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CRASH **SCIENCE**

The Myths and Realities of Motorcycle Helmets

by Dr. Voyko Banjac

READERS' CORRESPONDENCE AND DISCUSSION in FRICTION ZONE in the past few months, related to the proposed Idaho helmet law, opened up a number of interesting topics. A major concern shared by numerous readers (and riders) is the likely infringement of such a law on their personal choice and freedom, which is understandable. However, as part of the discussion, I noticed several exaggerations, half-truths, and even outright nonsense spouted in the name of "scientific evidence," both for and against helmet usage. I believe it's high time that we set the record straight. As riders, it's in our best interest to educate ourselves as much as possible about all aspects of motorcycling so that we can have the knowledge to ride safely and enjoy our sport.

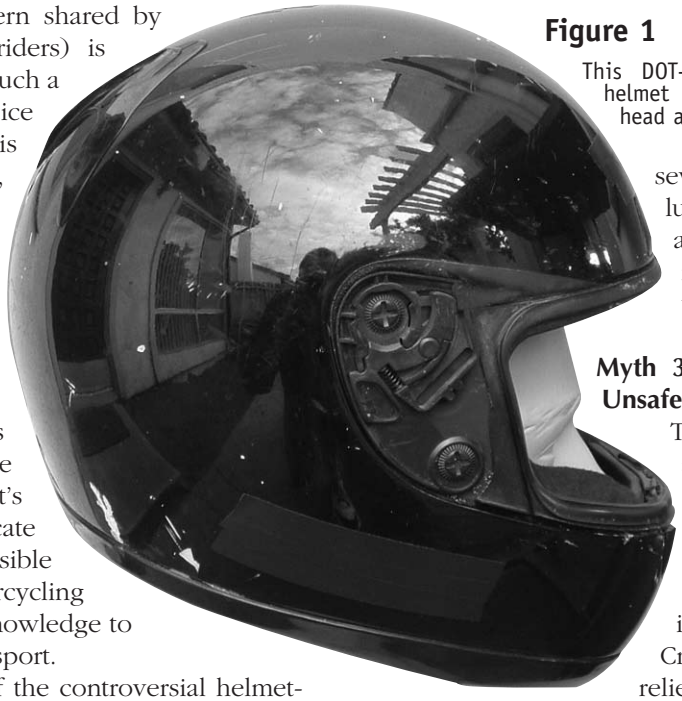

Figure 1
This DOT-certified full-face helmet provides the best head and face protection.

Here is a list of some of the controversial helmet-related "facts" that seem to make the rounds. Within this article, I've attempted to address each issue with just a brief explanation. In the next few months, I'll address the most critical ones with a more detailed analysis.

Myth 1: All Helmets Are Made Essentially the Same

Not true. Other than the obvious wide variety of styles, designs, sizes, etc, there are three major functional types of motorcycle helmets: legal, DOT- and/or Snell-certified full-face (Figure 1); legal, DOT-certified half-face (Figure 2); and illegal, non-certified, "novelty-type" (Figure 3). The difference in safety and protection between the three types is enormous. DOT- and Snell-certified helmets are tested to stringent engineering standards to ensure they keep the impact forces below a certain tolerance level. Novelty-type helmets are not intended for use as head protection and therefore do not conform to any safety standard.

Myth 2: Helmets Do More Harm than Good

Not true. There is absolutely no question whatsoever in the scientific community about the benefit of helmets. Studies conducted in the US, Europe, and Asia over the past 50 years have consistently validated the injury-reducing qualities of helmets. Scientists have not only done testing but have also analyzed thousands of real-life crashes to determine the effect of helmets on the severity of injury. Although no helmet can absolutely eliminate all chance of injury, if you're about to get into an accident you're many times more likely to survive wearing a quality helmet than not wearing one.

