Helping Brains, One Helmet Liner At A Time

The Swedish scientists behind MIPS are on a mission to innovate helmets—and reduce the number of traumatic brain injuries riders suffer—with their research on rotation.

By **Lindsay Berreth**

When a rider suffers a serious head injury, chatter begins alongside the well wishes and GoFundMe accounts. "Well, was she wearing a helmet?" people ask on Facebook pages, in online forums, and in their tack rooms or on trail rides. If the answer is no, there's a sense that particular rider just made a bad choice. Those of us who do wear helmets every time, every ride, *we* should be OK.

But when the answer is yes, which it often is when talking about the English disciplines in 2020, that sense of safety starts shrinking. A 2018 Swedish study reported that 88 percent of 461 riders who suffered a concussion in a fall from a horse were wearing helmets. If a person wearing an approved safety helmet can suffer a career-ending—or even life-ending—traumatic brain injury, how can the rest of us feel safe strapping on helmets and climbing on horses?

The scientists behind Swedish-based company MIPS, which stands for multi-directional impact protection system, hope they can lessen your fears, at least a little. They've been designing, testing and marketing devices to reduce the incidence and severity of traumatic brain injuries—alongside developing a new testing system for helmets—since its founders came together in 1996. What began as a happenstance meeting between a brain surgeon and an engineer developed into first a collaboration and then a company that now reaches across multiple sports with 103 helmet brands and 583 helmet models, including equestrian helmets.

In short, MIPS produces a liner that can be integrated into a helmet. The liner allows the head to move 10-15 millimeters relative to the helmet in all directions on impact, thus reducing the rotational motion to the brain, which, according to their research, can reduce brain injuries in severity and in number.

In January, I was invited to MIPS' headquarters in Sweden to learn more about the company's start and their mission. Equestrians in this country were introduced to the MIPS system in 2018, when the Trauma Void EQ3 helmet went on sale to the U.S. market. Now more companies, including brands like Charles Owen and Tipperary, are integrating the technology into their helmets each year.

Walking up the stairs of MIPS' new office building in Täby, a suburb of Stockholm and just a few miles down the road from the company's old location, I was greeted by the sounds of saws and hammers. The company's been expanding and had moved a few weeks earlier to a more spacious building.

Marcus Lindgren, the company's public relations manager, gave me a brief tour of the building, apologizing for the mess. While the office space was lacking in decoration, what I could see was classic Scandinavian minimalism—white walls, with pops of color in the décor here and there. I met a handful of employees, including Elin Bonnedahl, general council, and Maria Daggenfelt, an engineer; both are riders who are passionate about safety.

Brain surgeon Hans von Holst *(left)* and engineer Peter Halldin combined forces more than 20 years ago to develop the MIPS technology. *LINDSAY BERRETH PHOTO*

Heading towards the conference room, Lindgren pointed to a small gym and told me his bosses want their staff to have a good work-life balance and a healthy lifestyle. Most are active in the sports that MIPS serves with its helmet technology, including snow sports, cycling and riding.

Lindgren tells me he's entertained more than 40 journalists from all over the world in an effort to spread knowledge of the MIPS system. The company went public on the Nasdaq in 2017, but Lindgren insists nothing has changed.

"We still have our values, and we don't have the dollar sign first. It's safety first," he said. "For us, the most important thing is to educate people about rotation. Normal helmets are only tested for linear impacts, and no one falls like that. This is the best way to protect your brain. When you know about rotation, it's hard to go back to having a helmet without rotation protection.

"It's like, I would not buy a car without seatbelts or an airbag," he continued. "When you know that kind of technology is out there, it's very hard to buy something without it, especially when it's not that much more money."

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—Marcus Lindgren

A BRAIN SURGEON AND AN ENGINEER WALK INTO A LAB

Several decades ago, Hans von Holst, a Swedish brain surgeon at the Karolinksa Institute and professor at the Royal Institute of Technology in Stockholm, realized he was seeing too many brain injuries in patients after accidents, even when they had been wearing helmets. So in 1995, he began studying how helmets were constructed, working with the World Health Organization to try to prevent head injuries. He contacted the Royal Institute to initiate biomechanical research on head and neck injury prevention.

At the same time, Peter Halldin was at the Royal Institute studying engineering. He connected with von Holst to study ways to make a better helmet. At the time, an engineer and a surgeon working together wasn't so common, but after they began to understand each other, they arrived at their lightbulb moment in 1996: the concept of MIPS. The idea was patented in 1998. By 2000, they had the first prototype of a MIPS helmet.

"MIPS is the first company in the world going beyond helmet production," von Holst said. "We want to go further, behind the curtains, and look at the consequences of a head injury, because if you can look in a molecular way, then you can start to develop new helmets."

