WORDS: Dexter Ford **PHOTOGRAPHY:** Jim Brown

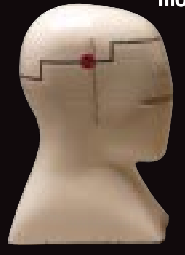
Blowing The Lid Off

Searching for the truth behind helmet design,helmet standards and actual head protection

How good is your helmet? Will it actually protect your brain in your next crash? These seem like easy questions. Questions you probably think you can answer by reciting the lofty standards your helmet meets and the lofty price you might have paid for it.

But the real answers, as you are about to see, are anything but easy.

There's a fundamental debate raging in the motorcycle helmet industry.



In a fiberglass-reinforced, expanded-polystyrene nutshell, it's a debate about how strong and how stiff a helmet needs to be—or should be—to provide you with the best possible protection.

Why the debate? Because if a helmet is too stiff it can be less able to prevent brain injury in the kinds of crashes you're most likely to have. And if it's too soft, it might not protect you in a violent, high-energy crash. What's just right? Well, that's why it's called a debate. If you knew how hard and on what you were going to hit your head, you could choose the perfect helmet for that one crash. But crashes are, well, accidents. So you have to guess.

To understand how a helmet protects—or doesn't protect—your brain, it helps to appreciate just how fragile that organ actually is. The consistency of the human brain is like warm, half-melted Jello. It's so gooey and insubstantial that when pathologists remove a brain from a cadaver, they have to use a kind of cheesecloth hammock to hold it together as it comes out of the skull.

Your brain basically floats inside your skull, within a bath of cervical-spinal fluid and a protective cocoon called the dura. But when your skull stops suddenly—as it does when it hits something hard—the brain keeps on going, as Sir Isaac Newton so sagely predicted. It then has its own collision with the inside of the skull. If that collision is too severe, the brain can sustain any number of injuries, from shearing of the brain tissue to bleeding in the brain, or between the brain and the dura, or between the dura and the skull. And after your brain ia injured, even more damage can occur. When the brain is bashed or injured internally, bleeding and inflammation make it swell. When your brain swells inside the skull, there's no place for the extra volume to go. So it presses harder against the inside of the skull and actually tries to squeeze through any opening, bulging out of your eye sockets and oozing down the base of the skull. As it squeezes, more damage is done to some very vital regions.

None of this is good.

To prevent all that non-good stuff from happening to our brains, we wear helmets. Modern, full-face helmets, if we have enough brains to protect, that is.

A motorcycle helmet has two major parts: the outer shell made of expanded polystyrene or EPS, the same stuff used in beer coolers and foam coffee cups; and the inner, energy-absorbing liner. Outer shells come in two basic flavors: a resin/fiber composite, such as fiberglass, carbon fiber and Kevlar, or a molded thermoplastic such as ABS or polycarbonate, the same basic stuff used in face shields and F-16 canopies.

The shell is there for a number of reasons. First, it's supposed to protect against pointy things trying to stab your head through the EPS-though that almost never happens in a real accident. Second, the shell protects against abrasion, which is a good thing when you're sliding into the chicane at Daytona. Third, it gives Troy Lee a nice, smooth surface to paint dragons on.

Riders—and helmet marketers—pay a lot of attention to the outer shell and its material. But the part of the helmet that does most of the work, that absorbs most of the energy of a crash, is actually the inner liner.

When the helmet hits the road or a curb, the outer shell stops instantly. But your head keeps going inside the helmet until it collides with the liner. When this happens, the liner's job is to bring the head to a gentle stop—if you want your brain to keep working like it does now, that is.

The great thing about EPS is that as it crushes, it absorbs lots of energy at a controlled, predictable rate. It doesn't store energy and rebound like a spring,

WHEN THE HELMET HITS THE ROAD OR A CURB, THE OUTER SHELL STOPS INSTANTLY. BUT YOUR HEAD KEEPS GOING INSIDE THE HELMET UNTIL IT COLLIDES WITH THE LINER. IT'S THE LINER'S JOB TO BRING THE HEAD TO A GENTLE STOP.

Helmet standards call for dropping helmets onto a stainless-steel "anvil". But roads aren't made of stainless steel. So we created our own asphalt anvil, after stealing a section of Sheldon Street. An even scarier test (lower left) involved dropping lids on an upright steel edge.

which would be a bad thing because your head would bounce back up, shaking your brain not just once, but twice. EPS actually gets rid of the kinetic energy of your moving head, turning it into a very small amount of heat as the foam collapses.

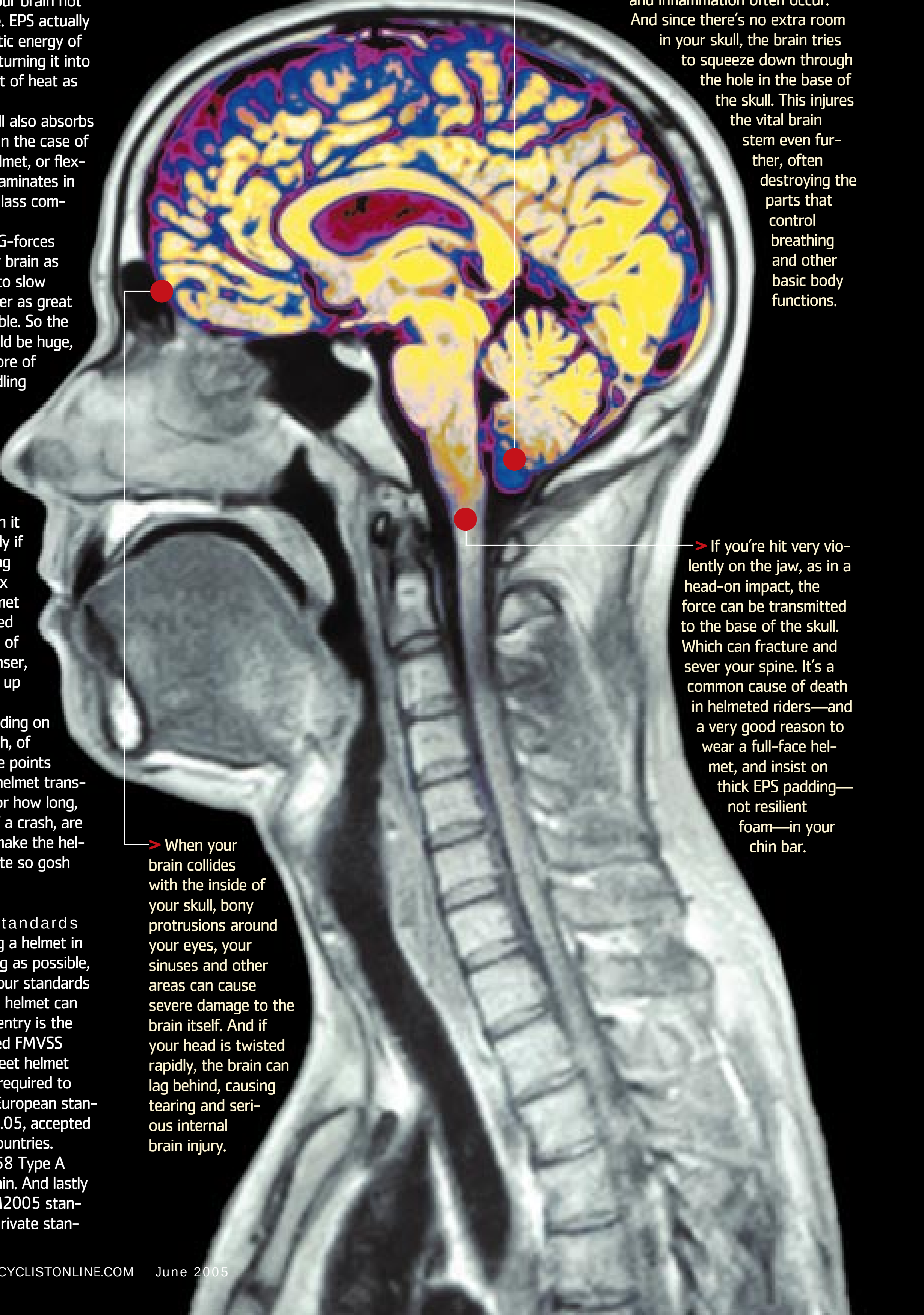
The helmet's shell also absorbs energy as it flexes in the case of a polycarbonate helmet, or flexes, crushes and delaminates in the case of a fiberglass composite helmet.

