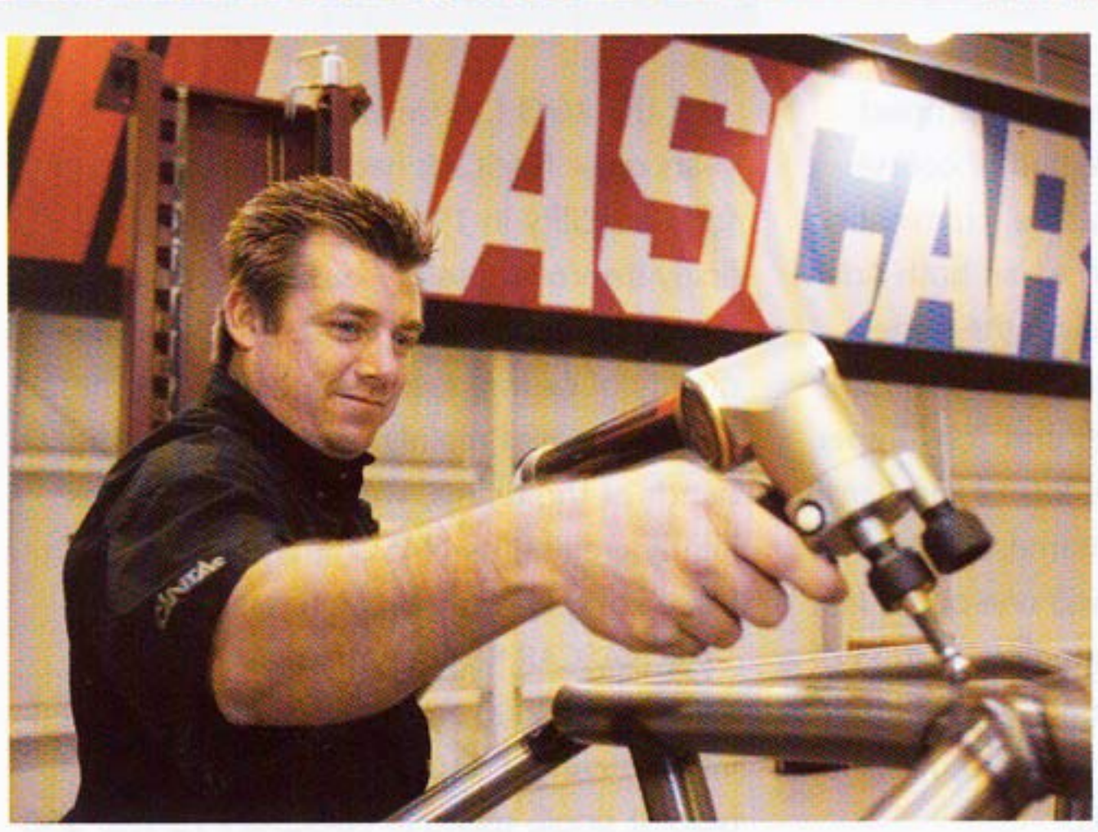
Among the various departments are those specialising in engineering, fabrication, CNC machining, fluid dynamics and powertrain measurement. Any team building a new chassis must bring it to Concord for certification before it can be raced, the process involving laser and ultrasonic testing ranging from general dimensions to metal thicknesses – to date more than 1100 have been checked, with just 10 per cent failing. Any new part, from an anti-roll bar to an engine, must be approved here before it can go anywhere near a race weekend. And when teams push the rules too far, it is in a secured room at the centre where confiscated parts or even cars are impounded.

Another part of the facility investigates accidents – the centre can perform low-speed crash testing on-site, the data gained contributing to the growing amount of computer modelling now being carried out in one of the newer departments at the centre. High-speed testing is sub-contracted to the University of Nebraska, in the department headed by SAFER barrier creator Dean Sicking – he would have been responsible for analysing the data gained from McDowell's crash.

At any given time, as many as 20 short-term and long-term projects are in varying stages of completion and centre management constantly prioritises the amount of resources and time earmarked for each specific task.