Trauma Void was the first U.S. helmet manufacturer to feature MIPS technology in the United States, releasing the EQ3 in 2018. *PHOTO COURTESY OF TRAUMA VOID*

The idea behind MIPS was to simulate the brain's own protective system.

"We are mimicking the safety system inside our head, where the brain can slide a little, but against the skull in the cerebral spinal fluid," said Halldin. "We copied that system into the helmet."

A MIPS-equipped helmet has a low-friction layer between the head and the helmet, which enables that relative motion of 10-15 millimeters. It's designed to reduce rotational motion transferred to the brain from angled impacts to the head—and that focus on angled impacts is crucial for Halldin and van Holst. During their studies, the pair looked at how people fall in different kinds of accidents.

"We found out that the way helmets are tested today, with a pure linear impact, is not how an accident will happen," said Halldin. "Most often the impact is at an angle. If the impact is at an angle to the ground, the helmet can grab into the ground, and we have the rotation. For Hans it was obvious that the brain is sensitive to rotation, but not to me and my colleagues, so we investigated that and came to the conclusion that rotation is very severe for the brain, and a rotational protection system could be very protective."

A linear impact can cause a skull fracture or contusion, but a rotational impact can cause a concussion, which is the most common type of brain injury. Wearing a MIPS helmet, according to the company's research, will result in less rotational energy transmitted to your brain when you hit the ground.

"To explain about rotation, we can look into boxing where they stand hitting each other round after round, then suddenly someone gets an upper cut where you get the rotation of the head, and that's when they're knocked out," said Halldin.

He also mentioned baseball, where it's common for a player to get a linear hit to the head by a ball at a high rate of speed, and then the ball bounces off. After

studying those scenarios, MIPS scientists decided their system would not be beneficial and didn't pursue integration into baseball helmets.

"People might say, 'I can put the helmet on my head, and I can move it anyway. Why do I need MIPS?' " Halldin continued. "If you look to the impact situation, it's very short with the ground. It's about 10 milliseconds. During that 10 milliseconds, the force is very large, so it's like having more than 10 people standing on your helmet during this short time period. Then it's not that easy to move the helmet if you don't have this low coefficient sliding layer."

A NEAR-BANKRUPTCY EXPERIENCE

In the beginning, the people behind MIPS decided to manufacture their own helmet. Though they'd hoped to implement the system into motorcycle helmets, Halldin said the industry wasn't ready for it. As they continued developing the product, they got some funding from a couple of Swedish insurance companies that also offered horse insurance, so that was their way into the equestrian market.

The first MIPS helmet, the EQ1, hit stores in 2007 after three years of development. Over that time, Halldin took 25 trips to China, where the helmets were manufactured, to oversee the process. The helmet launched at the Gothenburg Horse Show in Sweden with a small booth in the trade fair. After two features in Sweden's biggest equestrian magazines, the company started getting interest.

Soon after the launch though, issues with the tension system on the helmet started popping up. In the cold Swedish winter, the plastic pieces would get brittle and break.

"We had to withdraw 3,000 helmets from the market," said Halldin. "We were such a small company and were very close to being bankrupt."

But in 2009, a Swedish venture capitalist company came to the rescue and invested in MIPS. Halldin stepped back from the CEO position, and the company became

MIPS' first equestrian helmet hit the Swedish market in 2007, but issues with the adjustable harness meant it was discontinued. *LINDSAY BERRETH PHOTO*

an ingredient brand instead of manufacturing its own helmets. They began getting interest from the skiing and biking industries, so they turned focus to those sports instead of the equestrian side.

For years after that the company mainly focused on snow sports and bicycle helmets, then got into motorcycle helmets. An article about the technology came out in Popular Science magazine in 2012, when the concussion rate in football was becoming a major topic, and that publicity helped propel the brand further. Around that time, MIPS scientists started working with equestrian helmet companies again.

Back On Track USA owner and founder of Trauma Void, Bo Lofvander, chose to sell a MIPS helmet starting in February 2018.

