SNELL MEMORIAL FOUNDATION ®
ESTABLISHED 1957

Voluntary & Mandatory Motorcycle Helmet Standards

IFZ Conference

October, 2012

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This is a presentation delivered October 2, 2012 at the IFZ conference in Cologne, Germany. The presentation does not follow the development of the paper I prepared for that conference but there is a considerable overlap in the ideas and arguments. I hope that you will read through both the paper and the presentation and that you will consider the time well spent.

Sincerely

Ed Becker

Main Thrust

- Current Mandatory Helmet Standards
  - (that is: Government minimum requirements)
    - In the US: FMVSS 218 (DOT)
    - In Europe: ECE 22-05 (UNECE Regulation 22)
  - Ask for much less than what riders should reasonably demand
- Some ECE 22-05 and some DOT Helmets
  - Will provide much more crash protection than others.

The argument I'm here to make today is that modern technology and materials enable motorcycle helmets to be much more protective than current traffic regulations demand. This additional protection is not to be found in every current helmet but there are helmets available which will provide crash protection well beyond that demanded by DOT in North America or by ECE 22-05 in Europe.

This is important because even the most protective helmet currently possible may not be enough. There are reasonably foreseeable crashes which will exceed the best helmet's protective capabilities to prevent death or serious, long term disability. Riders cannot get all the head protection they might need. Next best is to wear all the protection they can reasonably carry on their heads.

Which Ones?

- The ones which are also Snell M2010
- Snell M2010 certification plus ECE and/or DOT
  - Demonstrates superior protective capability
  - Well beyond that of DOT or ECE 22-05
- Superior Protective Capability
  - Is invisible at time of purchase
  - Certification to a voluntary standard may be the best way to know

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Which helmets are more protective? Those which are also certified to Snell M2010. I say "also" because helmets sold for street use in North America are legally obliged to meet Federal Motor Vehicle Safety Standard 218 which is also known as DOT; and over here these helmets must meet ECE 22-05. Fortunately, neither of these is intended to limit protective capability; there is no objection what-so-ever to helmets exceeding DOT or ECE 22-05. The catch is that unless a rider goes looking for superior protective capability, he's very likely not to get it. And looking for additional protection is not straightforward. Superior crash protection is invisible at the time of purchase. The best most riders can do is look for certifications to standards demanding more than just the statutory minimums. I urge Snell certification in addition to the ECE or DOT labels for riders who want more than just the statutory minimums.

Who/What is Snell

- Crash Helmet Standards & Programs Group
  - Mission:
    - To Encourage the development, manufacture and use of superior headgear
  - Non-Government & Not-for-Profit
    - 501 C3 – Testing for public safety
  - Expert board
    - engineers, scientists and medical doctors
  - Salaried staff
    - Engineers, test technicians

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Snell is a crash helmet standards and programs group. We publish standards and we administer certification programs for those standards. Effectively, we tell the industry what sorts of protective performance their helmets ought to provide and invite them to submit their best helmets to us for testing. If the helmets meet our requirements, we offer our standard license agreement. This is effectively a contract which entitles the manufacturer to use our name and logo to market his helmet but which also allows us to perform routine enforcement testing on samples of that helmet from then on.

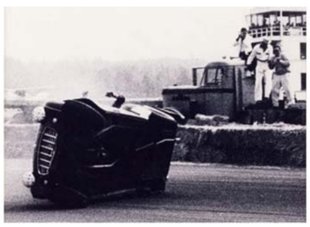
We're not a part of the US government. Instead, we're organized as a 501 C3 corporation performing testing for public safety. This means no tax-free donations and no political activity.

We're not-for-profit and our accountants tell me there's no danger of this changing.

We have an expert board composed of engineers, scientists and medical doctors and a salaried staff of engineers and test technicians, of which I am a member. No member of the board or the staff has any financial interest in or separate professional connection with any helmet company.

Beginnings

- Amateur Racer William “Pete” Snell
- Rollover Crash in Arcata, California,
  - August 6, 1956
- Pete died of head injuries
  - Sustained in a then state-of-the-art helmet



The Snell Foundation goes back to the 1950’s. William “Pete” Snell died of head injuries received in an amateur racing crash in 1956. He had been wearing what was then a state of the art helmet but which failed to prevent fatal head injuries in what was otherwise said to be a survivable crash.

