Danger zone *This artist's representation highlights the potential hazard from an exploding air bag*

Computer-generated illustration by Richard Kolker for TIME

BUSINESS

BLOW OUT

AIR BAGS ARE MEANT TO SAVE LIVES. NOW A MASSIVE RECALL SHOWS HOW THEY SOMETIMES CAN TURN DEADLY

BY BILL SAPORITO

FORENSIC INVESTIGATOR SAL FARIELLO, whose job is to deconstruct car crashes, has witnessed a catalog of carnage caused by air bags over the past two decades. In his collection, there is a photo of a woman who has been horribly scarred by an inflating air bag. There's an X-ray of a driver's broken wrists snapped in the "fling zone" of an air bag that mashed both arms from a 10-and-2 position into the car's roof. He can cite numerous drivers who suffered torn aortas or lacerated brain stems, all the result of being "punched" by an air bag inflating at 200 m.p.h. (322 km/h). "What's sitting in the front of the steering wheel is an explosive device," explains Fariello, the author of *Airbag Injuries: Causation & Federal Regulation*. "Nasty, unexpected events can occur."

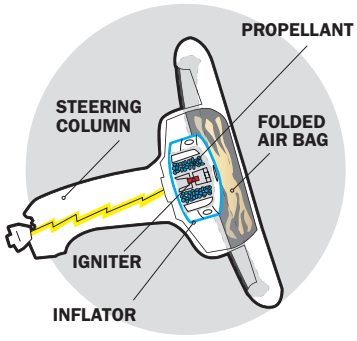
None have been nastier than the injuries and deaths caused by exploding inflators in air bags made by automotive supplier Takata Corp., based in Tokyo. Its air bags have been blamed for killing five motorists in the U.S. so far. More than 10 million cars from 10 makers—including BMW, Chrysler, Honda, Nissan and Toyota—have been recalled. On Nov. 26, the National Highway Traffic Safety Administration (NHTSA) ordered Takata to expand its most recent recall from a regional one to a national one. Takata declined on the basis that the problem is confined to areas like Florida with high relative humidity. Toyota and Honda are following NHTSA's advice and issued a national recall. All the cars are from model year 2011 or older.

Takata's suspect inflation canisters contain a propellant—tablets of ammonium nitrate—that is ignited at the onset of a crash to initiate a chemical reaction that produces

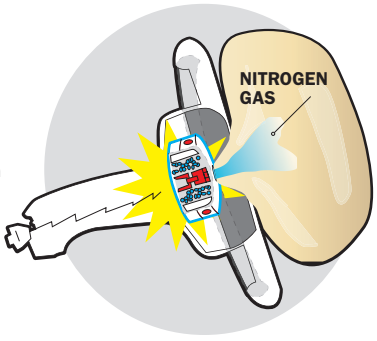
HOW AIR BAGS WORK

THEY DEPLOY ONLY IN CERTAIN CRASH CONDITIONS. DEFECTS CAN HARM THE VEHICLE'S OCCUPANTS

IMPACT
Sensors in your car detect the pulse of impact as well as the position of occupants, sending signals to the electronic control unit in the middle of the car. An algorithm decides whether to deploy the air bags and at what force—full or partial power.



DEPLOYMENT
Air-bag inflators are small metal containers that hold an igniter and a propellant. In a crash, the ignited propellant triggers a chemical reaction that produces nitrogen gas, which fills the bag rapidly.



nitrogen gas to fill the bag. Moisture may be destabilizing the ammonium nitrate. In the faulty inflators, the blast shatters the canister, sending metal shards through the air bag toward the driver. Arriving at the scene of one such incident, police thought the victim had been shot in the face before crashing. "My understanding is our products in this accident worked abnormally," said Hiroshi Shimizu, who is in charge of Takata's global quality assurance, when prodded by Nevada Senator Dean Heller during Senate-committee testimony on Nov. 20.

On Dec. 2, Toyota called for a joint industry initiative to independently test the Takata bags. "The safety, security and peace of mind for our customers are our highest priority, and I believe this is shared with all the other automakers," said Simon Nagata, CEO of Toyota's North American manufacturing unit.

Perhaps these scenes—accident reports detailing both gore and tragedy, congressional hearings well stocked with outrage, and executives who struggle for the right tone of response—should come as no surprise. It has, after all, been a very bad year for the auto industry. General Motors' recall of 2.6 million vehicles earlier in 2014 stemmed in part from defects that led to air bags' not deploying at all, causing injury and death.

But the Takata crisis once again reminds us that this foundational piece of auto safety equipment has always carried the risk of injury—and death—riding shotgun. People have been hurt because they are the wrong size, shape or age to get the optimal benefit from a device first designed for an average male. And now, in Takata's case, because of a defect.

How Did We Get Here?

AN AIR BAG IN DEPLOYMENT HAS TO FIRST measure—and then counter—the considerable inertial forces that are brought to bear when your car crashes into another vehicle or object. In a collision, your car stops abruptly, but you don't. Your head and body keep moving forward, translating that energy according to Newtonian physics until some other force arrests it. Before the advent of air bags and seat belts, this "velocity debt" was repaid—at terrible cost—when your head or body smashed into the steering column or dashboard.