To minimize the G-forces on your soft, gushy brain as it stops, you want to slow your head down over as great a distance as possible. So the perfect helmet would be huge, with 6 inches or more of soft, fluffy EPS cradling your precious head like a mint on a pillow.

Problem is, nobody wants to wear a 2-foot-wide helmet, though it might come in handy if you were auditioning for a Jack in the Box commercial. So helmet designers have pared down the thickness of the foam, using denser, stiffer EPS to make up the difference. This increases the G-loading on your brain in a crash, of course. And the fine points of how many gs a helmet transmits to the head, for how long, and in what kind of a crash, are the variables that make the helmet-standard debate so gosh darn fun.

Standardized Standards

Just to make buying a helmet in the U.S as confusing as possible, there are at least four standards a street motorcycle helmet can meet. The price of entry is the DOT standard, called FMVSS 218, that every street helmet sold here is legally required to pass. There is the European standard, called ECE 22.05, accepted by more than 50 countries. There's the BSI 6658 Type A standard from Britain. And lastly the Snell M2000/M2005 standard, a voluntary, private stan-



> If your brain is injured, swelling and inflammation often occur. And since there's no extra room in your skull, the brain tries to squeeze down through the hole in the base of the skull. This injures the vital brain stem even further, often destroying the parts that control breathing and other basic body functions.

> If you're hit very violently on the jaw, as in a head-on impact, the force can be transmitted to the base of the skull. Which can fracture and sever your spine. It's a common cause of death in helmeted riders—and a very good reason to wear a full-face helmet, and insist on thick EPS padding—not resilient foam—in your chin bar.

> When your brain collides with the inside of your skull, bony protrusions around your eyes, your sinuses and other areas can cause severe damage to the brain itself. And if your head is twisted rapidly, the brain can lag behind, causing tearing and serious internal brain injury.

dard used primarily in the U.S. So every helmet for street use here must meet the DOT standard, and might or might not meet one of the others.

Just by looking at the published requirements for each standard, you would guess a DOT-only helmet would be designed to be the softest, with an ECE helmet very close, then a BSI helmet, and then a Snell helmet.

Because there are few volunteers for high-impact helmet testing—and because they would tend to be a little confused after a hard day of 200-G impacts—it's done on a test rig.

The helmets are dropped, using gravity to accelerate the helmet to a given speed before it smashes onto a test anvil bolted to the floor. By varying the drop height and the weight of the magnesium headform inside the helmet, the energy level of the test can be easily varied and repeated with precision. As the helmet/headform falls it is guided by either a steel track or a pair of steel cables. The guiding system adds friction to slow down the fall slightly, so the test technician corrects for this by raising the initial drop height.

The headform has an accelerometer inside that precisely records the force the headform receives, showing how many Gs the headform took as it stopped and for how long.

If you test a bunch of helmets under the same conditions, you can get a good idea of how well each helmet is absorbing the impact of a particular hit. And it's important to understand that as in lap times, golf scores and marriages, a lower number is always better when we're talking about your head receiving extreme G forces.

On The Highway To Snell

On the stiff, tough-guy side of this helmet-debate pride-fighting ring is the voluntary Snell M2000/M2005 standard, which dictates each helmet be able to withstand some tough, very high-energy impacts.

The Snell Memorial Foundation is a private, not-for-profit organization dedicated to “research, education, testing and development of helmet safety standards.”

If you think moving quickly over the surface of the planet is fun and enjoy using your brain, you should be grateful to the Snell Memorial Foundation. The SMF has helped to create standards that have raised the bar in head protection in nearly every field in which humans hit their heads: bicycles, horse riding, harness racing, karting, mopeds, skateboards, rollerblades, recreational skiing, ski racing, ATV riding, snowboarding, car racing and, of course, motorcycling.

But now, as helmet technology has improved and accident research has accumulated, many head-injury experts feel the Snell M2000 and M2005 standards are, to quote Dr. Harry Hurt of Hurt Report fame, “a little bit excessive.”

> THE KILLER—THE HARDEST SNELL TEST FOR A MOTORCYCLE HELMET TO MEET—IS A TWO-STRIKE TEST ONTO A HEMISPHERICAL CHUNK OF STAINLESS STEEL ABOUT THE SIZE OF AN ORANGE. THE FIRST HIT—150 JOULES—IS AN EXTREMELY HIGH-ENERGY IMPACT ALL BY ITSELF.

The killer—the hardest Snell test for a motorcycle helmet to meet—is a two-strike test onto a hemispherical chunk of stainless steel about the size of an orange. The first hit is at an energy of 150 joules, which translates to dropping a 5-kilo weight about 10 feet—an extremely high-energy impact. The next hit, on the same spot, is at 110 joules, or about an 8-foot drop. To pass, the helmet is not allowed to transmit more than 300 Gs to the headform in either hit.

Tough tests such as this have pushed the development of helmet-making over the years. But do they have any practical application on the street, where a hit as hard as the hardest single Snell impact may only happen in 1 percent of actual accidents? And where an impact as severe as the two-drop hemi test happens just short of never?

Dr. Jim Newman, an actual rocket scientist and highly respected head-impact expert—he was once a Snell Foundation director—puts it this way: “If you want to create a realistic helmet standard, you don't go bashing helmets onto hemispherical steel balls. And you certainly don't do it twice.

“Over the last 30 years,” continues Newman, “we've come to the realization that people falling off motorcycles hardly ever, ever hit their head in the same place twice. So we have helmets that are designed to withstand two hits at the same site. But in doing so, we have severely, *severely* compromised their ability to take *one* hit and absorb energy properly.

“The consequence is, when you have one hit at *one* site in an accident situation, two things happen: One, you don't fully utilize the energy-absorbing material that's available. And two, you generate higher G loading on the head than you need to.

“What's happened to Snell over the years is that in order to make what's perceived as a better helmet, they kept raising the impact energy. What they should have been doing, in my view, is lowering the allowable G force.

“In my opinion, Snell should keep a 10-foot drop [in its testing]. But tell the manufacturers, ‘OK, 300 G is not going to cut it anymore. Next year you're going to have to get down to 250. And the next year, 200. And the year after that, 185.’”

The Brand Leading The Brand

“The Snell sticker,” continued Newman, “has become a marketing gimmick. By spending 60 cents [paid to the Snell foundation], a manufacturer puts that sticker in his helmet and he can increase the price by 30 or 40 bucks. Or even 60 or 100.

“Because there's this allure, this charisma, this image associated with a Snell sticker that says, ‘Hey, this is a better helmet, and therefore must be worth a whole lot more money.’ And in spite of the very best intentions of everybody at Snell, they did not have the field data (on actual accidents) that we have now (when they devised the standard). And although that data has been around a long time, they have chosen, at this point, not to take it into consideration.”

A World of Hurt

Dr. Hurt sees the Snell standard in pretty much the same light.

“What should the [G] limit on helmets be? Just as helmet designs should be rounder, smoother and safer, they should also be softer, softer, softer. Because people are wearing these so-called high-performance helmets and are getting diffused [brain] injuries ... well, they're screwed up for life. Taking 300 Gs is not a safe thing.

“We've got people that we've replicated helmet [impacts] on that took 250, 230 Gs [in their accidents]. And they've got a diffuse injury that they're not gonna get rid of. The helmet has a good whack on it, but so what? If they'd had a softer helmet they'd have been better off.”

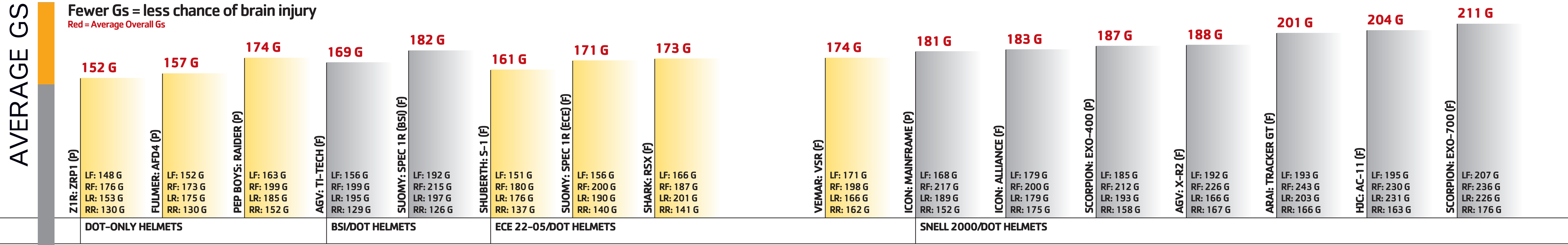
How does the Snell Foundation respond to the criticism of head-injury scientists from all over the world that the Snell M2000/2005 standards create helmets too stiff for optimum protection in the great majority of accidents?

