Can crash test dummies really simulate human injuries?

by
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How much do crash test dummies really contribute to crash research? ©iStockphoto/ Jester Caps Photography

Introduction

We seldom think about how fragile life is until we experience a traumatic event, such as a car accident. Your life could very well hang in the balance of what happens in just a few milliseconds, and the outcome may depend on the construction of your car. While no car is perfectly safe, engineers work to improve designs to minimize the potential of serious injuries.

To do this, auto manufacturers pour millions of dollars into test crashes to study what exactly happens in a crash with different car models. The point is to find out how dangerous a collision would be for a car's driver and passengers. But, of course, who would volunteer to be a human guinea pig in that kind of situation? Even in a controlled environment, it's far too dangerous to test crash a vehicle with human occupants. So, the important task falls to anthropomorphic test devices (ATDs), also known as crash test dummies. These are made in different sizes to imitate the range of a human family -- from infants to adults.

But engineers can't just settle for a simple human-shaped stuffed doll and call it a day. That's because a simple doll wouldn't be able to tell a researcher whether a crash resulted in a broken bone, a cracked rib cage or skin abrasions. Crash test dummies are becoming sophisticated enough to simulate such injuries. A modern ATD has such an advanced, detailed construction that one costs more than $100,000 -- though it lasts dozens of crashes.

Also, in a crash, the car may stop, but your body keeps moving. A person's injuries largely depend on how your body is thrown in the accident. Because of that, the dummy must not only have a realistic human weight in relation to its size, but the weight must be distributed just like a human's. This way, researchers can watch just how hard and quickly a 10-pound head hits an inflating airbag.

The difficulty in creating a sophisticated crash test dummy reminds us of the sheer complexity of the human body. Next, we'll explore the anatomy of a crash test dummy in more depth.

THE NAKED TRUTH

It seems researchers have thought of everything. Though we've perhaps never thought about it, the clothes we wear make a big difference in the way we slide on the seat during a vehicle crash. This is why they also put clothes on ATDs.

Modern Crash Test Dummies

The evolution of the crash test dummy dates back at least to 1949, when the U.S. Air Force used "Sierra Sam," a dummy developed by Sierra Engineering, to test ejection seats. In the 1970s, General Motors came out with the "Hybrid" dummy, which made several improvements on Sierra Sam. The Hybrid I came first in 1971, followed by Hybrid II in 1972; finally, the ATD still used today, the Hybrid III, appeared in 1976.

Hybrid III ATDs have skeletons of aluminum and steel, including six steel ribs with polymer-based material to imitate a real human chest, encased by vinyl imitation skin. Realistic joints as well as a neck, spine and pelvis made of rubber- or foam-encased metal constructions give a dummy lifelike posture and flexibility -- both of which play a large part in collision injuries.

Beyond its humanlike construction, Hybrid III dummies have extra features that range from simple to sophisticated. Merely smearing the dummies with grease paint allows researchers to see exactly where the dummy hits the car in the crash. Also, sensors inside the dummies measure forces of impact at different points.

The standard Hybrid III represents the 50th percentile male -- the average driver at 5-feet, 10-inches tall and weighing 168 pounds. Federal regulations stipulate the specifications for this ATD as well as the "family" of Hybrid III dummies. Among other things, having dummies of different sizes helps researchers determine the effectiveness of standard seat belts on various body types. In addition to the different Hybrid III dummies, there are also different types of ATDs for different crash tests. Hybrid III dummies are used primarily for frontal impact test crashes. But others include the side impact dummy (SID) and the biofidelic rear impact dummy (BioRID).

The next generation of ATDs is THOR, which has made many improvements on Hybrid III. In particular, THOR can more accurately predict facial injuries because the head is equipped with unidirectional load cells [source: Schmitt]. Other improvements include a new neck and flexible spine design and an advanced rib cage with elliptical ribs. In recreating a controlled crash, researchers also film it with as many as 20 specialized cameras, which can film at high speeds (about 1,000 frames per second) at different angles [source: Weber]. This way they can watch the crash in clear slow motion to observe every detail.