The Car of Tomorrow is probably the most high profile innovation to emerge from the NASCAR R&D Centre, and the centre is now involved in creating a COT for introduction to the second-division Nationwide Series. But just as important a centre creation has been the 'Spec' engine which has cut team engine costs by half in NASCAR's Whelen and Camping World feeder series, thus maintaining the ladder towards the sport's highest levels. And a demonstration of how the centre covers the full spectrum of NASCAR's operations is the fact that Director of Cost Research Brett Bodine, another important official based at the Concord facility, spends a major portion of his time heading a committee that approves the suitability of drivers to compete in the various championships – from the weekly touring series right up to Sprint Cup. RT





ABOVE & LEFT Inside the NASCAR Research & Development Centre. Above, the facilities are to say the least extensive – this is the main fabrication bay. Left, every new NASCAR chassis is certified to the finest tolerances at the R&D Centre (Photos: NASCAR)

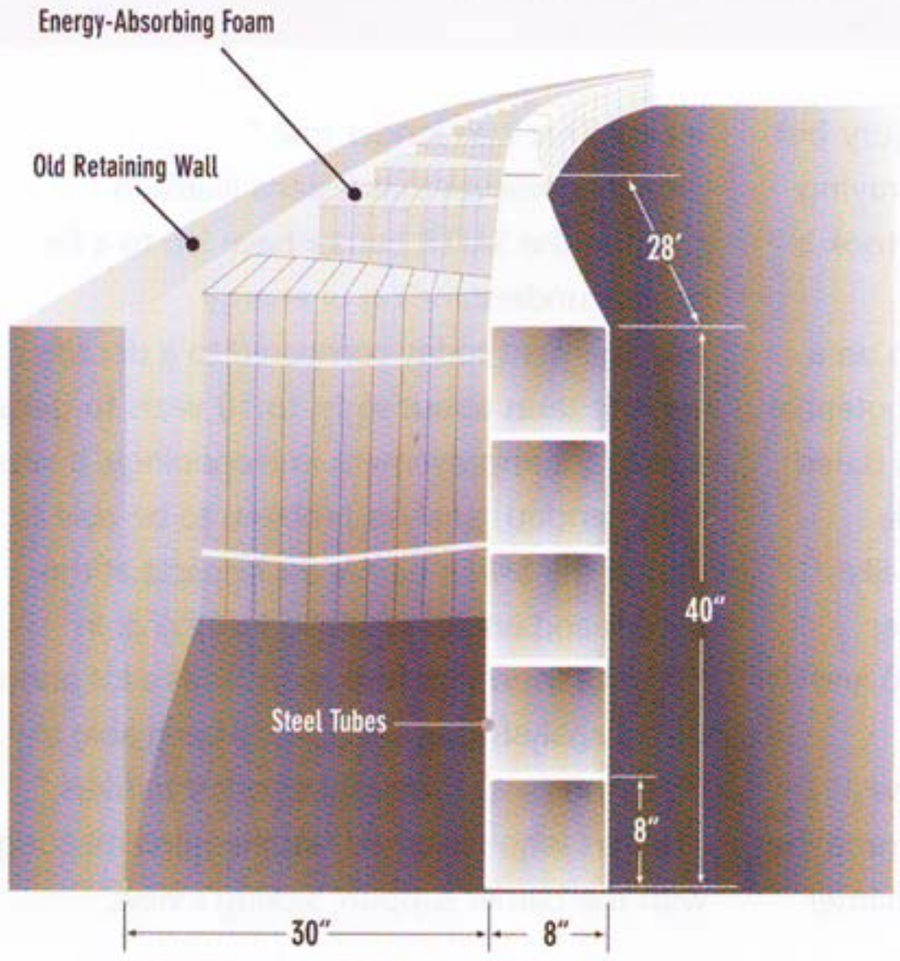
is a safer car than its predecessor, in obvious and less obvious ways. The larger cockpit area makes driver extraction easier in an accident. Said driver sits closer to the cockpit centre line further away from that wall. A combination of extra frame bars and steel protective plate protects his side of the car, along with several centimetres of foam-based padding. Similar padding surrounds the fuel tank.

Less obvious advantages focus on that aerodynamic package, which has enabled drivers experiencing a rear-end breakaway to straighten up the car and carry on racing – to the unalloyed surprise of said pilots. Previously such a slide would almost always end in that wall. Despite repetitive driver complaints over the COT's lack of grip, at high speed the cars display such 'stickability' that at this year's Talladega superspeedway race, drivers were able to 'bump-draft' each other for much longer, cars circulating for much of each lap in pairs glued together nose to tail.