To stop your head's violent forward motion requires considerable counterviolence. After a car's accelerometers and sensors detect a crash pulse—the rapid deceleration that signals impact—an algorithm in the electronic control unit (ECU) then decides whether to deploy the air bag and at what pressure. If the ECU says deploy, the explosion that rapidly expands an air bag also hurtles it toward your head at speeds ranging from 98 m.p.h. to 200 m.p.h. (158 km/h to 322 km/h). In fact, the bag should be deflating by the time your head makes contact, creating a cushioning force that dissipates the energy of the crash by distributing it over the larger surface area of the bag. The entire process of sensing and deploying the air bag has to take place in 20 to 30 milliseconds, by which time your head has already moved forward five inches.

Air bags have been saving lives since 1973, when General Motors produced 1,000 Chevrolet Impalas equipped with air bags as an option. According to Byron Bloch, an auto-safety expert who has long campaigned for better air bags, Chevy produced a good one: a dual-pressure system that protected children from a fully powered air bag's potentially lethal force. GM was satisfied with the technology—the concept was patented in 1953—and Bloch said the company was ready to expand the program. "We were going to have dual-pressure air bags phased in the '74–'75 model year," he says.

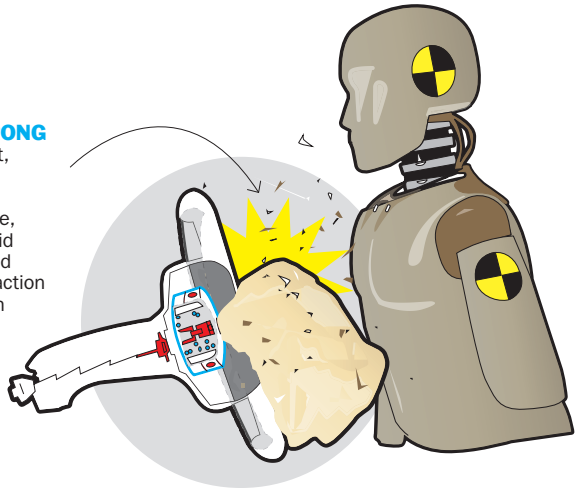
Instead, air bags disappeared for nearly 20 years. Why? The Big Three auto companies, led by Ford boss Henry Ford II and his deputy Lee Iacocca, convinced President Richard Nixon that air bags wouldn't be cost-effective. The pressure on the Big Three to offer air bags ultimately came from smaller competitors, like Volvo, that made air bags standard equipment. With consumers clamoring for protection, Congress made air bags mandatory as of September 1998.

The design and testing standards of these late-1990s air bags, however, would not make them better than the ones GM used in the early 1970s. When two elderly women were killed by air bags in the early '90s, it was a lethal indication that there were flaws. "The elderly die very easily in car crashes," says Fariello, who has been a paid expert witness for both plaintiffs and defendants in injury lawsuits. The force of the deployed air bag, even in low-speed fender benders, was causing fatal chest and brain injuries. Short women were being injured because they moved their seats forward to reach the gas and brake pedals. As a result, their faces were within 10 in. of the steering wheel, which experts say is the minimum safety margin.

Auto-industry safety organizations, consumer groups, the Society of Automotive Engineers, NHTSA and the Insurance Institute for Highway Safety have debated test conditions for decades. NHTSA's frontal tests are run at 35 m.p.h. (56 km/h) into a rigid barrier using a crash-test dummy optimized for a 50th-percentile male—about 172 lb. and 5 ft. 9 in. (78 kg and 175 cm). Yet most crashes happen at speeds below 35 m.p.h., and they involve all kinds of people, objects and crash angles. Hitting a pole is different from hitting a wall or another vehicle.

The test method meant that passengers who weren't perfectly average were "out of position," in the vernacular of crash

WHAT GOES WRONG
Takata's propellant, ammonium nitrate tablets, may be degrading over time, particularly in humid climates. This could cause a violent reaction in a crash, in which the force blasts apart the inflator, causing injuries or death.



8–14 M.P.H.
Minimum crash speed (13–23 km/h) that could cause an air bag to deploy

2,213
Lives saved by air bags in the U.S. in 2012

AFTER A CRASH, IT TAKES:

0.02 SECONDS
for an air bag to deploy

0.06 SECONDS
for the passenger to hit the air bag

SOURCES: NHTSA; TAKATA

analysis. "If you are not a 50th-percentile male, something else happens," says Fariello. Something very bad, it turned out, happens to women and children. According to NHTSA's data, air bags killed 191 children from 1990 to 2009, as well as 39 women who were 5 ft. 2 in. (157 cm) or shorter.

"In the real world, crashes occur in all different directions, but we still need some standard test procedures to design around. The question is, What proportion of real-world crashes have you covered?" says Priya Prasad, a safety consultant and expert in injury biomechanics who was formerly Ford's top safety scientist. It would take several years of debate before NHTSA added a fifth-percentile female crash dummy to the test.