We used the state-of-the-art helmet-testing rig at Collision and Injury Dynamics. An accelerometer inside the headform transmits its findings to a computer, which calculates the acceleration, in gs, over the eight-to-ten millisecond impact event.

“The whole business of testing helmets is based on the assumption that there is a threshold of injury,” says Ed Becker, executive director of the Snell Foundation. “And that impact shocks below that threshold are going to be non-injurious.

“We're going with 300 Gs because we started with 400 Gs back in the early days. And based on [George Snively's, the founder of the SMF] testing, and information he'd gotten from the British Standards Institute, 400 Gs seemed reasonable back then. He revised it downward over the years, largely because helmet standards were for healthy young men that were driving race cars. But after motorcycling had taken up those same helmets, he figured that not everybody involved in motorcycling was going to be a young man. So he concluded from work that he had done that the threshold of injury was above 400 Gs. But certainly below 600 Gs.

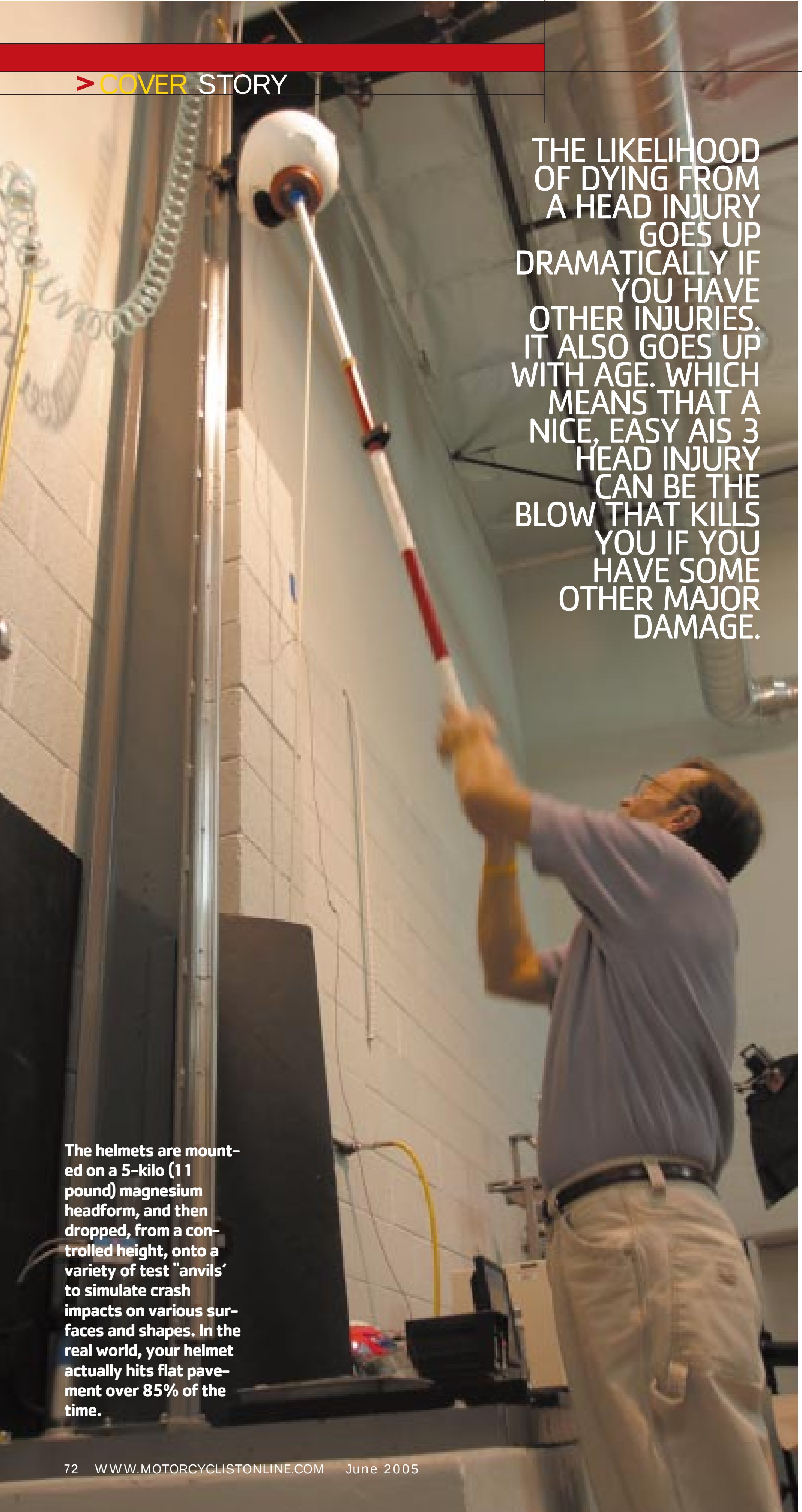
“The basis for the 300 G [limit



Fewer Gs = less chance of brain injury

Red = Average Overall Gs

IMPACT KEY:
LF:Left Front, 7-foot drop, Flat Pavement. RF: Right Front, 10-foot drop, Flat Pavement. LR: Left Rear, 7-foot drop, Flat Pavement. RR: Right Rear, 7-foot drop, Edge Anvil
SHELL KEY: (P): Polycarbonate. (F): Fiberglass



THE LIKELIHOOD OF DYING FROM A HEAD INJURY GOES UP DRAMATICALLY IF YOU HAVE OTHER INJURIES. IT ALSO GOES UP WITH AGE. WHICH MEANS THAT A NICE, EASY AIS 3 HEAD INJURY CAN BE THE BLOW THAT KILLS YOU IF YOU HAVE SOME OTHER MAJOR DAMAGE.

The helmets are mounted on a 5-kilo (11 pound) magnesium headform, and then dropped, from a controlled height, onto a variety of test "anvils' to simulate crash impacts on various surfaces and shapes. In the real world, your helmet actually hits flat pavement over 85% of the time.

in the Snell M2000 standard] is that the foundation is conservative. [The directors] have not seen an indication that a [head injury] threshold is below 300 Gs. If and when they do, they'll certainly take it into account."

"So *nobody* is being hurt by the added stiffness of a Snell helmet?" we asked.

"That's certainly our hope here," answered Becker. "At this point I've got no reason to think anything else."

European Style

The Snell Foundation may have no reason to think anything else. But every scientist we spoke to, as well as the government standards agencies of the United States and the 50 countries that accept the ECE 22.05 standard, see things quite differently.

The European Union recently released an extensive helmet study called COST 327, which involved close study of 253 recent motorcycle accidents in Germany, Finland and the U.K. This is how they summarized the state of the helmet art after analyzing the accidents and the damage done to the helmets and the people: "Current designs are too stiff and too resilient, and energy is absorbed efficiently only at values of HIC [Head Injury Criteria, a measure of g force over time] well above those which are survivable."

As we said, it's a lively debate.

How hurt is hurt?

Doctors and head-injury researchers use a simplified rating of injuries, called the Abbreviated Injury Scale, or AIS, to describe how severely a patient is hurt when they come into a trauma facility. AIS 1 means you've been barely injured. AIS 6 means you're dead, or sure to become dead very soon.

Here's the entire AIS scale:

AIS 1 = Minor
AIS 2 = Moderate
AIS 3 = Serious
AIS 4 = Severe
AIS 5 = Critical
AIS 6 = Unsurvivable

A patient's AIS score is determined separately for each different section of the body. So you could have an AIS 4 injury to your leg, an AIS 3 to your chest and an AIS 5 injury to your head. And you'd be one hurtin' puppy.

Newman is quoted in the COST study on the impact levels likely to cause certain levels of injury. Back in the '80s he stated that, as a rough guideline, a peak linear impact—the kind of impact we're measuring here—of 200 G to 250 Gs generally corresponds to a head injury of AIS 4, or severe; that a 250 G to 300 G impact corresponds to AIS 5, or critical; and that anything over 300 G corresponds to AIS 6. That is, unsurvivable.

