

VEHICLE COCKPIT SAFETY



STORY BY >> CHRIS PAULSEN

My friends at *Dirt Sports* magazine have requested that this month's Competition Corner focus on a subject that I'm very passionate about — safety. Many times it's overlooked or not taken seriously. Sadly, it will also get stepped over every time if it gets in the way of performance. That's the racer's mentality, performance is always first. And I speak from experience as I have thought that way too.

This month, we will highlight various racing situations and some components to help you understand how other series make decisions and rules. In a future article, we'll get down to the details on how to properly implement safety in your race car.

Given the choice of spending money on a set of cylinder heads that will make six more horsepower or buying a seat that may be a little expensive but could save your life, the true racer will go for the horsepower every time. Kind of crazy when you think about it, isn't it? I've known and worked with drivers that would be really pissed if you spent the final dollars of the budget on a good seat when a performance enhancement could have been purchased instead.

When it comes to safety, the major sanctioning bodies lead the way. Formula 1, IRL, NHRA, ALMS, and NASCAR are always on the cutting edge. Whether it's the race car, race track, or the track-side medical staff, these groups always seem to be the most advanced out there. IRL has one of the best traveling safety crews in the sport. These safety programs are cutting edge and set the standard for the smaller organizations to follow. It's this cutting edge safety that let's an Indy Car driver walk away after hitting a wall at over 200

THE INSTIGATOR: While the 2001 death of Dale Earnhardt during the Daytona 500 was tragic, the incident is now credited for kick-starting massive scientific research of high-speed racing accidents that has benefited driver's safety world-wide.

mph. And, unlike Saturday night racing at the local short track, the major organizations have a budget for their safety programs and a full time staff.

If you look closely, the major sanctioning bodies are responsible for remarkable technology. The SAFER Barrier, for instance, is one of the most awesome innovations that has happened to racing in many years. The HANS device is right there with it. Now, thanks to the HANS, there are other head restraints that have been designed and are working. A company called Shock Doctor has invented a very clever system called Eject. It's a bladder that goes in the helmet with a capillary tube and fitting that hangs out the bottom of the helmet. If a driver is unconscious and has a possible head or neck injury, the safety crew has a small co2 canister that plugs into the capillary. They slowly fill the bladder which sits between the top of the head and the helmet. This expands and lifts the helmet off the drivers head without putting stress on the neck and it is mandatory in the IRL.

NASCAR has driven seat technology to a new level. A combination of seat improvements and the HANS device has had a dramatic effect on NASCAR's safety record. More on this later as it is important. Unfortunately, it takes awhile for this technology to make its way down to the lower levels of racing.



F. PIERCE WILLIAMS PHOTOGRAPHY

HOW DOES OFF-ROAD RACING COMPARE?

Now let's talk about off-road safety. The statement I'm about to make will upset some people, but, from my perspective, a point needs to be made here. Compared to other forms of racing, the off-road world is behind the times.

From what I can see, it is mostly left up to the competitor to create his own level of safety. The sanctioning bodies don't mandate new belts with current SFI-dated certification. Belt mounting isn't looked at very closely and I have sure seen some installations that are appalling at best. The seat could be anything and probably mounted in any fashion. Fire-proof gloves, shoes, and head and neck restraints are an option. The only things I've seen SCORE or BITD look at are the Snell stickers in helmets and fire suits. It takes a lot more than that to make you safe. Some teams are very good at making sure all the details are covered and done properly. Most aren't.

It's up to the sanctioning body to enforce proper safety. If left up to the competitors, some will be good and some will be bad. If sanctioning bodies are going to make money off all the hard work and huge money spent by the car owners, they must implement strict rules to keep the drivers as

safe as possible. Let's face it; many of the drivers in the various classes don't do this full time. They don't necessarily know what's right from what isn't. As mentioned earlier, it's a "heat of the moment" thing with a race driver. Anyone who has been to Baja has seen this at sometime during the event. All right, enough of the philosophical dialog, let's look at some details.

G-LOADS

Let's take a minute to understand what causes severe injury or death in a race car, aside from blunt force trauma. It's the severe g-loading your body sees in a hard impact. Experts, like Dr. John Melvin, have spent their careers working on this. The simple explanation comes down to how high the g-loading spike is and how much time is spent at that spike. A 50 g impact can kill you if the duration at 50 g is long enough. The duration is measured in milliseconds. At the same time, I've seen drivers survive 130 + g loads, but the duration was short. Dale Earnhardt's crash was estimated at less than 60 g's. And, while Indy Cars have had crash recorders for many years, NASCAR didn't implement recorders until after the death of Earnhardt.