NASCAR's safety drive has focused far beyond the cars, however, and a prime area to address was that wall. On NASCAR's corners concrete has always been preferred to Armco barriers and tyres – bouncing a car back out into a 200 mph pack is never a good idea. But it required looking elsewhere in American racing to find a way of making impacts with that wall less unyielding.

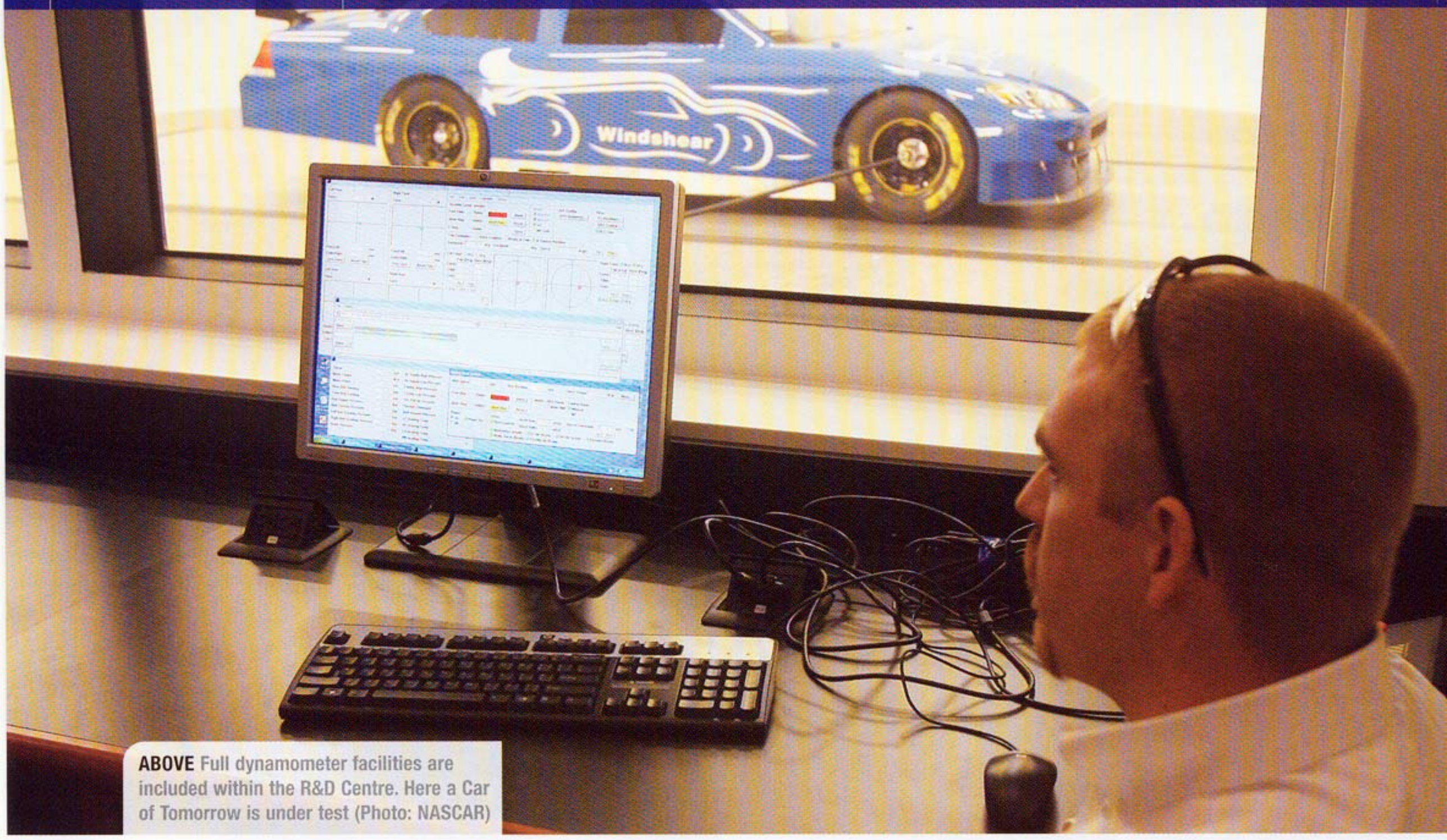
Tony George, owner of the Indianapolis Motor Speedway and creator of the Indy Racing League single-seater series, can be credited with forcing through one of NASCAR's major safety innovations – the ▸