Newman isn't the only scientist who thinks getting hit with much more than 200 Gs is a bad idea. In fact, researchers have pretty much agreed on that for 50 years.

The Wayne State Tolerance Curve is the result of a pretty gruesome series of experiments, back in the '50s and '60s in which dogs' brains were blasted with bursts of compressed air, monkeys were bashed on the skull, and the heads of dead people were dropped to see just how hard they could be hit before big-time injury set in. This study's results were backed up by the JARI Human Head Impact Tolerance Curve, published in '80 by a Japanese group who did further unspeakable things to monkeys, among other medically necessary atrocities.

The two tolerance curves agree on how many Gs you can apply to a human head for how long before a concussion or other more serious brain injury occurs. And the Wayne State Tolerance Curve was instrumental in creating the DOT helmet standard, with its relatively low G-force allowance.

According to both these curves, *exposing a human head to a force over 200 Gs for more than two milliseconds is what medical experts refer to as "bad."* Heads are different, of course. Young, strong people can take more Gs than old, weak people. Some prizefighters can take huge hits again and again and not seem to suffer any ill effects other than a tendency to sell hamburger cookers late at night. And the impacts a particular head has undergone in the past may make that head more susceptible to injury.

Helmet designers have devised a number of different liner designs to meet the different standards. The Vemar VSR (top) uses stiffer EPS than most, but has channels molded in to soften the assembly (to ECE specs) and enhance cooling. The Shuberth S1 (right) uses five separate foam parts, glued together, to meet the ECE standard. And the Z1R ZRP1(below left) uses a soft, 1-piece liner to soak up joule after joule of nasty impact energy.

Is an impact over the theoretical 200 G/two millisecond threshold going to kill you? Probably not. Is it going to hurt you? Depends on you, and how much over that threshold your particular hit happens to be. But head injuries short of death are no joke. Five million Americans suffer from disabilities from what's called Traumatic Brain Injury—getting hit too hard on the head. That's *disabilities*, meaning they ain't the same as they used to be.

There's another important factor that comes into play when discussing how hard a hit you should allow your brain to take: the other injuries you'll probably get in a serious crash, and how the effects of your injuries add up.

The likelihood of dying from a head injury goes up dramatically if you have other major injuries as well. It also goes up with age. Which means that a nice, easy AIS 3 head injury, which might be perfectly survivable on its own, can be the injury that kills you if you already have some other major injuries. Which, as it happens, you are very likely to have in a serious motorcycle crash.

The COST study was limited to people who had hit their helmets on the pavement in their accidents. Of these, 67 percent sustained some kind of head injury. Even more—73 percent—sustained leg injuries, and 57 percent had thorax injuries.

You can even calculate your odds using the Injury Severity Score, or ISS. Take the AIS scores for the worst three injuries you have. Square each of those scores—that is, multiply them by themselves. Add the three results and compare them with the ISS Scale of Doom below.

A score of 75 means you're dead. Sorry. Very few people with an ISS of 70 see tomorrow either.

If you're between 15 and 44 years old, an ISS score of 40 means you have a 50-50 chance of making it. If you're between 45 and 64 years old, ISS 29 is the 50-50 mark. And above 65 years old, the 50-50 level is an ISS of 20.

For a 45- to 64-year old guy such as myself, an ISS over 29 means I'll probably die.

If I get two "serious," AIS 3 injuries—the aforementioned AIS 3 head hit and AIS 3 chest thump—and a "severe" AIS 4 leg injury, my ISS score is ... let's see, three times three is nine. Twice that is 18. Four times four is 16. Eighteen and 16 is 34. Oooops. Gotta go.

Drop my AIS 3 head injury to an AIS 2 and my ISS score is 29. Now I've got a 50-50 shot.

Obviously, this means it's very important to keep the level of head injury as low as possible. Because *even if the head injury itself is survivable on its own, sustaining a more severe injury—even between relatively low injury levels—may not just mean a longer hospital stay, it may be the ticket that transfers you from your warm, cushy bed in the trauma unit to that cold, sliding slab downstairs.*

Department Of Testing

In the other corner of the U.S.

helmet cage-fighting octagon is the DOT standard. It mandates a testing regimen of moderate-energy impacts, which happen in 90 percent or more of actual accidents, according to the Hurt Report and other, more recent studies.

Where the Snell standard limits peak linear acceleration to 300 G, the DOT limits peak Gs to 250 G. Softer impacts, lower G tolerance. In short, a kinder, gentler standard.

The DOT standard has acquired something of a low-rent reputation for a number of reasons. First, because it comes from the Gubmint, and the Gubmint, as we know, can't do anything right.

The DOT standard, like laws against, say, murder, also relies on the honor system; that is, there's only a penalty involved if you break the law, in this case sell a non-complying helmet and get caught. Manufacturers are required to do their own testing and then certify that their helmets meet the standards. But it also gives helmet designers quite a bit of freedom to design a helmet the way they think it ought to be for optimum overall protection. The question is, how well are those designers doing their job with all that freedom?

THE DOT STANDARD, LIKE THE LAWS AGAINST SAY, MURDER, RELIES ON THE HONOR SYSTEM; THAT IS, THERE'S ONLY A PENALTY INVOLVED IF YOU BREAK THE LAW, IN THIS CASE SELL A NON-COMPLYING HELMET, AND GET CAUGHT.

DOT, ECE BSI, SMF—let's call the whole thing off

In a typical large motorcycle dealership you're likely to find helmets that conform to all these standards.

Most U.S.-market full-face helmets made in Asia—Arai, HJC, Icon, KBC, ScorpionExo, Shoei, and most Fulmer models—are Snell M2000 or M2005 certified. (The Snell standard did not change substantially from M2000 to M2005.) Most helmets from European companies—Vemar, Shark, Shuberth, etc.—conform to the ECE 22.05 standard.

Suomy helmets sold under its own name conform to either the ECE or the BSI standard, but Suomy private-labels some helmets to brands such as Ducati that are built and certified to Snell. Some AGV models sold here are made to Snell standards, some to BSI. And a few Asian-made helmets are DOT-only. Among major manufacturers, Z1R (a subbrand of Parts Unlimited) and Fulmer Helmets sell DOT-only lids at the lower end of their pricing scales. You can also get 'em at Pep Boys under the Raider brand name.

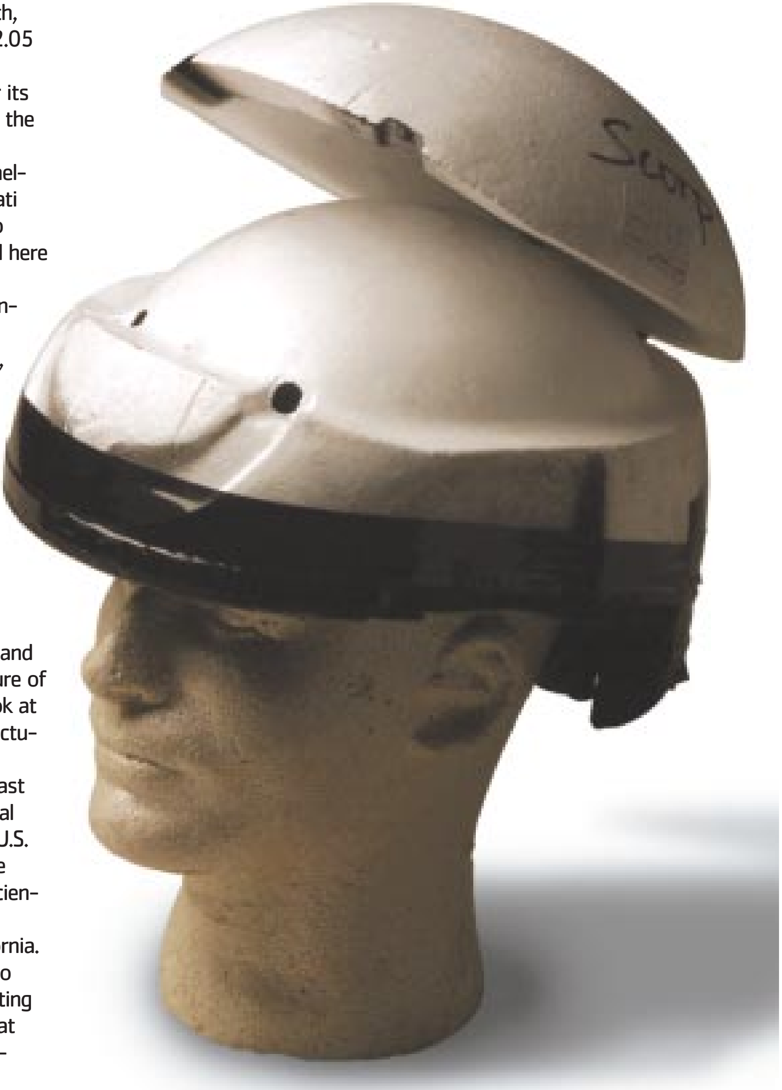
Hurts So Good

To talk about helmet design and performance with any measure of authority, we should first look at the kinds of accidents that actually occur. The Hurt Report, issued in '81, was the first, last and only serious study on real motorcycle accidents in the U.S. The study was done by some very smart, very reputable scientists and researchers at the University of Southern California. The Hurt researchers came to some surprising and illuminating conclusions—conclusions that have not been seriously challenged since.