Myth 3: Published Studies Show that Helmets Are Unsafe

Theoretically true, but deceptive. In this day and age, anyone can "publish" anything they wish. A quick Google search will reveal web sites and even books that claim the earth is flat, Elvis is alive, the president is an alien robot, and similar nonsense. The true test of any study is its acceptance by the scientific community. Criteria such as author's credentials, references relied on, and scientific accuracy of calculations are all used to gauge the credibility of studies. To date, no recognized scientific society has accepted the blanket argument that helmets are unsafe. There are indeed non-scientific, popular-based articles that attempt to prove helmets are unsafe, but most (if not all) of those have been critiqued and proven false due to incorrect physics, misinterpretation of reference data, or biased/subjective methodology.

Myth 4: A Helmet Can Cause Injury to the Neck or Even the Head Itself

Partially true, but deceptive. Given the right hit at the right angle to the right part of the body, virtually anything can cause injury. Yes, a poor-quality helmet can fracture in an impact and the jagged pieces can penetrate the head. A worn visor can crack and poke

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out an eye. The back part of a helmet can, under just the right circumstance (like when a rider falls on his back and hyper-extends his head) act as a fulcrum and injure the cervical vertebrae or even the spinal cord. However, these types of injuries are so rare that it would be foolish to focus on them and ignore the much more likely, and much more injurious, "head bonk" which causes the vast majority of injuries and fatalities (brain injury, concussion, skull fractures, hemorrhages, etc.).

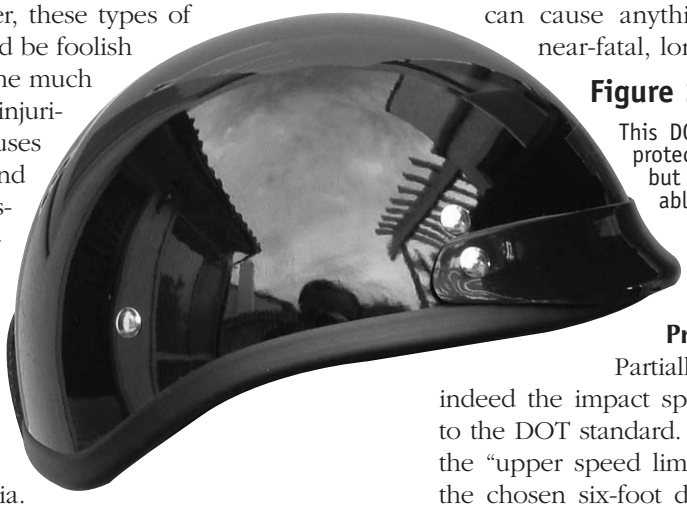

Figure 2

This DOT-certified half helmet protects most of your head but leaves your face vulnerable to injury.

Myth 5: Helmets are Designed to Pass Laboratory Tests, not Real-Life Accidents

Not true. In order to sell a helmet, manufacturers have to meet DOT testing criteria. Thus, before a new model is put out to market, it is tested in a laboratory to make sure it meets those criteria. Not only that, but the DOT itself randomly checks helmets for compliance and can censure manufacturers whose helmets do not meet the necessary standards. This is good for riders, because it allows us to compare apples to apples when shopping for helmets rather than have to rely on dubious marketing and advertising ploys. The test criteria themselves actually stem from more than 50 years of accident investigation and head injury research, so it's nonsense to claim that just because they are tested in a laboratory, helmets have no real-life application.

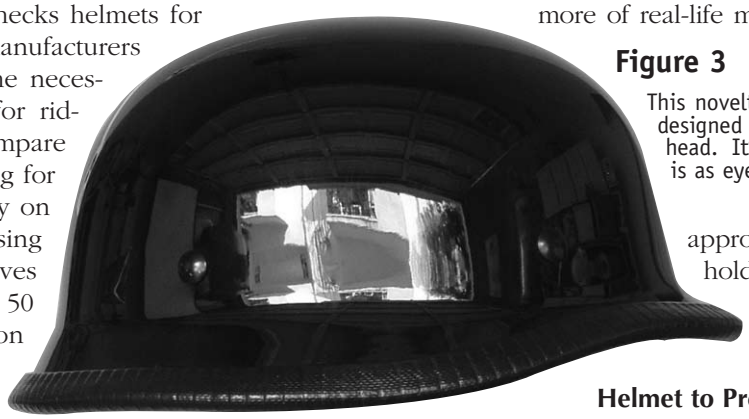

Figure 3

This novelty helmet is not designed to protect your head. It's only purpose is as eye candy.