'Had Earnhardt worn a HANS at Daytona, he probably would have survived'



ABOVE This shot showing Sprint Cup Series driver Jeff Burton and then Lowe's Motor Speedway President H.A. 'Humpy' Wheeler installing the SAFER Barrier on the inside retaining wall clearly shows the barrier's construction (Photo: HHP/ Harold Hinson)

LEFT The SAFER barrier has been a major contributor to lessening the severity of impacts with the wall in NASCAR (Graphic: NASCAR)



ABOVE Full dynamometer facilities are included within the R&D Centre. Here a Car of Tomorrow is under test (Photo: NASCAR)

SAFER barrier. Actually standing for Steel And Foam Energy Reducing barrier, it was designed by Dr Dean Sicking of the University of Nebraska in Lincoln, Missouri.

George's efforts to reduce impact severity in the Indianapolis 500 (famed for images of cars disintegrating on the wall, often leaving drivers' legs sticking out the front) initially led to PEDS, a Polyethylene Energy Dissipating System created by John Pierce, a former GM engineer. Fitted to an inside wall at Indianapolis it took a hard impact from Arie Luyendyk during an International Race of Champions sportscar event in 1998. Luyendyk escaped serious injury but in the crash the barrier erupted, spraying the track with plastic debris which took a very long time to clear up.

> **'A 10-year 50 million dollar investment in three core areas'**

Sicking was initially assigned to help on a redesign of PEDS, but soon saw the potential for a different system. His design was based around steel tubes, with the crushable material placed behind them in a rib-like setup (see diagram). The SAFER barrier debuted in the 2002 Indianapolis 500 and proved an immediate success.

Almost unnoticed, NASCAR was now involved in the development programme, but concerned as to whether the SAFER barrier could be as effective when hit by a stock car, twice as heavy as a single-seater. Extensive testing proved such concerns were unfounded, and adoption of the technology was swift – today the outside of every corner of every track on the Sprint Cup schedule is swathed in SAFER barrier.

To date not one fatality has resulted from an impact with such a barrier. "We think the magnitude of the safety problem associated with outer wall barriers has been dramatically reduced," says Sicking. "Up until 2001 or 2002, the highest risk for a driver was striking the outer wall barrier at a high angle at high speed. That's no longer true."

He also believes that lessons learnt in creating the SAFER barrier have led to a far greater understanding of energy management today compared to a decade ago. "It takes about eight to 10 years to get a significant improvement in technology. It was a tremendous analysis problem to be able to design the SAFER barrier for impacts at the speeds and angles we were looking at in NASCAR. And that helped us learn a lot about doing analysis that we haven't been able to do in the past, in designing other barriers."

Drivers who have had unscheduled meetings with the barrier support Sicking's view, notably four-time champion Jeff Gordon, who credited it with protecting him from serious injury in a heavy impact on the driver's side at Pocono in 2006. However a more recent crash involving Gordon, at Las Vegas in March this year, proved that NASCAR cannot afford to relax its effort. Gordon's Chevrolet heavily impacted the inside of the track, striking an access opening where no SAFER barrier was installed. The car was wrecked and Gordon lucky to escape injury.

Gordon admitted that the new COT had been instrumental in his walking away from the crash, adding that seven years earlier he probably would not have survived. But he heavily criticised the safety measures at that point on the track: "Thankfully, everything did its job. The HANS device, the seat and the way the car crushed. Everything did its job except for the wall. Hitting that was not fun."

Within days owners Speedway Motorsports Inc pledged to install the SAFER barrier before the Sprint Cup returns to the track next season. Other tracks have quickly begun extending their SAFER barrier to include the inside walls.

Meanwhile drivers have become more responsible for their own safety, and today in every interview they can be seen wearing beneath their helmets the HANS device, designed to reduce sudden neck movement in an accident. Its adoption in international motorsport proved an almost ▸

SEAT OF THE ISSUE

WHILE NASCAR heads up the continuing quest for safety, the teams are still very much involved, many making their own advances which are used after gaining NASCAR approval. Possibly the best example is the carbon fibre seat, developed by Hendrick Motorsports to replace traditional aluminium versions.