First, about half of all serious motorcycle accidents happen when a car pulls in front of a bike in traffic. These accidents typically happen at very low speeds, with a typical impact velocity, after all the braking and skidding, below 25 mph. This was first brought out in the Hurt Report but has been recently backed up by two other studies, a similar one in Thailand and especially the COST 327 study done in the European Union, where people have fast bikes, like to ride very quickly and ride on some roads with no speed limits at all.

Actual crash speeds are slow, but the damage isn't. These are serious, often fatal, crashes. Most of these crashes happen very close to home. Because no matter where you ride to, you always have to leave your own neighborhood and come back to it. And making it through traffic-filled intersections—the ones near your home—is the most dangerous thing you do on a street motorcycle.

The next-biggest group of typical accidents happens at night, often on a weekend, at higher speeds. They are much more likely to involve alcohol, and often take place when a rider goes off the road alone. Those two groups of accidents account for almost 75 percent of all serious crashes. So the accident we are most afraid of, and thus tend to



All the Snell/DOT helmets we examined use a dual-density foam liner. The upper cap of foam on this Scorpion liner is softer, to compensate for the extra stiffness of the spherical upper shell area. Some manufacturers, including Arai and HJC, use a one-piece liner with two different densities molded together.

buy our helmets for—crashing at high speeds, out sport riding—is actually relatively rare.

Even though many motorcycles were capable of running the quarter-mile in 11 seconds (or less) and topping 140 mph back in '81, not one of the 900-odd accidents investigated in the Hurt study involved a speed over 100 mph. The "one in a thousand" speed seen in the Hurt Report was 86 mph, meaning only one of the accidents seen in the 900-crash study occurred at or above that speed. And the COST 327 Study, done recently in the land of the autobahn, contained very few crashes over 120 kph, or 75 mph. The big lesson here is this: It's a mistake to assume that going really fast is what causes a significant number of accidents just because a motorcycle *can* go really fast.

Another eye-opener: In spite of what one might assume, the speed at which an accident starts does not necessarily correlate to the impact the head—or helmet—will have to absorb in a crash. That is, *according the Hurt Study and the similar Thailand study, going faster when you fall off does not result, typically, in your helmet taking a harder hit.*

How can this be? Because the vast majority of head impacts occur when the rider falls off the bike and simply hits his or her head on the flat road surface. The biggest impact in a given crash will typically happen on that first fall, and the energy is proportional to the height from which the rider falls—not his forward speed at the time. A big highside may give a rider some extra altitude, but rarely higher than eight feet. A high-speed crash may involve a lot of sliding along the ground, but this is not particularly challenging to a helmeted head, because all modern full-face helmets do an excellent job of protecting from abrasion.

In fact, the vast majority of crashed helmets examined for the Hurt Report showed that they had absorbed about the same impact you'd receive if you simply tipped over while standing, like a bowling pin, and hit your head on the pavement. Ninety-plus percent of the head impacts surveyed, in fact, were equal to or less than the force involved in a six-foot drop. And 99 percent of the impacts were at or below the energy of a 10-foot drop.

DR. NEWMAN PUT IT THIS WAY: "IN MOST CASES, BOTTOMING (COMPRESSING A HELMET'S EPS COMPLETELY) IS NOT GOING TO OCCUR EXCEPT IN REALLY VIOLENT ACCIDENTS. AND IN THESE KIND OF CASES, ONE MIGHT LEGITIMATELY WONDER WHETHER THERE IS ANYTHING YOU COULD DO."

To Snell? Or Not to Snell?

In analyzing the accident-involved helmets, the Hurt researchers also addressed the question of whether helmets certified to different standards actually performed differently in real crashes; that is, did a Snell-certified helmet work better in actually protecting a person in the real world than a plain old DOT-certified or equivalent helmet? The answer was no. In real street conditions, the DOT or equivalent helmets examined worked just as well as the Snell-certified helmets.

In the case of fatal accidents, there was one more important discovery in the Hurt Report: There were essentially no deaths to helmeted riders from head injuries alone.

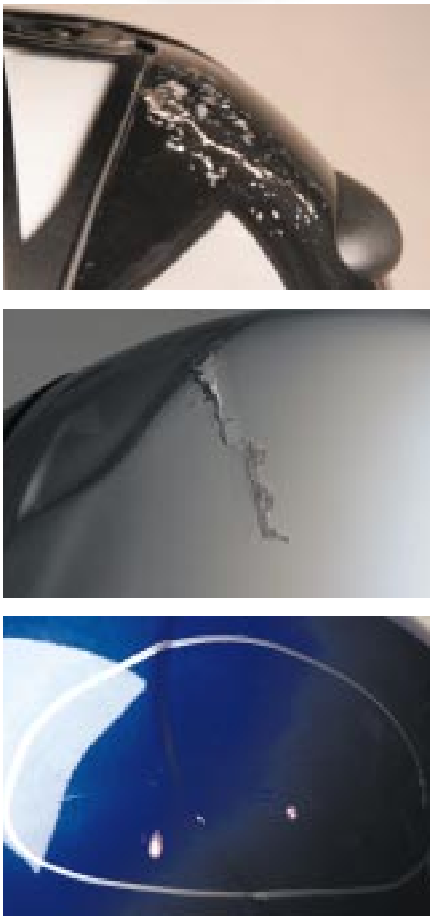
Some people in the study, those involved in truly awful, bone-crushing, aorta-popping crashes, did sustain potentially fatal head injuries even though they were wearing helmets. The problem was that they also had, on average, three other fatal injuries that would have killed them if the head injury hadn't.

In other words, a crash so violent that it overwhelmed *any* decent helmet was usually so violent it essentially destroyed the rest of the body as well.

Newman put this into perspective. "In most cases, bottoming [compressing a helmet's EPS completely] is not going to occur except in really violent accidents. And in these kind of cases, one might legitimately wonder whether there is anything you could do."

How many people were saved because their helmet was designed to a "higher" or "higher energy" standard than the DOT standard? As far as the Hurt researchers could ascertain, none.

But the Hurt Report was done nearly 25 years ago. Well, there have been a couple of significant accident studies done since. Both of which, by our reading,



Fiberglass helmets like the Shuberth S1 (top) and the Arai Tracker (center) showed substantial damage to the shells after the edge impact. The polycarbonate-shelled helmets, like the Scorpion EXO-400, were largely unmarked. Neither result is essentially better: either shell material can be used to make excellent helmets. Polycarbonate-shelled helmets generally transmitted fewer gs to the head in our testing than fiberglass-shelled lids—even when certified to the same standards.

tend to back up the Hurt Report's findings.