There's no question that air bags can and do save lives, especially in combination with advanced seat belts. But frontal-air-bag performance hasn't changed significantly in recent years, says Professor Richard Kent. He is deputy director of the Center for Applied Biomechanics at the University of Virginia, which does testing for the government and other institutions. The adoption of advanced air bags that depower in low-speed crashes, mandatory since 2006, and moving kids out of the front seat and into backseat restraints marked the last big survivability improvements. "As far as injury effectiveness, there's no reason to think it's substantially different than what it was five years ago," he says.

How Good Are Air Bags Anyway?

BUT THE BOTTOM LINE ON AIR BAGS IS that their contribution to an accident's survivability has always been incremental. Seat belts are the first and most important line of defense. Studies show that if you wear a seat belt, you have about a 45% greater chance of surviving a potentially lethal crash. Adding an air bag improves that figure to 50%, with a margin for error in both cases. According to NHTSA, frontal air bags saved 2,213 lives in 2012, but seat belts saved 12,174 lives, more than five times as many. Keep in mind that 33,561 highway deaths were recorded in 2012. If you crash at a high speed and aren't wearing a seat belt, having an air bag in the car is as useful as having a balloon.

Can air bags get better? "In my opinion, air-bag technology is mature. It has sort of done what it is supposed to do," says Kent. There's more promise in advances elsewhere. Electronic stability control, for instance, is reducing rollovers, which are particularly lethal. More advanced seat belts and sensors offer even more possibilities. By sensing the weight and position of occupants, and whether they are belted, belts work with air bags first to pretension (that is, tighten) the shoulder strap and then let it unspool to apply the minimum force needed to restrain passengers without injuring their ribs or thorax, with the air bag arriving to cushion the head. That's particularly important for the increasing number of older drivers, who suffer a disproportionate number of chest injuries.

It might be possible, says Prasad, to move to a smarter three-stage air-bag system. More likely, he says, is that black-box data recorders now in every car combined with newer anticollision warning and braking systems will improve the margin of safety. "You will be able to predict what type of crash. And once you start predicting, you could fire an air bag before the crash." Ultimately, self-driving cars may render the whole driver-safety issue moot. But that could take a decade or even two.

10 MILLION+
Number of cars in the U.S. recalled by 10 manufacturers for Takata air bags

In the meantime, there are still a lot of old cars out there. Fariello recommends that you follow the New York State transportation department's advice and hold the wheel in the 9 and 3 o'clock position, as opposed to the 10 and 2 that many people were taught. If you are short, consider pedal extenders to keep your face at least 10 in. (25 cm) from the wheel. And as far as car sizes go, in a collision big beats small. Newton's laws won't have it any other way.

Fariello, Bloch and others are concerned that overweight people still face greater danger. Current testing hasn't accounted for them. According to Humanetics, a company that makes crash-test dummies, obese people are 78% more likely to die in crashes than average-weight people. The company is developing a test dummy that is 273 lb. (124 kg), with a body mass index of 35.

There is no precaution that protects you if your air bag becomes a weapon, as has happened in some of the Takata incidents. Bloch, a longtime advocate for safer air bags, believes carmakers should disclose the air-bag supplier for each model. Some inflate in a basketball shape, while others are pillow shaped, which is better. Some have tethers that limit the distance they can travel, which is potentially less damaging.

Amid all this sobering news, it's worth noting that the death rate on U.S. roads is declining—it has fallen 23% since 2005 and should decrease again this year—and seat-belt usage is at a record high. We're a lot safer—and will be even more so when the defective air bags are fixed. ■

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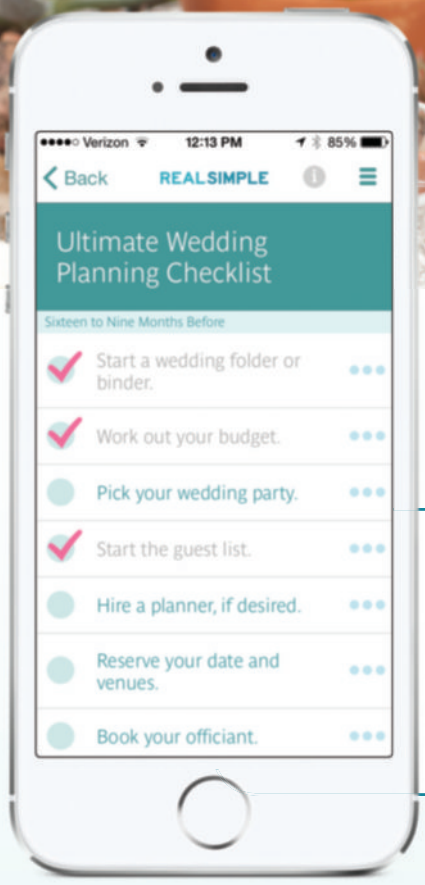

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