Researchers will even dress dummies in clothes to make the situation as close to reality as possible. ©iStockphoto/ uatp2

Simulating Internal Human Injuries

It makes sense that watching a slow-motion video of a properly weighted, humanlike dummy could help researchers determine if a crash will result in external injuries. Perhaps less believable is that a dummy could tell us whether the crash will result in an internal injury. The human body and its sensitive internal organs are so complex that a mere polymer and metal construction seem an inadequate representative.

However, we have a good idea of what the human body can sustain and how much force will result in a critical internal injury. The trick is to find if a crash results in those particular forces.

If you remember from the last page, we mentioned that ATDs are equipped with sensors in various points of the body. These electronic sensors can actually measure the force of impact, accelerations and deformations that are sustained in the collision. In the Hybrid III, these are mounted in the head, neck, chest, pelvis, thighs, legs and ankles. In all, these sensors can record 37,200 different pieces of data in one ATD [source: Mello]. Knowing this information helps researchers to determine what forces will happen to a body and where, which can help them predict all different kinds of injuries. They can use this data to determine if something will likely be a flesh wound or an internal injury.

But another technology has also developed that can perhaps more accurately predict internal injuries. By simulating a crash and a dummy completely in a computer model, researchers believe they can determine whether an internal injury will be sustained. In particular, researchers at the Virginia-based National Crash and Analysis Center have been working on computerized crash tests. They say they can look at details of brain injuries, for instance, that are seen easily in computerized models [source: Science Daily].

Although it may be strange to think about, using cadavers in crash tests gives researchers useful data that might save lives. ©iStockphoto/ sebastianiov

Using Cadavers in Crash Testing

We mentioned earlier that the U.S. Air Force used the original crash test dummy in the 1940s. But, in a sense, the history of crash testing subjects date back even further. As early as the 1930s, Wayne State

University researcher Lawrence Patrick wanted to test the limits of the human body. Instead of manufacturing a humanlike dummy, he actually used a human -- himself. He took on a 22-pound metal pendulum to the chest among other blows.

But when Patrick needed to test what happens when a body is thrown, he wanted to send a person down an elevator shaft. This time, he again used a human. But rather than himself, he used a dead person. As gruesome, morbid or unethical as it may sound, using cadavers as crash test subjects makes a lot of sense from a practical standpoint. There is no danger to human life, and researchers can reap some of the most useful, life-saving information from cadaver tests. Patrick has claimed that despite the public outcry that this violated the dignity of the human body, he treated the dead bodies with respect [source: Roach].

The U.S. National Highway Traffic Safety Administration (NHTSA) funds crash tests with cadavers. And, although they don't like to admit it, auto manufacturers are believed to still use cadavers in tests [source: Hyde].

Cadaver testing isn't perfect, though. The available bodies are usually elderly, meaning bones break more easily than the average driver. Also, there is no pressure in the lungs and blood vessels of cadavers, among other problems. Living biological tissue is dramatically different from dead tissue just as it's different from synthetic ATD material. Even using cadavers, it's been difficult for researchers to simulate a pedestrian accident [source: LASTPEP].

In his cadaver crash tests, Patrick had to manipulate the bodies' joints to loosen them. He also took out the brain and put gelatin in its place, in addition to screw-mounting accelerometers to the head [source: Roach]. It's a controversial question as to whether such adjustments, in addition to smashing the bodies full force in a crash test, is inherently disrespectful to a body. It's no wonder auto manufacturers like to keep quiet about cadaver testing.

Have crash tests ever used live (or dead) human occupants?

by Jamie Page Deaton

<http://auto.howstuffworks.com/ car-driving-safety/safety-regulatory-devices/human-crash-test-dummy.htm> 05 May 2015.

The result of a head-on collision between car and wall at an automobile safety research facility in Wolfsburg, Germany. See more car safety pictures. ~ Peter Ginter/Getty Images

Have crash tests ever used live (or dead) human occupants?

Some days, you go into work and just get slammed. For most people, that's just a figure of speech. But for a select few professions, like linebackers, pro wrestlers and crash test dummies, getting slammed is part of the job -- literally.

