September 2001

WELCOME

Mark Ortiz Automotive is a chassis consulting service primarily serving oval track and road racers. This newsletter is a free service intended to benefit racers and enthusiasts by offering useful insights into chassis engineering and answers to questions. Readers may mail questions to: 155 Wankel Dr., Kannapolis, NC 28083-8200; submit questions by phone at 704-933-8876; or submit questions by e-mail to: markortiz@vnet.net.

BAD NEWS, AND GOOD NEWS

The tech forum at www.racecartech.com, arguably the hottest chassis forum on the internet, has now been down for a month and a half. Over the past year or more, I have answered questions for free on this forum, and have gotten quite a few paying clients as a result. Since people have come to think of that site as the place to find me, I would prefer to stay there. But if it stays down much longer, I'm going to have to start my own message board, or possibly find another one to hang out on. I have e-mailed the owners of the racecartech site, asking them what we should expect. I have received no answer. Stay tuned. Meanwhile, I am definitely still in the consulting business, though the "economic slowdown" has hit me hard.

On a brighter note, I have recently come to an agreement with *Racecar Engineering* magazine to publish a monthly column based on this newsletter. For those unfamiliar with that magazine, it is published in England and features deeper and better tech articles than the car magazines at your local supermarket. Subscriptions for the US, Canada, and Mexico are handled by EWA Magazines, 205 US Hwy. 22, Green Brook, NJ 08812; phone 1-800-392-4454; website www.ewacars.com.

STOCK CAR SAFETY ISSUES

The month of August has seen the release of NASCAR's report on the death of Dale Earnhardt, and the first public demonstration of the Humpy Bumper. There was also one independent study released which advocated crush structures in stock car noses.

On the whole, I find NASCAR's official conclusions, as presented by Dr. James Raddin, to be logical and consistent with the physical evidence as presented. The only real room for doubt lies in the difficulty of verifying that physical evidence, particularly in view of the long delay before the separated belt was announced, the rescue worker's insistence that the belt was not separated, and the refusal to allow public access to the autopsy photos.

Concerning the belt, I agree that it was installed improperly, if the illustrations we've seen are correct. I also agree that the shoulder harness was installed with an inordinately long run to the anchor point. I agree that the lap belt's mounting could cause failure, at approximately the point where the belt passed through the hole in the seat, which is also where the adjuster was. But we are being asked to believe that this happened during the crash; that the separated portion of the belt was displaced 4 to 8 inches after the crash (therefore more than that during the crash); that the driver moved far enough to severely deform the steering wheel and break 8 ribs and his sternum against it - and that somehow the harness was still tight enough to make it hard to release the buckle, and the separated belt was somehow invisible to everybody until some days after the accident. Maybe I'm missing something, but I don't see how that's physically possible. I can see how the belt could have separated, but I don't see how it could have done so without the separation being immediately apparent.

Looking at published photographs of the belt, I agree that it appears to have been pulled apart, not cut. However, this appears to have happened in two stages, not all at once. I say this because the bottom third of the break has a different appearance than the top two thirds. The bottom third of the break appears to have been initially torn over a sharp edge, such as the adjuster, and operated in this condition for a while, with the tear slowly growing. If this were not so, the fibers on the left (in the photo), or working, segment would not be bent back and flattened the way they are, and the edge of the right, or unstressed tail, segment would not be so cleanly cut. The entire break would be ragged, without the fibers being bent back and flattened, like the top two thirds.

Here's a possible explanation: the belt did fail, or was in the process of failing, due to improper installation, *but not to the point of complete separation*. It stretched more than one would normally expect, and the shoulder straps did too. But the belt still held together. Then some time after the crash, somebody discovered the damage to the belt, and somebody pulled it apart the rest of the way.

I realize the enormity of this suggestion, and I realize that there is no direct proof that this occurred. However, this theory would explain the initial absence of any mention of the belt failure, and the 5-day delay in announcing it. I have heard no other plausible explanation of these things.

This theory does require a concerted attempt to deceive the public, and this would require a motive. Such a motive is not hard to discern, however. The Earnhardt crash was the fourth in a string of similar ones, resulting in similar fatal injuries. Without belt failure as an issue, the focus inevitably shifts to car and wall construction. Changing cars and walls costs big money, and is fraught with the perils of developing new technology, which may not always work as intended. Remember that the France family owns big interests in a number of tracks, as well as a controlling interest in NASCAR. With the belt failure controversy raging, the waters are muddied sufficiently that changes to cars and walls can be deferred for some time – perhaps indefinitely.

I do not prefer conspiracy theories over simpler, less dramatic explanations. But I will believe in a conspiracy more readily than I will believe in a miracle. And what we're seeing with this belt issue appears to me to be unexplainable except as a conspiracy or a miracle. I await the explanations of those who think otherwise.