Myth 6: A Five-Pound Helmet, at 60 mph, Becomes a 300-Pound Object on Impact

Absolutely not true. As a matter of fact, this statement has so many errors that one could write a whole book just critiquing it. First of all, the physics is wrong: force is *not equal* to mass times speed. Second, even the units don't balance out: "pounds-force" is *not equal* to "pounds-mass" times "miles per hour." Third, it doesn't account for the stiffness of whatever the object is hitting—the same object, at the same speed, suffers very different forces if it hits a bush vs. a brick wall. Fourth, it doesn't account for the stiffness of the object itself. Throw a five-pound pillow vs. a five-pound brick at someone. Which hits harder? Fifth, the significance of a "300-pound object" is questionable—is it a static or dynamic load? How long of a duration? Spread out over what area? Depending on the circumstances, a 300-pound object can cause anything from benign short-term discomfort to near-fatal, long-term trauma. For years I have been hoping that this ridiculous statement would finally die away, but it still seems to be regurgitated every now and again.

Myth 7: A Helmet is Designed to Only Protect Us Up to A 13 mph Impact Speed

Partially true, but deceptive. The 13 mph value is indeed the impact speed at which helmets are tested, according to the DOT standard. However, this value wasn't chosen as being the "upper speed limit" of protection. It is the physical result of the chosen six-foot drop height. The six-foot height stems from the 90th percentile (i.e., 90% likely) accident type identified by the Hurt Report of 1981, and verified numerous times since. In 90% or more of real-life motorcycle accidents, the rider suffers a blow to the head by falling off his bike from approximately a six-foot riding height, thus hitting the ground at approximately 13 mph. This impact speed holds true regardless of the cruising speed of the motorcycle.

Myth 8: It is Impossible to Design A Helmet to Protect the Head at High Speeds

Not true. From a physics standpoint, designing a protective device such as a helmet is a fairly straightforward task. Starting with an anticipated impact speed and an impact surface, we can calculate the impact energy and stiffness. Then, selecting an injury threshold, we can determine the design specifications of the helmet. In simple terms, impact energy depends on the square of the impact speed. Impact attenuation thickness, on the other hand, varies as the square-root of the impact energy. Therefore, to a first approximation, an X times greater impact speed requires a helmet that is X times thicker. For example, if the current DOT standard results in helmet thicknesses of 1.5 inches to protect against a 13 mph impact, to protect against a 100 mph impact, we would need

$$\frac{100 \text{ mph}}{13 \text{ mph}} \times 1.5 \text{ inches} = 11.5 \text{ inches}$$

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or about a foot of helmet thickness. With today's advanced materials, making such a helmet would not be a problem; unfortunately, selling it would be a different story, as I can't imagine many riders willing to sacrifice looks for safety.

Myth 9: To Truly be Effective at 100 mph, A Helmet Would Have to Be One Foot Thick

True, but deceptive. To maintain the same level of protection, and assuming an impact into the same type of object (e.g., strong and stiff), higher impact speed does indeed require a thicker helmet (as explained in the previous question). However, very few head impacts actually occur at anything close to 100 mph, even if this were the actual pre-accident cruising speed. In just about 100% of cases, the rider loses control of his bike, falls down and hits his head on the pavement, and then continues to slide (thereby scrubbing off speed) before finally hitting a roadside object. Thus, the primary concern would still be protecting the head from a six-foot (i.e., 13 mph) impact. FZ