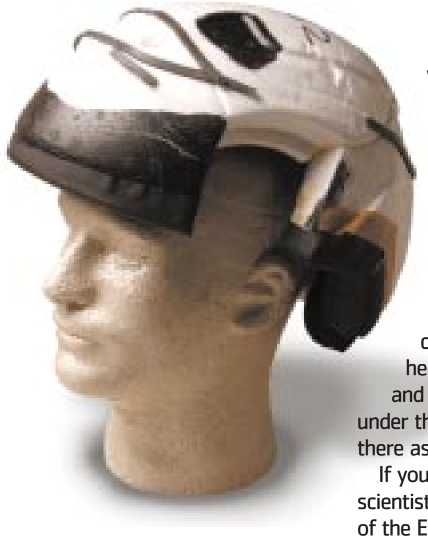
The COST 327 study investigated 253 motorcycle accidents in Finland, Germany and the United Kingdom, from ’95 to “8. Of these, the investigators selected 20 crashes that were well documented, and replicated the impact from those crashes by doing drop tests on identical helmets in the lab until they got the same helmet damage. This allowed them to find out how hard the helmet in the accident had been hit, and to correlate the impact with the injuries actually suffered by the rider or passenger.

The COST 327 results showed that some very serious and potentially fatal head injuries can occur at impact levels that the stiffer current helmet standards—such as Snell M2000 and M2005—allow a helmet to exceed.

And remember, these guys are investigating crashes in Europe, where Snell-rated helmets are a rarity, because Snell helmets can't generally pass the softer ECE standard required there.

In other words, the latest relevant study, done using state-of-the-art methods, covering accidents in countries where there are plenty of 10-second, 160-mph superbikes running around, concludes that current standards—even the relatively soft ECE standards—are allowing riders' heads to be routinely subjected to forces that can severely injure or kill them. The COST people estimated that better, more energy-absorbent helmets could reduce motorcycle fatalities up to 20 percent. If that estimate is legit and was applied over here, it would mean saving about 700 American riders a year.

IF YOU TALK TO THE REPRESENTATIVES OF MANY OF THE TOP SNELL-APPROVED HELMET COMPANIES, THEY'LL IMPLY THAT HELMETS CERTIFIED TO LOWER-ENERGY STANDARDS—THAT WOULD BE ANY OTHER STANDARD IN THE WORLD—ARE SUSPICIOUS OBJECTS, MUCH LIKE SMOKED CLAMS FROM THE 99-CENTS-ONLY STORE.



There's no good reason to think things are different here in the States than they are in Germany, Britain and Finland, all modern, well-developed, superbike-rich countries. Heads are heads, asphalt is asphalt, and falling bodies operate under the same laws of physics there as they do here in America.

If you ask most head-impact scientists or the representatives of the European helmet manufacturers how they like the Snell M2000/M2005 standard, they will generally tell you that it's unrealistic, based more on supposition than on science, and forces manufacturers to make helmets that are stiffer than they should be.

If you ask the representatives of many of the top Snell-approved helmet companies, they'll say the Snell standard is a wonderful thing, and imply that helmets certified to lower-energy standards—that would be any other standard in the world—are suspicious objects, much like smoked clams from the 99 Cent Store. And not as good at protecting you in an extremely high-energy mega-crash as a Snell-approved helmet.

What the Snell advocates *won't* tell you is that when these same makers sell their helmets in Europe, Japan and the U.K., those helmets are not the same helmets they sell here, and are *not* Snell rated. They are built softer, tailored to conform to exactly the same ECE or BSI standards as the European makers.

If you get these two groups of folks in a room together and ask these questions, we'd suggest wearing a helmet yourself.

Can less be more?

In the last 10 to 15 years a number of Asian-made helmet brands, such as HJC, Icon, KBC and Scorpion, have entered the market to challenge the once-reigning Japanese leaders, Shoei and Arai.

These new brands offer helmets that look and feel pretty

HELMET IMPACT STANDARDS

STANDARD	SNELL M2000/2005	DOT FMVSS 218	BSI 6658-85 TYPE A	ECE EN 22-05	COST 327 (PROPOSED ECE)
FLAT ANVIL	Two Drops (all sizes) 1st: 150 j 2nd: 110 j	Two Drops Small: 63 j Medium: 90 j Large: 109.8 j	Two Drops (all sizes) 1st: 141 j 2nd: 70 j	One Drop Small: 115.3 j Medium: 132.2 j Large: 157.5 j	One Drop Medium: 180 j One Drop Medium: 100 j
HEMI ANVIL	Two Drops (all sizes) 1st: 150 j 2nd: 110 j	Two Drops Small: 47.3 j Medium: 67.6 j Large: 82.5 j	Two Drops (all sizes) 1st: 123 j 2nd: 63 j		
CURB ANVIL				One Drop Small: 115.3 j Medium: 132.2 j Large: 157.5 j	One Drop Medium: 180 j One Drop Medium: 100 j
EDGE ANVIL	One Drop (all sizes) 150 j				
ALLOWED PEAK G	300 g	250 g (dictated by dwell-time limits)	300 g	275 g	180 g for 100 j drops 275g for 180 j drops

much like the Arais and Shoeis we were used to wearing and seeing on all the magazine covers, but at substantially lower prices. Problem is, a lower price, especially in a potentially life-saving piece of safety equipment, can do as much harm as good to a brand; there's always the perception lingering in a buyer's mind that a product can't be as good or protect as well if it doesn't cost as much.

So what can a lower-priced maker do to enhance its brand reputation? Get Snell certified. Whether they think a Snell helmet is actually better at head protection or not—and as we've seen there's no shortage of debate on that subject—they're essentially over a barrel. If they don't get Snell certified, they give the perception their products are not as good as the others on the shelf. And their helmets will sell like Girls Gone Wild videos at a Village People concert.

In six months of researching this article, I spoke to many helmet company representatives. Some in civil tones. Some not so much. One, in particular, summed up the Snell-or-not quandary best. It was Phil Davey, brand manager for the very popular Icon helmets and riding gear. "When you build a helmet for this market, meeting the Snell standard is your first, second, third, fourth and fifth concern. You can then start designing a helmet that's safe," he said.

It is important to note that every one of Phil Davey's Icon helmets is Snell certified. He's no fool.

WE SUBJECTED THE SOFTEST HELMETS—THE Z1R ZRP1S—TO EXTRA, "LET'S-KILL-THEM-IF-WE-CAN" IMPACTS. WE RAN THE RIG UP TO THE MAX AND LET FLY. THESE INDIVIDUAL IMPACTS WERE TRULY MONSTROUS—WAY BEYOND THOSE CALLED FOR IN ANY STANDARD, SNELL 2005 INCLUDED.

The rules rule

OK. We promised you an actual helmet impact test, so we suppose it's time to give it to you.

We asked the major helmet brands sold in the U.S. to each pick one model of their helmets. We asked for two functionally identical helmets in the same size, medium or 7¼. Why two? To give us a look at the consistency of the manufacturer's production techniques. Why all one size? To make sure any differences we saw were due to design and production differences, not random differences due to differing sizes. And we wanted to use the same-size headform in all our testing, again for consistency.

We were also interested in learning as much as we could about different helmet constructions, and about how helmets built to different standards vary. So if a manufacturer made both fiberglass-shell and plastic-shell helmets, we invited it to send a pair of each. And if a manufacturer made helmets to two different standards, we invited it to send both as well.

Icon and Scorpion sent both fiberglass and polycarbonate helmets, all Snell/DOT rated. AGV sent a pair of Snell/DOT-rated X-R2s and a pair of BSI/DOT rated TiTechs. And Suomy sent the same model, its Spec 1R, in both BSI-rated and ECE-rated versions.

In the end, we wound up with 16 models, 32 helmets in all. A look at the accompanying chart will give you a rundown of the helmet brands that elected to participate and the models they sent. A number of manufacturers chose not to participate: Bell, KBC, OGK, Shoei and Simpson were contacted repeatedly, but chose not to send helmets. We also tested a couple of full-face Raider helmets purchased from Pep Boys for $69.95 a pop.

Unlike in other standards testing, where the test parameters are published often years ahead of time, we did not reveal the actual tests we were going to do to the manufacturers before we did the testing. So there was, essentially, no chance for them to send mislabeled or "ringer" helmets.

We needed somebody to help us design the tests and do the actual testing. So we hired David Thom. Remember the Hurt Report? Thom was one of the USC researchers who went out to investigate all those motorcycle accidents and then helped pull it all together. Thom worked at USC with Professor Harry Hurt for many years, investigating all the various ways motorcyclists and other folk hurt themselves, and striving mightily to find ways to prevent that.

Thom now works for his own company, Collision and Injury Dynamics. He has his own state-of-the-art helmet impact lab where he does impartial, objective certification testing for many helmet companies. The DOT standard, for instance, relies on companies certifying their own helmets, and Thom is one of the people they contract with to do the actual testing. In other words, he knows what he's doing.