The most spectacular crashes are many times the most survivable. A race car flipping violently over several hundred feet looks wicked. The car rides down the crash over a longer period of time. The energy is dissipated over seconds, not milliseconds. It's the sudden stop that injures or kills. The Earnhardt crash didn't look spectacular but the cars energy was arrested very suddenly. As we know today, that was a survivable crash if all the seat and restraint mounting was done properly and if Earnhardt was wearing a HANS device.

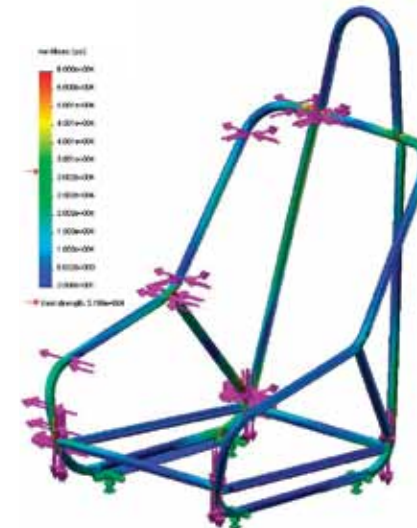
SEATS

Obviously seats are key components to safety and an item that still needs more attention. Companies like MasterCraft and others make very good racing seats for the off-road environment, but it isn't all about seat construction either. Is the seat mounted properly? Are the right fasteners used? How are the belts mounted in conjunction with the seat and are the angles and lengths right? Is the seat the proper size for the driver?

I have to share two stories to help make you understand the importance of proper racing seats. First of all, I've had three very good friends killed in race cars — Danny Milburn, Kenny Irwin and Dale Earnhardt. They would be alive today had they been sitting in a correctly designed, properly mounted racing seat. I started working on seat design in the early 90's after Danny got killed at Phoenix. This really went forward when Kenny got killed in a NASCAR Cup car. Cal Wells (former owner of Toyota's factory PPI team) was very forward thinking when he went to NASCAR, getting together with Reynard to design a carbon fiber seat for his driver. At this same time, I was working on NASCAR to allow carbon fiber seats. My company and Reynard worked very closely in Indy Car so we all collaborated on the project. I was in charge of getting the NASCAR approval.

Reynard engineers had decided crash testing would be very important and Steve Peterson from NASCAR agreed. This crash testing, along with high speed video, was very dramatic. To get a baseline, a ButlerBuilt seat was used because it was the most common seat used in NASCAR. At that time (1999), there were no seat rules in NASCAR and most seats were aluminum. Dale Earnhardt used a seat from a 1965 Mustang but later had aluminum versions made. The comparison test of aluminum versus the new design carbon fiber was dramatic

CRASH DUMMY: In order to achieve valued FIA certification for its seats, Mastercraft has also spent an inordinate amount of time and money on testing via an independent third party in England.



COURTESY OF MASTERCRAFT

DRAWING ON ACCURACY: According to MasterCraft's Robbie Pierce, his company creates its products on CAD, which includes Finite Element Analysis (above) to allow his engineers to pre-test the seat frame's design and construction.

and the crash dummy died in the aluminum seat every time during 75 g lateral impacts. NASCAR showed this dramatic video to all the drivers.

The key point here is that up until this video, all the drivers thought they knew what happened in the cockpit during a crash. In fact, they didn't have a clue. This crash testing proved that many things were happening so fast that no human could ever realize it. The primary discoveries were head and neck movement, belt stretch, helmet movement and deflection of the seat.

The head and upper torso must not move. The seat and restraints must keep the driver from moving especially in the severe crashes. When a seat deflects, especially on a lateral impact, the drivers head will accelerate. The head also accelerates on frontal impact. The primary cause of death in severe crashes is basil skull fractures or, as we know it, a broken neck. The seat, head restraint and belts must keep the driver contained, no matter how hard the impact and let the car ride down the crash. The old way of thinking was that the seat needed to move a little to absorb the shock. Absolutely not.

The design of the Reynard carbon fiber NASCAR seat had shoulder supports, a very strong head surround and the belts were mounted integral with the seat, insuring proper angles and minimizing stretch. The integral belts were a great feature because it prevented many possible mistakes made when belts are passed through holes in the seat and are

wrapped around the most convenient tube on the frame.

The design of the lay-up was structural like an Indy Car tube and it was very strong. To replicate this strength in aluminum takes a lot of material, either in thickness or a lot of gusseting. This high strength is important for the lateral g loading when there is a side impact. In off-road, any angle impact can occur. The shoulder support is the best way to contain a driver for any lateral impacts. At the same time, the head must be contained by the head restraint and head surround on the seat.