NASCAR's position on crush structures in the nose is that there may be "unintended consequences" in the form of cars moving each other around more when light contact occurs. This concern is not entirely unwarranted, but I certainly think the concept of energy-absorbing noses should be tested, not merely dismissed.

Also, it is my understanding that the object of nudging another car is to move it, at least when the nudge is deliberate. In the case of purely accidental contact, we are faced with the classic design tradeoff that we always encounter when designing any kind of cushioning system in a finite space: softer is better for light forces, but a soft cushion bottoms out when forces are greater. This dilemma is the same one we face with seat pads, roll bar pads, and even vehicle suspension systems.

I was not present for the demonstration of the Humpy Bumper, the carbon fiber structure designed to fit inside stock car noses. Published reports say a test car was driven into a wall at an angle, with an impact speed of 40 mph. I am not clear whether that is the car's speed, or the component of its velocity perpendicular to the wall, or the reduction of its velocity during impact. The last of these is the one that would create a similar condition to the Earnhardt crash. The car's velocity decreased 42 to 44 mph during the two impacts combined, from an initial speed of around 160 mph.. Reportedly, the test car's nose crushed visibly less than would normally be expected, and the car bounced off the wall, requiring some reporters to move fast to evade it.

I am not certain how much to make of this one instance, but it is not desirable for an energy-absorbing structure to be resilient: it should not spring back. It should crumple, and stay squashed.

For reasons of both cost and non-resilience, I would suggest looking hard at crush structures of mild steel, aluminum, or plastic such as ABS or polyethylene. How about "egg-crate" radiator ducts, with internal vanes forming a crush structure while also maintaining orderly air flow to the radiator?

The independent report that suggested crush structures proposed styrene foam, encapsulated in sheet aluminum. This has possibilities, especially in the fenders, ahead of the wheels and alongside the radiator duct. Aluminum honeycomb or egg-crate has potential in that area as well.

Whatever material is used, the structure should incorporate *graduated* rigidity or yield strength. The portions closest to the nose molding should deform easily, and the structure should offer progressively greater resistance as deformation moves further inboard. This increase in resistance should be as gradual and stepless as possible. With an egg-crate structure, this is easily achieved by using more panels, and/or thicker material, for the inboard portions.

I sent copies of my April newsletter, which addressed adding crush structures to both noses and walls, to Mike Helton and Gary Nelson. NASCAR sent them back, with a letter saying that their
policy is to not accept any unsolicited suggestions! Remember that next time you see a NASCAR representative on TV saying they are receiving new ideas all the time. No doubt they are receiving them, but this evidently doesn't mean they read them.

Lest any one suppose that I am unconditionally critical of NASCAR, I do think they are making good decisions in establishing a new safety research center in Conover, NC, and putting impact data recorders in the cars. Hopefully, crush structures will be among the items investigated.

TIRE DATA

Why is it so difficult to find data for mathematical modeling of tire properties? Do tire companies have the ability to test the forces a tire generates at various slip angles, loads, camber angles, and so on? If so, why don't they make this information public?

Tire companies do have machines that can test a tire against a simulated road surface, at controlled normal force (vertical load), camber angle, and slip angle, and measure the drag and lateral forces the tire generates. Sometimes they also contract out this work to a laboratory like Calspan, where much of the equipment used for this was first developed.

The machines use a large wheel or a very strong belt to simulate the road surface. This of course most closely simulates pavement, not dirt. Early machines also were built that rolled the tire along the ground, attached to a heavy truck.

The indoor machines with simulated road surfaces were developed to produce more accurate and repeatable measurements. The fact that this was necessary tells us something important about tire behavior: in the real world, what occurs doesn't just depend on the tire. It depends at least as much on the road surface and the weather. Therefore, tire data are only meaningful when taken under very carefully controlled conditions. To model tire behavior accurately for the real world, testing needs to be done under a variety of carefully controlled conditions, and the effects of these changes have to be included in the report.

As if this weren't enough, tires themselves are highly variable in their behavior. Their properties vary with age, heat cycling (itself sensitive to amount and speed of temperature change), wear, inflation pressure, tire temperature, air temperature, road temperature, air flow to the tire, vehicle speed, combination of loadings in multiple directions, manufacturing variations, rim width, and other factors. The tire even has different properties as it proceeds through a turn, because it rapidly heats up. It heats faster at a high road speed than at a low road speed.

Any attempt to test and analyze how these factors play off against each other results in a voluminous report. The best we can do for purposes of mathematical simulation is to assume a simplified tire model, preferably averaged from such a report, that we can use for comparative calculations when varying other factors. If we are dealing with incremental changes to the car, on known tracks, with many runs already logged, as in F1, then reasonably accurate lap time prediction is possible. If we are trying to predict less familiar situations, accuracy available from the simulation inevitably diminishes.