Incorporation

- Snell Memorial Foundation
- August, 1957
  - In California
- Dedicated to:
  - The development, production and use of superior head protection
  - And to the memory of Pete Snell

Dr. George Snively

Founders:

- Dr. George Snively
- Dr. Clinton Chichester
- Mr. Rod Aya

Dr. George Snively had been investigating auto racing helmets and crash injuries on his own at that time. With the support of the Sports Car Club of America, Snively and Pete's other friends and admirers continued these efforts under the auspices of the Snell Memorial Foundation which was incorporated the following year in California.

The first Snell standard was published in 1959. Although Snell and Snively set out to improve auto racing helmets; motorcyclists began wearing them as soon as they became available. This worked well for everyone. There are a lot more riders than auto racers. Their demand and economic power have driven helmets and helmet capabilities well beyond that first 1959 Snell standard.

What Snell Wants

"All the impact protection a rider can reasonably wear"

- More Impact Energy Management
  - Higher impact velocities
- Which Implies
  - Thicker helmet liners
  - And/or stronger, more rigid helmet shells
- And, ultimately
  - Heavier helmets with bigger silhouettes

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Snively had and Snell continues to have definite ideas about impact protection. We look for safe levels of shock attenuation for the highest impact velocities reasonably possible. Higher impact velocities necessitate thicker helmet walls and stronger, tougher shells. That means heavier, bulkier helmets. The limits for these are always what riders are willing to wear. We cannot force anyone to wear heavier, bulkier helmets but many riders seeking superior protection wear Snell helmets voluntarily. And those helmet companies voluntarily seeking Snell certification do so in order to serve these riders.

In our fifty plus years, Snell standards with the support of many US motorcyclists, have demanded progressively greater levels of impact management. Interestingly, as Snell helmets have gotten bigger and bulkier, so have many non-Snell helmets. The larger silhouette has become familiar. Many are willing to put up with the extra bulk even if they haven't thought about crash protection. But if riders are willing to put up with heavier, bulkier headgear, they ought to get the superior protection to go with it.

DeMarco, Alyssa L, et al. The impact response of motorcycle helmets at different impact severities, Accident Analysis and Prevention, 2010

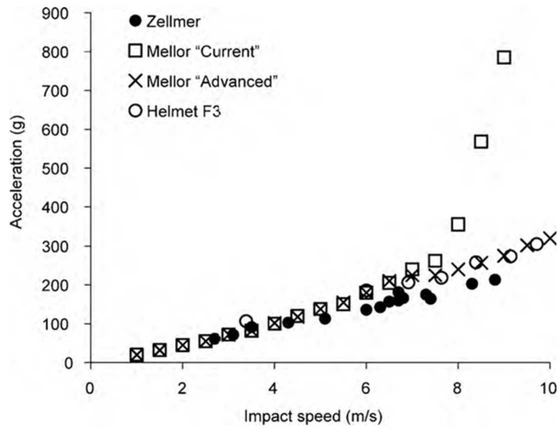

Fig. 8. Comparison of the ECE helmet data (Zellmer, 1993; Mellor and StClair, 2005) against helmet F3. The “Current” helmet is an ECE-approved helmet; the “Advanced” helmet is one developed by Mellor and StClair (2005).