We had no interest in checking to see whether our helmets conform to any specific standard. Because a helmet's job is protecting your head, not passing a standard. *We came up with our own battery of tests designed to duplicate, as best we could, the impacts that really happen on a statistically*

continued on page 140

continued from page 80

significant basis.

Real motorcycle accidents don't end with a helmet hitting a machined stainless-steel anvil—they end up with a helmet bashing down on good old lumpy, gravel-studded asphalt. So the industrious Mr. Thom grabbed a square-foot piece of Sheldon Street in El Segundo, California, the street out in front of his lab, when the paving crew tore it up for resurfacing. He set that in concrete, and that would be our "anvil," as they say in the biz, for our flat-surface impacts.

Three of the four impacts we planned for each helmet would be on that flat asphalt surface—simply because that's what real motorcyclists land on when they fall, over 75 percent of the time. The Hurt Report established this, and in the recent Thailand helmet study 87.4 percent of the helmet hits were from the road surface or the shoulder. Helmets do hit curbs a small percentage of the time, but usually after sliding along on the road for a while, which means that in most cases they are actually hitting a flat surface—the vertical plane of the curb.

As for the energy of each drop, we selected a range of hits typical of both the DOT and Snell testing regimens. We hit the left front and the left rear of the helmets with an energy of 100 joules, which translates to a drop of about two meters, or 6.6 feet. According to the findings of the Hurt Report, this drop represents the 90th-percentile energy of the crashes they investigated.

We also did one high-energy drop with an energy of 150 joules, the same energy—about a 10-foot drop—as the hardest hit specified in the Snell standards, on the right front of each helmet. This drop is 66 percent more violent than the drop specified by the DOT standard for a medium-sized helmet, and represents the 99th-percentile impact seen in the Hurt Report. Which means that 1 percent or fewer impacts seen on the street exceeded this energy level. So we weren't exactly taking it easy.

To see what happens when you're unlucky enough to rear-end a truck's lift gate, slide into a storm drain or be flung into the Eiffel Tower, we also did an edge hit onto a scary-looking piece of upright steel bar. We debated whether to do this hit at a two-meter, 100-joule energy level or a more violent three-meter, 150-joule impact level. We opted for the smaller hit, more to protect the helmet test rig than to play nice with the helmets. If a single helmet bottoms out, that is, squishes its EPS liner flat, the total impact goes right into the headform and test rig—as it would to your head. And just like your head, the test rig is gonna break. We weren't sure all the helmets would survive the 150-joule edge drop, so we pulled back to the 100-joule level. If we fractured the rig, we'd be out of commission for days, and we simply didn't have the time—or money—to risk that.

> REAL MOTORCYCLE ACCIDENTS DON'T END WITH A HELMET HITTING A MACHINED STAINLESS-STEEL ANVIL—THEY END UP WITH A HELMET BASHING DOWN ON GOOD OLD LUMPY, GRAVEL-STUDDED ASPHALT.

In the end we were too conservative. When we inspected the helmets after the full course of testing, we realized that the 100-joule edge hit hadn't come close to bottoming any of the helmets—even the supposedly wimpy DOT-only ones. We are confident we could have done the edge test at the 99th-percentile 150 joules—the Snell edge-anvil test—and seen results commensurate with those we saw from the other impacts.

The results of all our laborious impact testing were exactly as we might have expected—and still surprising as hell.

The helmets ranged from the softest regimen, the DOT standard, to the Snell standard, the stiffest. But would the real-world, production-spec helmets actually show that progression from soft to stiff? In other words, can you predict how stiff a helmet will be simply by looking at the standard label?

Absolutely.

In fact, our results show that modern helmets are *all* made with an amazing degree of precision, with their shell construction, liner density and liner thickness all controlled very well in the production process. In other words, *almost everybody designing serious helmets seems to know exactly how to get what they want—the only variable is deciding what they want*. And for the most part, the standards are making that decision for them, not flashes of genius on the parts of the helmet designers themselves.

All the helmets we tested performed exactly as the standards they were designed to meet predicted. And they seemed to exceed those standards—that is, the DOT-only helmets were better at high-energy impacts than they had to be just to pass the DOT standard, and the Snell helmets were better at absorbing low-energy impacts than *they* had to be to pass DOT or Snell.

So choosing a helmet, at least in terms of safety, is not a question of choosing high or low quality, it's one of choosing what degree of stiffness you prefer, finding a helmet in that stiffness by choosing a particular standard, and *then* worrying about fine points like fit, comfort, ventilation, graphics, racer endorsements or computer-generated spokesmodels.

How hard is hard?

Not one helmet came close to bottoming in any of our tests. And they all handled the low-energy impacts, even the scary-looking edge impact, without strain.

In fact, in most cases the peak Gs in the edge impact were lower than the flat-anvil peak Gs for the same helmet at the same impact energy. Why is this? Because the edge impact flexes and/or delaminates the helmet shell sooner in the impact, letting the EPS inside—the real energy absorber in the system—start doing its work sooner.

In the high-energy impact, the three-meter, 150-joule drop—the kind of high-energy hit a Snell helmet is, presumably, designed to withstand—the differences became more apparent.

The stiffest helmets in the Big Drop test, the Arai Tracker GTs, hit our hypothetical head with an average of 243 peak Gs. The softest helmets in the test, the Z1R ZRP-1s, bonked the noggin with an average of 176 peak Gs. This is a classic comparison of a stiff, fiberglass, Snell-rated helmet, the Arai, against a softer, polycarbonate-shell, DOT-only helmet, the Z1R.

OK. So let's agree that we want to subject our heads to the minimum possible G force. Should we pick an impressive, expensive fiberglass/Kevlar/unobtainium-fiber helmet—or one of those

continued from page 141

less-expensive plastic-shelled helmets?

Conventional helmet-biz wisdom has it that fiberglass construction is somehow better at absorbing energy than plastic—something about the energy of the crash being used up in delaminating the shell. And that a stiffer shell lets a designer use softer foam inside—which might absorb energy better.

Our results showed the exact opposite—that plastic-shelled helmets actually performed *better* than fiberglass. In our big, 3-meter hit—the high-energy kind of bash that one might expect would show the supposed weaknesses of a plastic shell—the plastic helmets actually transferred an average of 20 fewer Gs, compared with their fiberglass brothers, which were presumably designed by the same engineers to meet the same standards, and built in the same factories by the same people.

Why is this? Well, we're guessing—but it's a really good guess. And our guess is that the EPS liner inside the shell is better at absorbing energy than the shell. The polycarbonate shells flex, rather than crush and delaminate, and this flexing, far from being a problem, actually lets the EPS do more of its job of energy absorption while transferring less energy to the head.

Remember, these particular polycarbonate helmets, from both Icon and Scorpion, are also Snell M2000 rated. So they are tested to some very extreme energy levels. And Ed Becker, the executive director of the Snell Foundation, is on record as saying that a low-priced—that is, plastic-shelled—Snell-certified helmet is just as good at protecting your head as a high-priced—that is, fiberglass—Snell-certified helmet. So at the high end of impact energy, we have the Snell Foundation vouching for their performance. And our testing, without the extreme two-hit hemi test, says they're actually superior.

Score one for faceless government bureaucrats

The DOT helmets we had were all plastic-shelled, and none cost more than $100. How did they do? They kicked butt. In what must be considered a head-impact Cinderella story, the DOT-only helmets from Z1R and Fulmer delivered less average G force to the headform, through all the impacts, than any others in the test.

And both still excelled in the big-hit, 150-joule impact—a blast 66 percent harder than any actual DOT test for a medium-sized helmet.

The Z1R ZRP-1, in particular, continuously amazed us. After all the testing, its outer shell looked essentially unharmed: the slight road rash at the impact sites caused by our stubborn insistence on hitting actual pavement looked no worse than we'd expect if the helmet had fallen off the seat at a rest stop.

When we pulled the ZRP-1 apart we saw that the EPS had cracked and compressed at the impact sites, just as it's supposed to do, and as it did in every other helmet. But it had come nowhere near bottoming; there was still an inch or more of impact-absorbing foam left. And the plastic shell seemed completely unharmed, from the inside as well as the outside, even where it had taken the terrifying edge hit and the big three-meter bash.