According to Hendrick Safety Director Mark Hord, the idea for such a seat came several years ago from four-time champion driver Jeff Gordon. The first seat was produced in 2003 and duly approved by NASCAR. Today Hord estimates that around 70 per cent of the Sprint Cup field use Hendrick seats, each costing $10,400 plus $1200 for the headrest – Hendrick makes them available to teams at cost, team principal Rick Hendrick a strong advocate of safety advances. Each seat is permanently fitted to the car, but a specially-shaped insert goes in it to suit individual drivers.

While traditional materials can absorb an initial impact, it's the following impacts that lead to the greatest damage, Hord told Race Tech. "The second, third impacts are the most dangerous part of the accident for bodily injury, once the metal having absorbed the first impact is contorted out of shape. With carbon fibre we gained the happy medium where the seat is strong enough to absorb the g-load of the initial impact, but also has a springboard effect, continuing to absorb energy from further impacts."

The seat is subject to constant improvement work. Many credit the lack of serious injury suffered by Scot Dario Franchitti in a recent major accident at Talladega to the lower leg protection of his Hendrick seat, but Hord believes even more could have been done – he wants to build further protective areas all the way down the seat, in an effective large L-shaped lip. "We'd like to add further protection down the leg-board, but space is an issue – if we could have done that he likely would not even have broken his ankle."

Hord adds that more exotic materials are being considered for seat manufacture, though there is a cost issue. "Carbon fibre will puncture, which is why we use it in a Kevlar sandwich," he said, adding that the use of new materials such as Zylon would be an advance. However the big concern is the vastly increased cost of such materials, which could preclude some teams using the seat. Like Hendrick, NASCAR likes new technology to be available to all teams competing. RT

LEFT & BELOW Left, Hendrick's carbon fibre seats have become a consistent factor throughout the NASCAR field. Below, the head protection afforded by the seat is clearly visible in this shot in reigning Sprint Cup champion Jimmie Johnson's car. (Photos: Hendrick Motorsports)

overnight occurrence. NASCAR led the way, and initial resistance from some drivers paled into insignificance against a body of opinion suggesting that had Earnhardt worn a HANS at Daytona, he probably would have survived.

Many believe that Earnhardt's accident was the point in which NASCAR finally began to take safety seriously, moving away from a previous standpoint of a race series for the truly brave, but Brett Bodine, today Director of Cost Research at NASCAR and the man primarily responsible for bringing the COT to reality, does not totally agree. Instead he argues that the clutch of fatal accidents around that period helped NASCAR to understand the issues that were there. "That's really part of the process," Bodine told trackside media earlier this year. "You realize you have a problem and you become educated about the problem and you start working on it." He points also to the fact that with his family long focused on safety in the sport, he had been wearing a HANS device in races for almost a full season before Earnhardt's accident.

Whatever the past, safety is now uppermost in minds right across NASCAR from drivers to officials and track owners. All aspects are now being considered both around and outside the cars – while for example many are calling for changes to the COT to improve its raceability, the general opinion is that this must not be done at the expense of any of its safety improvements.

ABOVE The value of the Car of Tomorrow has already been shown in a number of accidents. This is Bobby Labonte's Dodge after a multi-car shunt at Watkins Glen (Photo: Rusty Jarrett/Getty Images for NASCAR)

ABOVE The Car of Tomorrow is a product of the R&D Centre. This graphic shows its enhanced safety features (Graphic: NASCAR)

Tracks are being looked at with a much keener eye – much criticism erupted earlier this year around the 2-mile Pocono tri-oval, scene of enormous accidents in the past and increasingly seen as long overdue for updating, particularly in the fact that it is ringed in wide grass areas and guardrails. "I don't see any reason to have grass from the inside wall to the outside wall," reigning Sprint Cup champion Jimmie Johnson recently said. "Grass does not slow the vehicle down; it gets the car airborne, speeds it up in some cases."

Johnson is equally scathing over the guardrails at Pocono: "That technology is from the '80s and it can be better. I know it's expensive to upgrade, but it's not worth losing somebody over and it's not worth hurting someone."

NASCAR has overcome several setbacks in its drive for safer racing, most recently the untimely death of Technical Director Steve Peterson, the man credited with heading up many of the innovations detailed on these pages. But while the NASCAR of today is a far safer sport than even less than a decade ago, the battle for safety can never be considered won. There will always be further improvements to be made – and never a time for complacency. RT