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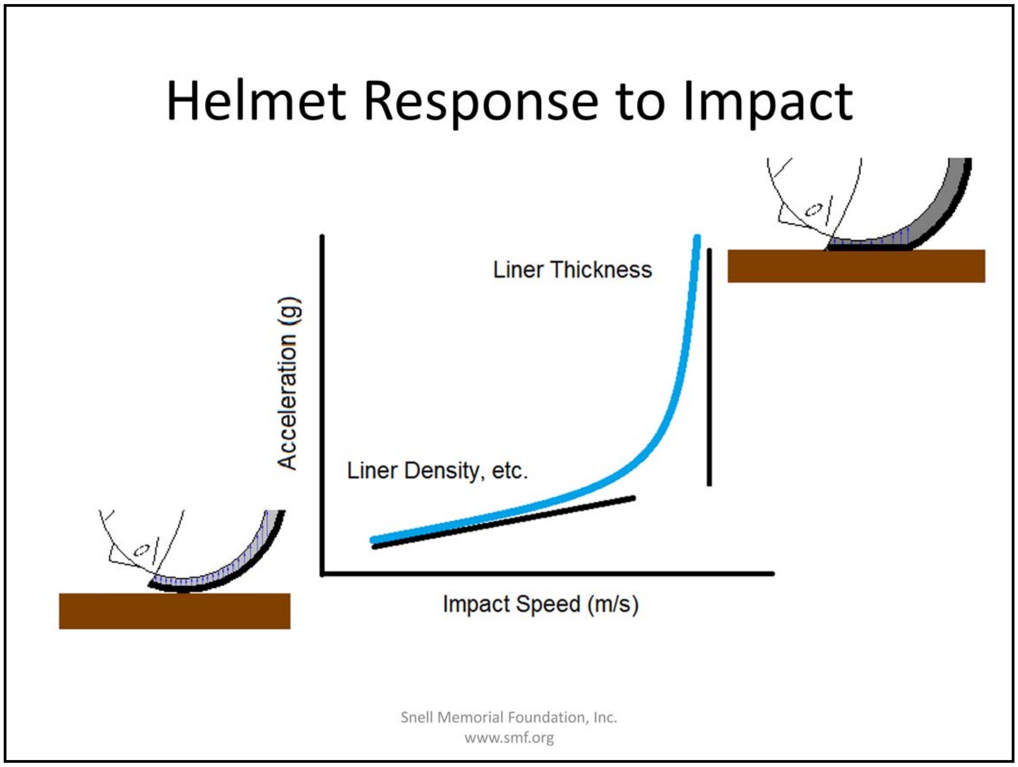
What of current helmets?

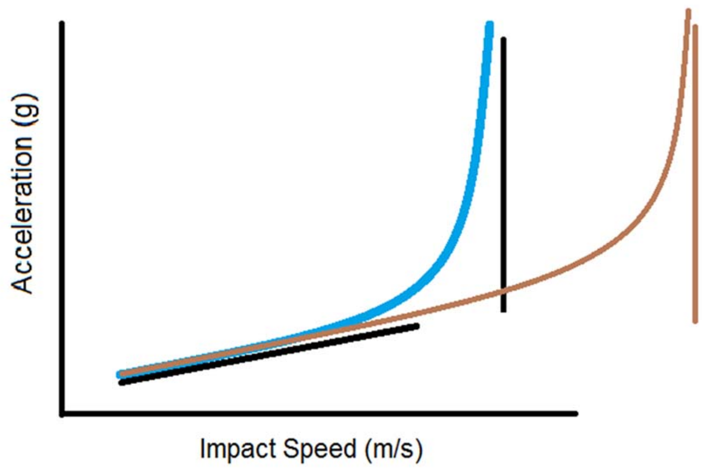
This is taken from a paper published in 2010. It shows peak G, a measure of the shock passed through a helmet into a test head form, versus impact velocity. Essentially, technicians dropped a series of similar helmets onto a flat surface at progressively higher speeds measuring the shock for each drop. They did this for a number of different helmet models and compared the results. Two of the helmet models were commercially available, the hollow circles are for an older Snell certified model and the hollow squares are an ECE model. The other two are for experimental prototypes. The graph shows all the helmets following essentially the same straight line up to just below 8 m/sec when the ECE helmet breaks sharply upward. Presumably, the other models will also break upwards too but at some impact velocity greater than 10 m/sec

This upward break means the protective capabilities of the helmet are about to be exhausted. Once the helmet has been used up, any remaining shock goes straight to the wearer. Woe unto the rider who gets a 9 m/sec thump in an 8 m/sec helmet.



This is effectively what's happening. The helmet response is at first dependent on the density of the helmet's impact liner and the shapes of the liner and head form. At higher velocities, though, the liner thickness predominates. The helmet wall cannot be crushed any further than its original thickness. At some point, the helmet response bends away from its initial slope and finally goes vertical.