This illustrates just how hard it is to tell, from the outside, whether a helmet has taken a severe hit. And why you should never, ever buy a used helmet.

The Hardest Hits

So the softest DOT helmets came through our tests with protection to spare. But the doubt still lingered, in spite of everything we had seen: How would they do in a monster, wicked big impact?

IN OUR BIG, THREE-METER HIT—THE HIGH-ENERGY KIND OF BASH THAT ONE MIGHT EXPECT WOULD SHOW THE WEAKNESSES OF A PLASTIC SHELL—THE PLASTIC HELMETS ACTUALLY TRANSFERRED AN AVERAGE OF 20 FEWER GS, COMPARED WITH THEIR FIBERGLASS BROTHERS

So we decided to kill them. We ran the Z1Rs up the test rig one last time. Not just to the 10-foot, 150-joule Snell test height, but all the way to the top of the rig: 3.9 meters, or 13 feet. This hit would be at 8.5 meters per second, an energy of 185 joules. That's higher and harder than any existing helmet standard impact. And, not coincidentally, the same height and energy called out in the COST 327 proposed standard, the one that may replace the current ECE 22-05 spec.

We did one hit on the pavement and one hit on the curb anvil—the same hits called out in the COST proposal. We did them on the back of the helmets, in the center, because that was the only place we hadn't hit them before.

So this last test is not directly comparable to the others. But it showed, in no uncertain terms, just how tough—and how protective—an inexpensive helmet can be.

The peak Gs for the monster hits were 208 G for the curb impact and 209 G for the flat-pavement impact. Just a few Gs more, that is, than many of the Snell-rated helmets transmitted in their *seven-foot* hits on the flat anvil. And even after those mega hits, the EPS liners were still nowhere near used up.

The ZRP-1s are also well finished, quiet and very comfortable, though maybe a little short on venting. They're also light: Our ZRP-1s weighed only about an ounce more than the lightest helmets in the test, the Arai Tracker GTs.

What's the cost for all this excellent impact absorption, comfort, light weight and highly durable finish? In a solid color, a ZRP-1 retails for $79.95.

The least-expensive helmets in the test, the $69.95 Pep Boys Raiders, also did well in all the standard impacts. But we hesitate to recommend them because their chin bars have soft, resilient foam, not the EPS you need to absorb a severe head-on impact. Our advice is to spring for the extra $10 and treat yourself to a Z1R ZRP-1.

Another helmet that taught us a thing or two was the Schuberth S-1. The Schuberth is certified to the ECE 22-05 standard, which dictates impact energies marginally higher than the DOT standard. Like the Z1R ZRP-1 and the Fulmer AFD4, it has relatively large outer dimensions, leaving room in the shell for thicker, and presumably softer, EPS. And like the DOT-only lids, it soaked up energy like a sailor soaks up Schlitz. If you can't bring yourself to wear a $79.95 helmet just to get excellent energy management, you'll feel very comfortable with the Schuberth, which sells for between $640 and $700.

The other helmets we pulled apart used either a one-piece or a two-piece EPS liner. The S-1, on the other hand, uses a com-

continued from page 143

plex, five-piece liner, with separate front, rear and overear pads glued to a central foam hat. Leave it to the Germans to use five parts to do what the Z1R does with one.

A few of the European helmets—the Vemar, the Shark and the Suomy—use a different kind of EPS liner than we're used to seeing in Asian-built helmets. Instead of a solid foam liner of a specific density, these Euro-lids use stiffer, more rigid foam, but with deep channels in it to soften up the assembly and to vent air through the shell. The effect is that of a highly vented bicycle helmet stuffed into the requisite hard outer shell. Both the ECE-rated Vemar and Shark, and the ECE and BSI-rated Suomy performed well on the impact torture rack, showing generally lower G-transmission than we saw in typical Snell-rated helmets.

The Human Race

"But I'm a racer," we hear you rationalizing. "I go really fast. I go so fast, in fact, that I need a very special, high-energy helmet to protect my wonderful manliness and fastness."

Not so, Rossi breath.

If you're going to land on flat pavement when you crash—and you almost always do—you can afford to wear a softer ECE or DOT helmet, because softer helmets do a very good job of protecting from big impacts—even really, really big impacts—on flat surfaces. Remember, the hard part about getting a helmet past the Snell standard involves hitting that mythical steel orange, very hard, twice in the same spot on the helmet, simulating a monster hit—or two—on, say, a car bumper. Been to Laguna Seca recently? No car bumpers or steel oranges nowhere.

Racers don't typically hit truck parts, storm drains, sign posts, tree shredders or the Watts Towers. They fall off, sometimes tumble, and almost always hit the racetrack. Or maybe an air fence, a sand trap or hay bale. In other words, the racetrack is the best-controlled, best-engineered, softest, flattest environment you're going to find. Racers are even more likely to hit flat pavement than street riders—and street riders hit flat pavement around 90 percent of the time.

The AMA accepts DOT, ECE 22.05, BSI 6658 Type A or Snell M2000-rated helmets. That's for going 200 mph on a superbike at Daytona. The FIM, which sanctions MotoGP races all over the world, accepts any of the above standards but DOT. Why not DOT if DOT helmets are comparable to ECE helmets? Because the DOT is an American institution, and the FIM doesn't really do America. And because the DOT standard doesn't require any outside testing—just the manufacturers' word that their helmets pass.

"BUT I'M A RACER," WE HEAR YOU RATIONALIZING. "I GO REALLY FAST. I GO SO FAST, IN FACT, THAT I NEED A VERY SPECIAL, HIGH-ENERGY HELMET TO PROTECT MY WONDERFUL MANLINESS AND FASTNESS." NOT SO, ROSSI BREATH.

Yes, size does matter

There's one more issue with the Snell and BSI standards we should mention, even if we didn't specifically address it in our testing.

Snell and BSI dictate that every helmet be impact-tested with the same-weight headform inside, no matter the size of the helmet. That is, an extra-small helmet is required to withstand exactly the same total impact energy as an extra-extra large.

The DOT and ECE standards vary the energy of the impacts by varying the weight of the headform, under the reasonable rationale that a very small head weighs less than a very big one. In the eyes of the governments of both the U.S. and the European Community, in other words, helmet makers should tailor the stiffness of their helmets to suit the head sizes of the wearers to protect everybody's brain equally.

What does this mean to you? If you have a relatively heavy head, the difference in stiffness between a Snell helmet and a DOT or ECE helmet will be relatively small. If you are a man, woman or child with a lighter head, on the other hand, the difference in stiffness between a Snell helmet and a DOT or ECE helmet will be relatively huge.

So if you are concerned, after reading all this, that a Snell helmet might be too stiff for you, Mr. XXL, you should be even more concerned about putting your XS wife or child into a Snell or BSI helmet.

The Snell Foundation's position on this is that they have no proof that big heads weigh more than small heads. Hmmm. Isn't a head basically a shell of thin bone filled with water? Doesn't more bone and water weigh more than less bone and water?

And it's not just us. One study, by our own Dave Thom, concluded that head weight *does* increase with head circumference. He found there is good evidence that smaller heads weigh less and that smaller helmets should thus be softer.

As Thom says regarding the Snell Foundation position on this: "They are not in touch with reality."

All helmets are great. We investigate

The good news in all this is that helmets—*all helmets*—are getting better. The last time we did an impact test on helmets was back in '91, in the November issue if you're going to go rummaging through that pile in the garage next to your 1929 Scott Flying Squirrel.

We did some of the same impacts this time, a six-foot flat drop and a 10-foot flat drop, as we (and Thom) did in '91. So the results, at least on those tests, are highly comparable.

Back in '91, both DOT and Snell/DOT helmets routinely exceeded 250 Gs in the six-foot drop, and often spiked past 300 Gs in the 10-foot drop. Ouch.

In our new results, no helmet exceeded 250 Gs in the 10-foot drop, and the vast majority of the six-foot drops stayed well below 200 Gs. So falling at a 10-foot energy level today—a 99th-percentile crash—is like falling at a six-foot energy level was back in '91. Meaning that more and more people are being protected better and better.

It also means that in well over 90 percent of the impacts we did, the rider would probably have come out with no more than an AIS 3—or serious—brain injury.

So helmets are getting better, And some of the least-expensive helmets provide truly amazing protection. But just how good can helmets get? Stay tuned—we're gonna explore just that topic next month. MC