Now, you're probably thinking it sounds silly to propose that inanimate objects, like crash test dummies, are employed. Before you start screaming for HAL to open the pod bay doors, consider this: Rusty Haight, a living, breathing human being, has completed more than 700 crash tests -- as the dummy. That's right, a human crash dummy. Crash testing is an integral part of automotive design and engineering, consumer protection and even law enforcement. A number of organizations perform crash tests. Advocacy groups, like Consumer Reports and the Insurance Institute of Highway Safety (IIHS) perform safety and crash tests to protect consumers. The U.S. government performs crash tests to make sure that cars sold in the United States meet minimum safety requirements. Car makers perform crash tests to test how well their cars work. All of these groups use crash tests to

find safety issues and test solutions to make cars safer and reduce injuries and deaths from car accidents.

Over the decades, crash test dummies have become remarkable sources of information about the damage that can result from the extreme forces exerted on a body during a violent impact. Read the next page to find out some of the advancements in dummy engineering.

SOME PEOPLE ARE STILL HAVING UNPROTECTED WRECKS

Everyone wants to look good at work, but human crash test dummies don't pass on helmets to avoid helmet hair -- they have much more practical reasons. Some actually avoid wearing a helmet in crash tests because the extra weight the helmet adds to their head would add to the stress on their neck, increasing the risk for injury.

A pregnant crash test dummy is fitted with a seatbelt prior to a test. Andy Sacks/Getty Images

Engineering Dummies

The purpose of crash tests is to gather data - not just about the car's systems, but about the effect of the crash on the people in the car. Some of the effects are obvious. In a crash, people in cars are exposed to physical force and as a result they usually get tossed around. That's obvious. Crash testing studies the forces car occupants are exposed to during a crash in a controlled, measurable environment. The data crash tests gather is so precise, it can help develop new and better safety systems.

Some of the most specific data in a crash test comes from the dummies themselves. Crash test dummies are engineered to mimic human physiology and to approximate what a human body endures during a crash. The dummies have sensors throughout, which allow crash test engineers to see exactly what forces the dummy was exposed to and how strong those forces were.

A lot of engineering goes into crash test dummies. They come in different sizes and shapes, to show what might happen to men, women and children in accidents. Crash test dummies can be overweight, thin, tall or short. Scientists have even developed a pregnant crash test dummy to study the effect of car crashes on pregnant women and their unborn babies.

But as advanced as crash test dummies are, they can't tell researchers everything that happens in a crash. That's why some people suit up and strap in as human crash test dummies. Read on to find out how and why they do it.

YOU COULD LEARN A LOT FROM A DUMMY

The most famous crash test dummies might be Vince and Larry, who appeared in public service announcements in the 1980s, encouraging people to buckle up. The most famous human crash test dummies are Rusty Haight and Lawrence Patrick. Haight is a retired police officer who participates in crash tests to help police learn improved techniques to investigate crash scenes. Patrick is a professor whose specialty was human impact survival research. Both have taken part in hundreds of crash tests.

They're highly advanced, but these dummies can't react to an approaching collision. A human crash test dummy can often provide better results. Peter Ginter/Getty Images

Human Crash Test Dummies

With all the sensors and technology built into a crash test dummy, why would a human occupant yield better crash test data? Crash test dummies are very good about showing how much force impacts a body during an accident. What they can't do is show how much force a human body can reasonably expect to take without getting injured. If actual humans weren't crash test dummies, scientists wouldn't have data to judge the forces in a crash as safe or unsafe.

There are also a few things crash test dummies can't do. Namely, they can't react to the impending collision. When people are in a crash, they instinctively tense their muscles. That's something a dummy can't do, and it's something that could also lead to injury during an accident. Crash test dummies also don't have skin -- and many of the injuries in an accident are cuts and abrasions.

That's where human crash test dummies come in. Human cadavers were first used in crash tests long before crash test dummies were invented. Occasionally, cadavers are still used today, although most automakers and research institutions don't like to talk about it. It's a lot more fun to talk about living human crash test dummies.

While uncommon, these volunteers participate in slow speed crash tests to provide invaluable data to crash investigators and engineers. Still, these tests aren't without problems. For one, constantly experiencing car crashes, even slow ones, takes a toll on a person. There are also ethical considerations: The quest for data can overshadow the need for safety. Though the crash tests are very controlled, and every precaution is taken, there is always the risk of severe injury or even death for the human tester.