What Snell Wants



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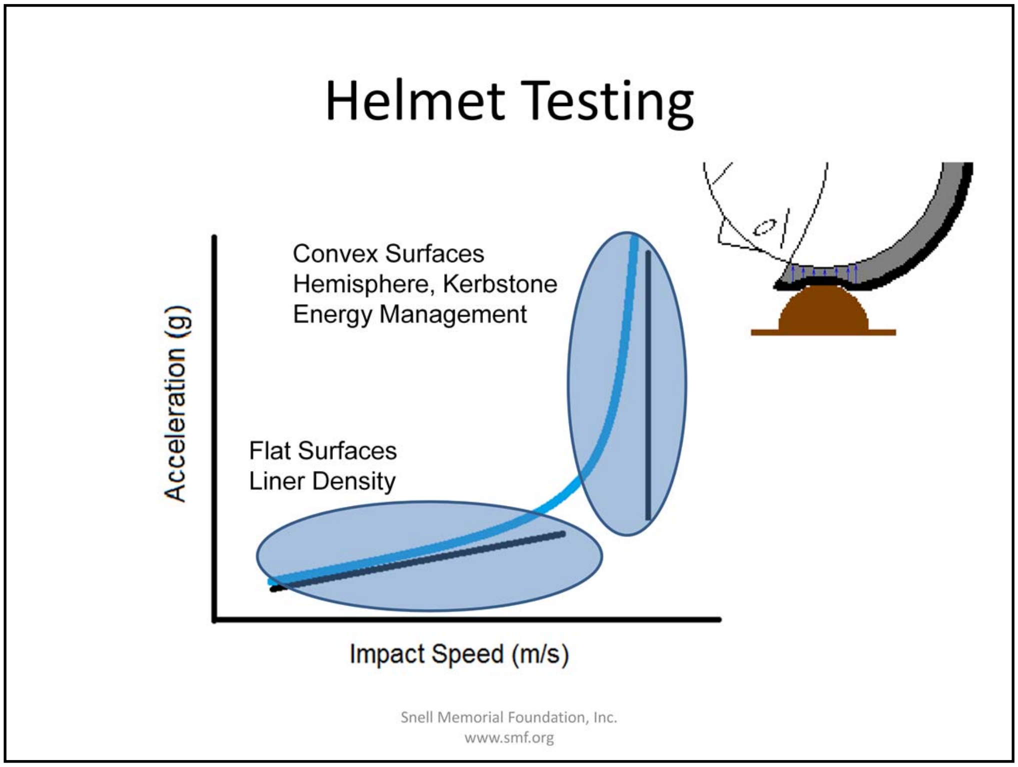
Snell wants that transition to vertical to take place at a significantly higher velocity. The eight meters per second figure works out to just under 29 kph. Even 10 m/s is still only 36 kph. And if the helmet happens to strike some convex shape instead of a nice, flat roadway, that break to the vertical will occur at much lower velocities than these.

Helmets are intended to go crunch in order to protect the head inside but they stop protecting at that break to the vertical. The more impact velocity a helmet can manage before that break, the better.



In helmet testing, we generally test on flat surfaces to see the lower part of the response and on convex surfaces to investigate the upper part. If the helmet liner is too stiff, flat impact is going to let us know. But if the liner is too thin, impact against a hemisphere or kerbstone shape will show it up. It's technically possible to fail against the flat because the liner is too thin or against a convex surface because the liner is too dense but this is unlikely. Flat impact will show up a density problem long before convex impact and vice versa.

Testing Differences

- Guided Fall vs. Free Drop
  - Snell (also DOT & FIA) Impacts Aligned with Head Form C.G.
  - Always worst case
- Two Drops vs. One Drop
- Hemisphere vs. Kerbstone
  - Hemisphere is more aggressive
  - More localized liner crush
- Impact sites: General Area vs. Specific Sites