The second story to help you understand seat integrity is about two crashes in NASCAR. Kyle Petty had a hard crash at Bristol in 2003, which was after NASCAR implemented g-force recorders. His car did a half spin going into the corner and pancaked the wall hard with the left side. It was a sudden stop and registered over 90 g. Kyle used the Reynard Carbon seat and he walked away making it back for the next race. A few races later at Richmond, Jerry Naedau had an identical crash. The car did a half spin and pancaked the wall on the driver's side. The g-loads were virtually the same as the Petty crash at Bristol but Naedau had an older style aluminum seat like so many at the time. He suffered head injuries and has never raced again.

SUSPENSION SEATS

In off-road racing, suspension seats, like those made by MasterCraft, Beard, PRP and others, are common. I certainly agree with the concept, as some of the bumps and holes are bone-jarring and very hard on the lower back and spine. The only concern is how much travel the seat may have. When the belts are mounted to the frame, independent from the seat, will the driver be loose under severe impact? I spoke to Robbie Pierce from MasterCraft, who is very adamant about this subject. Like all things, there seems to be two sides to the issue and there always are. Robbie said, "There is a debate about this whole issue. In off-road racing, most of the impact is vertical and more similar to a blast event seen in a combat theater. Mitigating the energy to the occupant's spine is crucial to their survivability. A MasterCraft suspension seat has been tested to reduce that energy by 84 percent."

Certainly, while science is science, the entire environment of off-road is a different animal too. Pierce admits

that the discussion of hard-shell versus suspension seat is a complex one and there "isn't a direct apples-to-apples comparison as other forms of motorsports don't require going 120 miles an hour over whoops for 10 hours."

What was the most amazing thing to me, however, was MasterCraft's dedication to proving the viability of its product. In recent years, Pierce (who's company has 16,000 vehicles outfitted with its product in Iraq) took the extra steps to have his seats FIA approved. He went to one of England's primary FIA approved test centers (TRL), which provided documentation that his suspension seats absorbed about 84 percent of a crash impact, and that his

"Compared to other forms of racing, the off-road world is behind the times...it is mostly left up to the competitor to create his own level of safety."

Mastercraft3G units were "approved with flying colors." However, a year later, he is still awaiting official certification from the FIA, a situation that is becoming increasingly difficult. "I am left with conclusion there must be some politics involved," he told me. "I have the test results and they [the seats] clearly passed. It's frustrating to do everything you can to follow guidelines set forth by the highest forms of motorsports in the world, then prove your product's safety and still not get anywhere."

BELTS

I don't need to state the importance of a lap belt and shoulder harness. They are key components to surviving the crash. The only way to properly install belts is to go by the manufacturer's instructions and do it exactly as illustrated and explained. But, remember, the shorter the belts, the better. On average, belt stretch is about four percent for nylon and about two to three percent with polyester. NASCAR's specification (Rule 16-5) allows a maximum stretch of four percent. If the belts are extra long due to mounting, this four percent could mean a lot. The older the belts, the more they will stretch. That's why the sanctioning bodies need to enforce the life of belts.

Having raced many sprint cars and now some off-road, I've experienced most of what we're talking about in this article. I am proud to have survived some very wild and spectacular sprint car crashes, as most sprint car drivers are apt to do. Then, at the BITD Parker 425 this year, I also flipped a Class 1 car too. It wasn't a hard crash, just a few endos and some barrel rolls, with the car stopping upside down. Let's review the details of the crash.

First of all, the belts were older. I'm not sure how old but they had probably been in the car for the life of the chassis. Secondly, I'm a medium sized guy, but the driver that normally drives the car (and was getting in for the second stint) is a very large person. The belts have to be able to fit the larger driver and it was difficult to get everything as tight as possible for the smaller driver. I think this happens a lot in off-road. The crotch strap was very long and not adjustable so I twisted

it several times to shorten its length.

During the flip, I was much looser in the car than I would have preferred to be. Refer to the "heat of the moment" line earlier in this article. My helmet was beating on the top cage bar and broke the air inlet off. It wasn't a violent crash so I could hold myself pretty well with the steering wheel. My right leg was thrown to the other side of the shift lever and it broke the steel lever off. My left knee hit a brake bias knob mounted on the underside of the dash creating a nice gash.

The car stopped on its top and I just wanted out but the window net had been broke off. I released the latch on the lap belt as I was hanging upside down but the crotch belt was hung up on the buckle. This was because of the twisting that had to take place to shorten the strap and with my body weight hanging, it just wouldn't release. After about five minutes, I was able to wiggle out of the straps. Thank God the car wasn't on fire.

The reason I'm showcasing this particular event is to highlight some things that the sanctioning body should implement in their safety rules. Window net mounting, belts, adjustable crotch straps, seat mounting, leg protection and overall cockpit integrity should all be scrutinized. 