So the next time you crash after a hard day's work, be thankful it's only an expression. For some people, crashing is part of the job.

CORPSES WITH A CAUSE

Live human crash test dummies sound strange enough, but what about cadaver crash testing? In May 2008, a Swedish newspaper reported that Saab had used donated cadavers in 10 crash tests. While Saab declined to confirm or deny the report, judging by the reaction it got in the blogosphere, the whole idea creeps out a lot of people. For some, nothing ruins that new car smell like embalming fluid.

Sources

- Foreman, Stephen M., Arthur C. Croft. "Whiplash Injuries." Lippincott Williams & Wilkins, 2001. (Nov. 28, 2010)http://books.google.com/books?id=De5LdqgeSf4C
- Haywood, D., M. Stonefrost. "The Influence of EuroNCAP on Frontal Impact Safety." "Proceedings of the 1st IMechE Automobile Division Southern Centre Conference on Total Vehicle Technology." John Wiley and Sons, 2001. (Nov. 28, 2010)http://books.google.com/books?id=QHx0BISdV3wC
- Hinckley, Jim, Jon G. Robinson. "The Big Book of Car Culture." MotorBooks International, 2005. (Nov. 28, 2010)http://books.google.com/books?id=fJ_qWhCZm04C
- Hyde, Justin. "How a Cadaver Made Your Car Safer." Jalopnik. MSNBC.com Updated Aug. 26, 2010. (Nov. 28, 2010)http://www.msnbc.msn.com/id/38868527/ns/technology_and_science-innovation
- LASTPEP. "Vehicle Safety, 2002." John Wiley and Sons, 2002. (Nov. 28, 2010)http://books.google.com/books?id=_war3_rR8REC
- Mello, Tara Baukus. "Meet the Crash Test Dummies." Edmunds.com. (Nov. 28, 2010)http://www.edmunds.com/ownership/safety/articles/105394/article.html
- Roach, Mary. "I Was a Human Crash-test Dummy." Salon.com Nov. 19, 1999. (Nov. 28, 2010)http://www.salon.com/health/col/roac/1999/11/19/crash_test
- Roach, Mary. "Stiff: The Curious Lives of Human Cadavers." W.W. Norton & Company, 2004. (Nov. 28, 2010)http://books.google.com/books?id=_war3_rR8REC
- Schmitt, Kai-Uwe, et al. "Trauma Biomechanics." Springr, 2009. (Nov. 28, 2010)http://books.google.com/books?id=HeXL_hGXyBsC
- Science Daily. "New Generation of Crash Test Dummies." Science Daily. May 1, 2008. (Nov. 28, 2010)http://www.sciencedaily.com/videos/2008/0506-new_generation_of_crash_test_dummies.htm
- Weber, Julian. "Automotive Development Processes." Springer, 2009. (Nov. 29, 2010)http://books.google.com/books?id=T2S5sL3EjHEC
- BBC News. "How The Dead Have Helped the Living." September 23, 1998. http://news.bbc.co.uk/1/hi/special_report/1998/car_crash/48062.stm

- Drury, Bob. "Meet the Human Crash Test Dummy." Men's Health. http://www.menshealth.com/cda/article.do?site=MensHealth&channel=guy.wisdom&category=howto.guides&conitem=ce5a99edbbbd201099edbbbd2010cfe793cd____
- Harley, Michael. "Ghastly! Saab may have used human cadavers for safety research." Autoblog. May 8, 2008. http://www.autoblog.com/2008/05/08/ghastly-saab-may-have-used -human-cadavers-for-safety-research/
- Left Lane News. "Report: GM/Saab used human cadavers for crash tests." May 8, 2008. http://www.leftlanenews.com/report-gm-saab-used-human-cadavers-for-crash-tests.html
- Roach, Mary. "I was a human crash test dummy." Salon.com. November 19, 1999. http://www.salon.com/health/col/roac/1999/11/19/crash_test/
- Rupp, Jonathan. "Development of the MAMA-2B Pregnant Crash Test Dummy." University of Michigan Transportation Research Institute. March 31, 2000. http://www.umtri.umich.edu/project.php?wipID=81