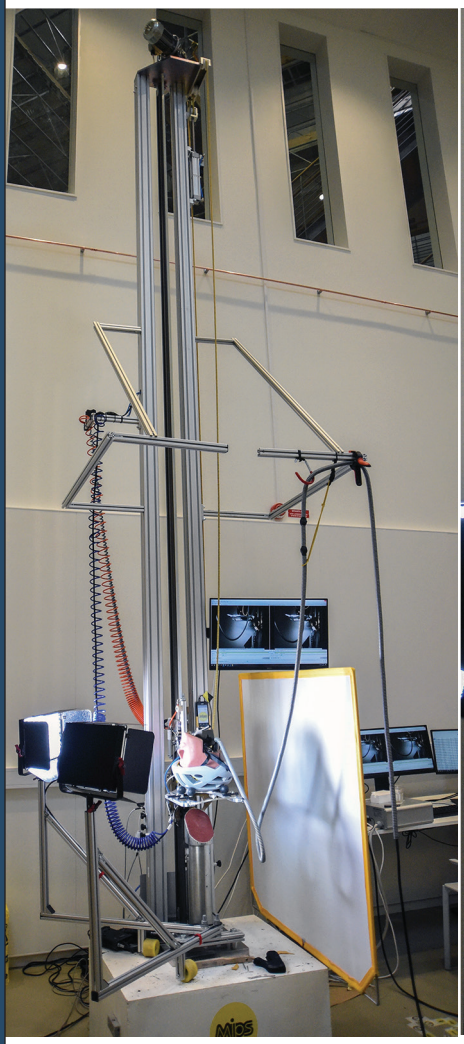
"There's always a need for new innovation in helmets," he said. "What attracted me to the technology is that it had been in riding helmets overseas for years, and it was in bicycle helmets here in the U.S. I had purchased a bicycle helmet, and I had a chance to bring them over here for the riding industry."

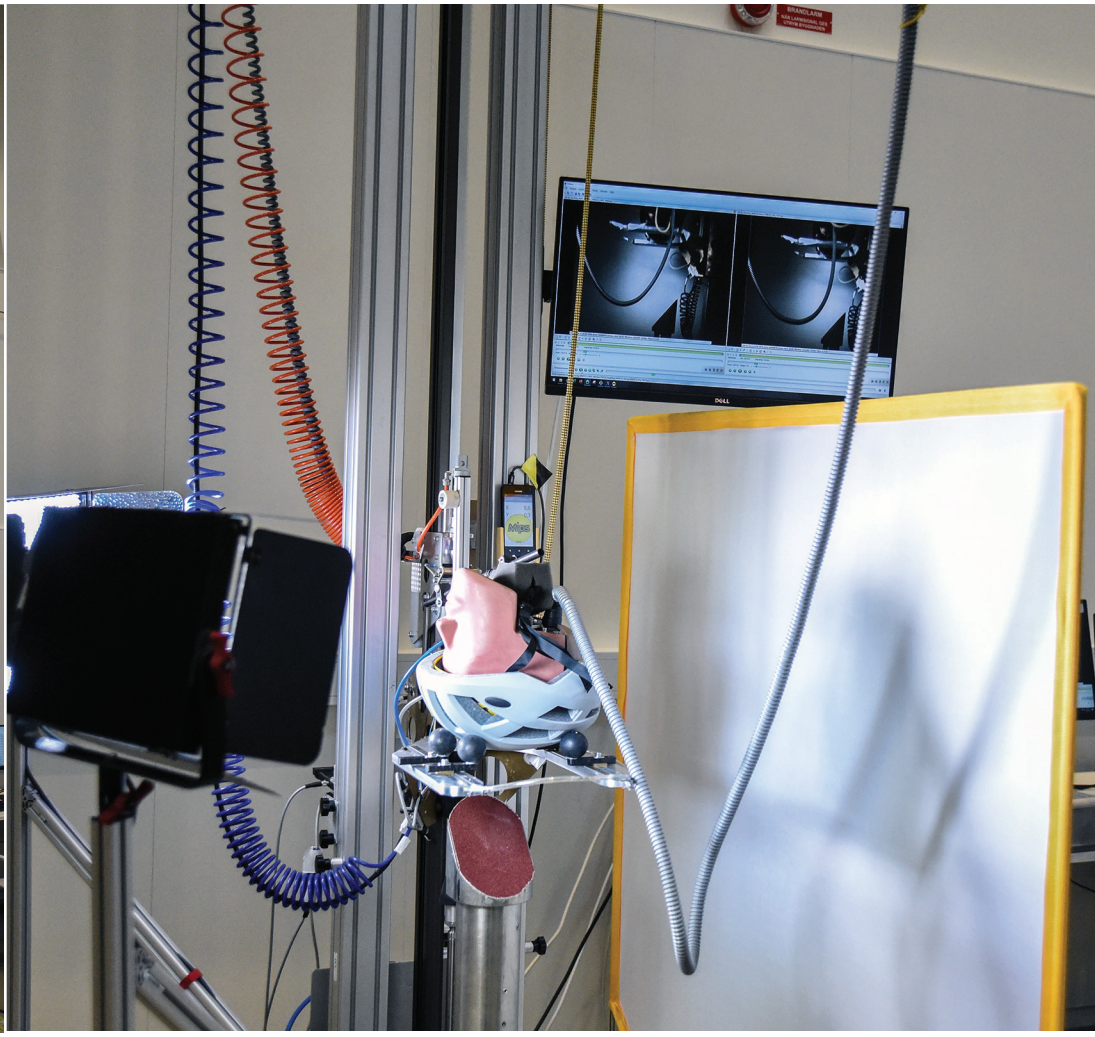
Since then, Trauma Void has come out with six styles of the EQ3, and its latest release is the Lynx. Charles Owen and Tipperary offer MIPS helmets for sale in the United States, and OneK plans to release a MIPS helmet later this year too.