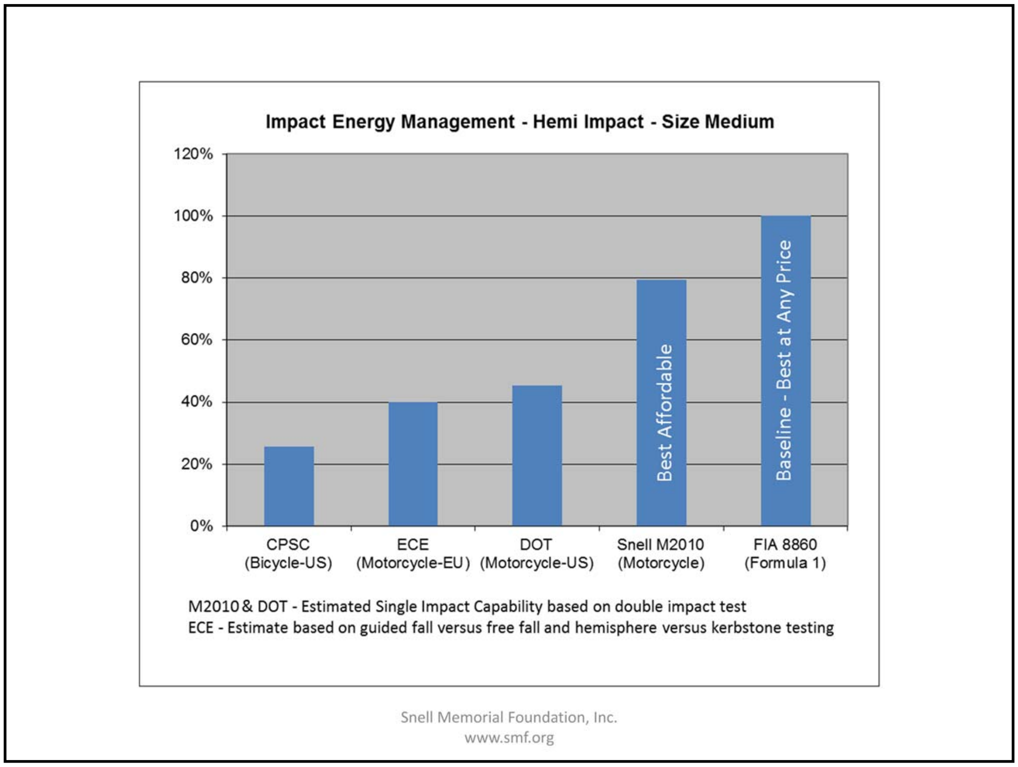
The tests for the various standards are similar but there are differences in equipment and procedure which make for significant differences in the energy management required.

Snell, along with DOT and FIA among others, calls for guided fall which aligns the center of gravity of the head form with the center of the impact surface. ECE testing calls out a different set of test gear which almost assures a substantial misalignment for the most important impact tests causing much of the severity of the impact to be lost to rotation.

Snell also impacts helmets twice. The velocity of the first Snell impact is only slightly greater than that of ECE 22-05 but then Snell performs a second impact.

Snell's convex impact surface is a hemisphere which concentrates the helmet loading about a point rather than along a line. The hemisphere intrudes more deeply into the helmet wall reaching the helmet's crush limits much more quickly than flat surfaces or the ECE kerbstone surface.

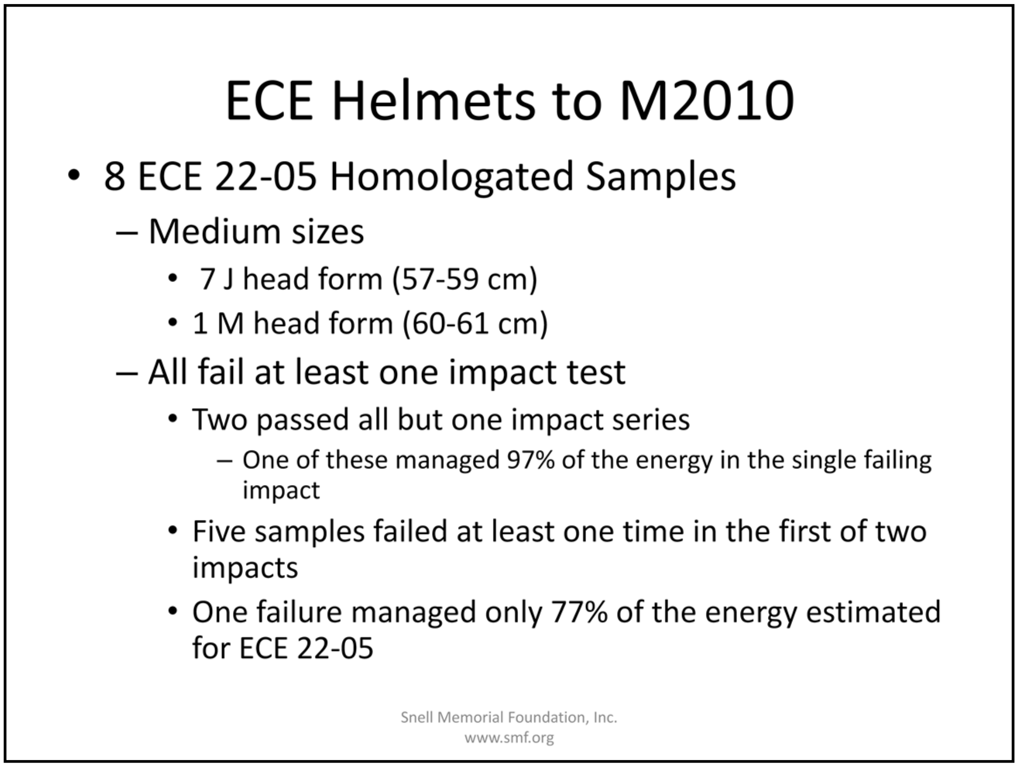
But one of the most serious flaws in ECE 22-05 procedures is that it specifies precise impact sites. There are broad expanses of helmet which are liable to real world crash impacts but which ECE procedures leave strictly alone. Snell testing calls out a test area: a line is drawn around the helmet and test impacts may be sited anywhere on or above it. Snell test technicians select the actual sites. They look to give each helmet model the most difficult test the standard will allow. If there's a hole in the helmet's capabilities, Snell technicians will find it.



This is a comparison of impact energy management for a number of different helmet standards. This energy is proportional to the square of the impact velocity. In a sense, when a motorcyclist accelerates up to speed, he's pumping himself up with kinetic energy and quite a bit of that energy is in his head. Later, when he decelerates to a stop, he gradually reduces his kinetic energy until, at last he can dismount, park the bike and walk away. But in a crash, he's got to off-load all that energy in a hurry. Crashing at speed is like being stopped by the police with a load of contraband, the only way to avoid serious trouble is to rid yourself of that energy, or contraband, very quickly. A good crash helmet can be an excellent place to dump that energy but only if it can handle all the energy you need to dump. This chart compares the energy capacities for a number of helmet standards from the US bicycle helmet requirement right up through the FIA 8860 requirements for Formula 1 headgear.

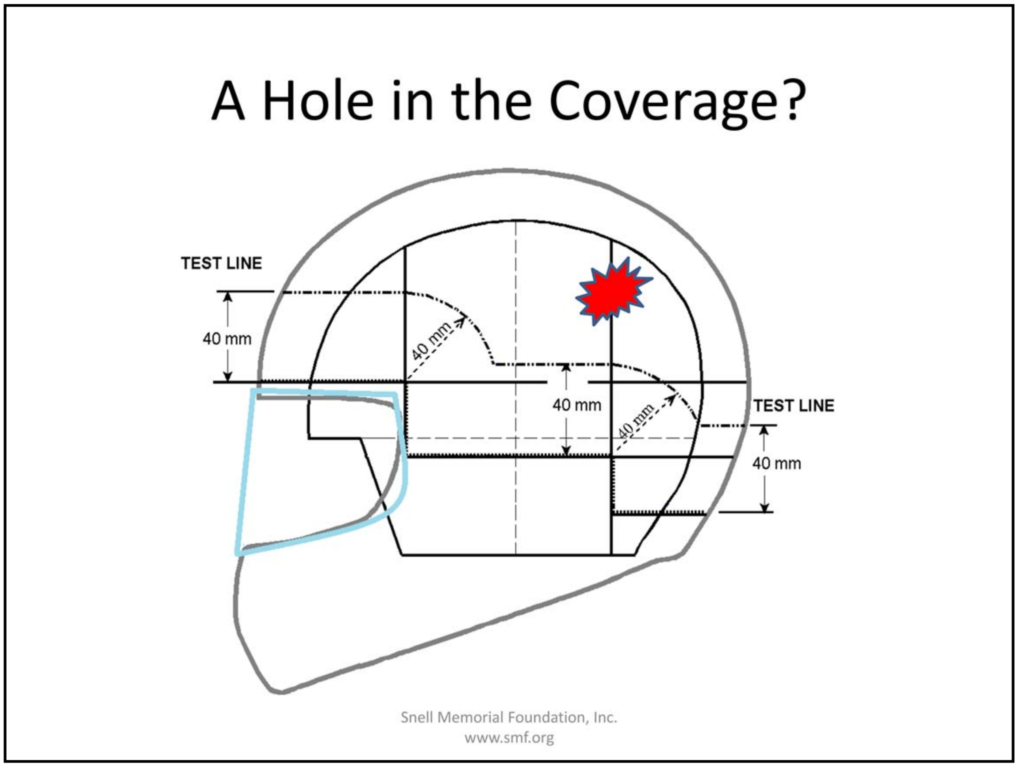
As you can see, ECE and DOT are both more demanding than US bicycle helmet requirements but they are by no means close to Snell. A possible excuse for DOT is that when the drafting began in the early 1970's, they went with essentially the same levels Snell had set in 1968. It's a shame DOT did not move with the times. The last extensive overhaul of ECE 22-05 is much more recent but, in terms of impact management, they're still somewhat below DOT. I've heard that many manufacturers of ECE helmets have had to strengthen their shells and thicken their liners in order to bring them to the US.