JUST THE START OF THE JOURNEY

To date, over 27,000 tests have been conducted in the MIPS on-site laboratory. The researchers are seeking between a 10 and 60 percent reduction in brain strain, depending on the design of the helmet. If it's less than 10 percent, the helmet doesn't pass and can't be sold with the MIPS liner. A high risk of concussion starts around 20 percent strain.

The lab ceiling is 8 meters high to accommodate the testing device, which drops a lifelike dummy head equipped with accelerometers and wearing a MIPS helmet. With a loud crack, the helmeted head bounces off the hard surface, and computers and cameras record





All MIPS helmets are tested using its liners at the company's test lab outside of Stockholm, Sweden. *LINDSAY BERRETH PHOTOS*

every piece of information. Every helmet is tested at a 45-degree angle, which is where the rotational protective properties of the helmet are under the most stress. Equestrian helmets are tested at a drop of 2.2 meters and at a speed of 6 ½ meters per second, about 14.5 miles per hour, to mimic riding falls.

Researchers have pieced together reconstructions from a number of real accidents in the motorcycle and bicycle worlds, but they haven't done the same with equestrian incidents yet. They do look at publications and studies on jockey accidents in the United Kingdom, examining the impact speed and angle.

And from their studies, they've found that testing for angled impact is the most important change needed in the future. The European Committee for Standardization, or CEN, produces standards that helmets in Europe must meet. (In the United States, ASTM International is the company creating the standards.)

"From this information, we know we should have linear tests to have protection for a skull fracture, but we should add a test for the angled impact," said Halldin. "That is our conclusion at MIPS, but it's also the conclusion from CEN. Within CEN, TC 158, the helmet test standard in Europe, there are 14 working groups. Working Group 1 is industrial helmets, Working Group 4 is bike, and Working Group 5 is equestrian helmets. I'm on Working Group 11 working towards new testing methods.

"We have come to the conclusion within CEN, MIPS, and other universities and test laboratories and helmet manufacturers that we should combine this test with a test at an angle for ski, motorcycle, equestrian and snow helmets," he continued. "That is the future. It's not in place yet, and I cannot tell you when. But it will happen.

What we know is the tests we do, we reduce the strain in the brain for a vertical drop against a 45-degree angle."

—Peter Halldin

The ball is rolling. The work within CEN takes time. My best guess today is 2024."

When asked whether MIPS helmets are safer, Halldin chose his words carefully.

"I would like to say we reduce the risk for injury, but to write that, we can be sued tomorrow," he said. "What we know is the tests we do, we reduce the strain in the brain for a vertical drop against a 45-degree angle."

Every head injury is different because every fall is different, as is every person. But the idea is that maybe MIPS can change the outcome of your fall from concussion to no concussion, or lower the injury from severe to moderate. The only downside for the consumer is that the helmets generally cost about $20 more than non-MIPS helmets.

A few third-party tests using angled impact have been completed to verify the effectiveness of MIPS helmets; Virginia Tech's Helmet Lab has tested a variety of MIPS helmets across numerous sports, and Swedish insurance company Folksam chose the Back On Track EQ3 Lynx as "best in test" in its 2018 equestrian helmet test.

Von Holst says he welcomes innovations from outside of the company too. "We cannot sit down crossing our arms and say, 'Now we've done everything.' This is the start of the journey," he said. "When Henry Ford in Detroit started the [Model] T Ford on the [assembly line], then we imagined that all other car companies would drop dead, but that was not so. It was the contrary. They started to really compete with him. The same is true with MIPS. There will be a huge amount of new companies coming into this field where we are. They will come up with better solutions.

"Thanks to the MIPS system, I hope we can reduce some of the head injuries, either the number or by reducing from a severe head injury to moderate, or moderate to mild," he continued. "I think this is a good start before we find the final MIPS solution or a helmet that can absorb every type of energy, so you don't injure your brain."

Making Strides In Sustainable Horse Care

Whether you run a large commercial operation or a backyard facility, green options exist for every barn.

By **Erin Harty**