The Snell levels are our best estimate of the most protection a rider can reasonably be expected to wear on his head. The concerns are weight, silhouette and expense. If the helmet is too heavy, too bulky or too expensive it won't succeed with the riding public. Of course, I've seen pictures of Tom Cruise on his motorcycle in Los Angeles sporting an FIA Formula 1 type helmet. Excellent protection but this kind of headgear is well beyond most riders' budgets.

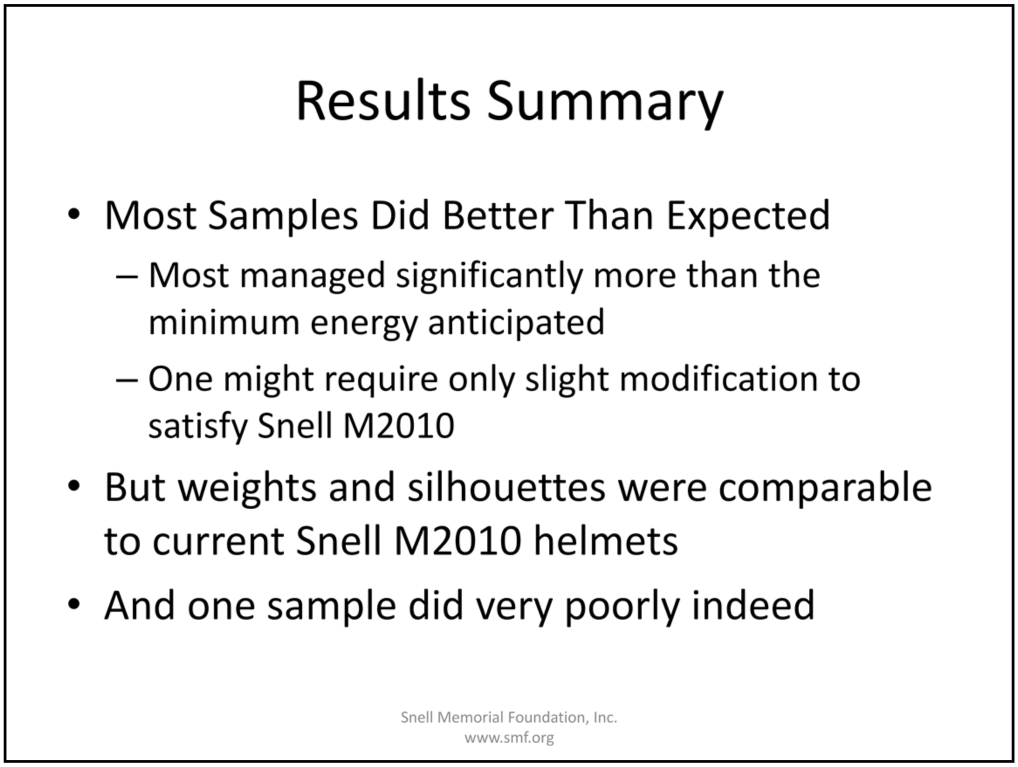


Of course, standards set floors on performance and not ceilings. The best way to know whether helmets built to ECE will also meet Snell is to test them.

We obtained eight samples of ECE helmets from sources in Europe and brought them into the Snell lab in California for impact testing. All failed at least one impact test but one did come within a whisker of passing all the tests. For the most part, the samples did better than my estimates. However, we only tested one sample of each of the eight models. The technician felt that he might have given them a rougher time if he had more samples and could have tested them under hot and cold conditioning. Snell test techs live to fail helmets though and, on the whole, the tech had a pretty good day. And there was one alarming result, at least one sample failed resoundingly managing much less than the energy I had estimated for ECE. Effectively, we found a hole in this particular helmet's capability.



The hole we found is right about here. It’s far enough from the ECE specified site to suspect that the helmet might still meet ECE requirements. I looked at the helmet liner afterwards. It appears to be much more substantial at the ECE site than at the one my colleague found. My guess is that the helmet’s designer had read the standard and knew exactly what was necessary to meet it.



To summarize, most of the samples did better than I expected and one did very well. This one might require only slight modification to satisfy Snell M2010. But the weights and silhouettes of most of these helmets were comparable to current Snell certified helmets. And, of course, one of these samples did very poorly indeed.

Recommendations

- Snell urges all the impact protection a rider can reasonably wear.
- Riders at least ought to have protection
  - Consistent with the best possible for helmets they are willing to wear
- ECE 22-05 should adopt
  - Test lines instead of specific test sites
    - No holes in the coverage
- There ought to be superior helmets for those riders willing to wear them

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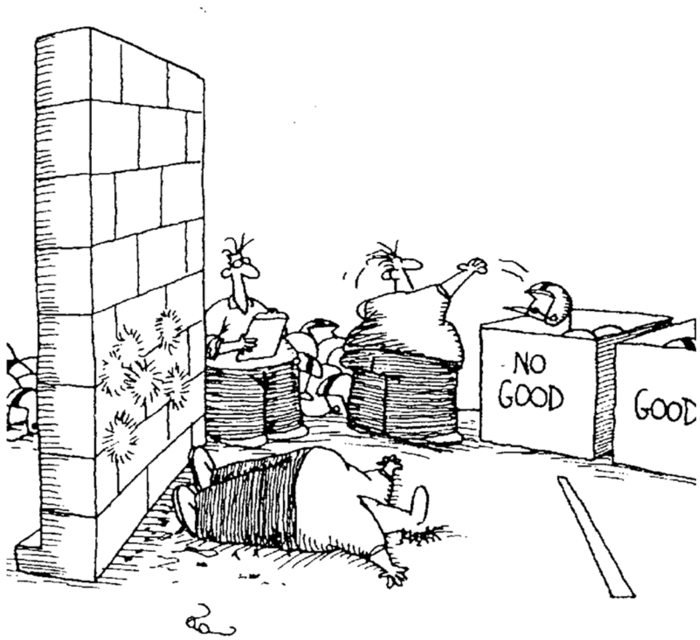
Snell looks for all the impact protection a rider can reasonably wear. We want safe levels of shock attenuation along with all the impact energy management that can be squeezed into a weight and volume that riders might reasonably carry on their heads. And we want it at prices riders can afford.

Many US riders take our advice and I'm grateful to them. If these riders weren't looking for Snell certification in their helmets, the industry would abandon us for sure and Snell would just dry up and blow away. But these riders do look for Snell because they want the superior protection that Snell certification assures. And we at Snell will continue to do all we can to justify their confidence.

Of course, there are quite a few riders who are content with DOT or, at least resigned to it. But if a rider is willing to put up with a full face or three quarter helmet, I think he ought to get the Snell levels of protection those configurations can handle.

As for ECE 22-05, I think the standard should catch up to the industry. Manufacturers can build much more capable helmets with little appreciable change in weight or silhouette and, judging from existing configurations, riders can certainly manage to afford and wear them. At the very least, ECE 22-05 should be rewritten to eliminate the possibilities of holes in the protective coverage.

Finally, riders ought to have a choice. There may be some who will be content with the minimum levels of head protection traffic authorities will tolerate but I am certain there are others who would choose more. Maybe because they have other reasons to live besides riding. Maybe because their families, friends and colleagues would demand it of them. But whatever the reason, their ought to be a tier of superior helmets available, certified to a reliable, voluntary standard. The immediate benefit is better protection for those that choose to wear it. The long term benefit is a continuing challenge to the industry for better headgear and to the authorities, if they're listening at all, for better standards.



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Thank you for your attention. I'd be grateful for comments, questions and criticisms.

Ed Becker, ed@smf.org