LIFESAVING DATA

Injury Biomechanics Data Advances Soldier Safety

Say it's 2008, and you're a U.S. soldier in the war-torn city of Ghazni, Afghanistan. You've just been ordered to determine if there are enemy combatants hiding out in a specified building. In order to breach the building and gain access, you may need to use explosives. But you also know that explosives could cause severe injuries, including combat-related brain injuries to your own nearby team members.

This is not a far-fetched scenario. And the real-world ramifications are significant. In the early 2000s, in order to assess the probability and severity of potential blast-related injuries, the U.S. military realized they needed to be able to collect high-frequency pressure, acceleration, and force measurements of explosions. This data would help diagnose causes of injuries in the field, determine if a soldier should seek medical attention, and inform the design of better protective equipment. But they also knew that it's extremely difficult to collect high-quality data for harsh blast incidents that last only milliseconds.

In 2009, the U.S. Army Small Business Innovation Research (SBIR) program solicited solutions from the small business community. In response, Diversified Technical Systems (DTS) developed the Personal High Rate Data Recorder (PHRDR), an ultra-small, low power, wearable, and waterproof data acquisition system meant to be worn by the warfighter.

"PHRDR was designed to collect high frequency exposure measurements in warfighter training and operational environments," said Mike Beckage, co-founder and Chief Technical Officer (CTO) for Support at DTS.

Prior to the PHRDR, existing data logging methods included heavy equipment, bulky cables that tangled easily, and/or close-range wireless transmission that required personnel activities to be predicted or controlled—both impractical and unsafe in training and mission operations that often included penetrating buildings or launching rockets.

Beckage said, "There was no existing device that could record high-quality data from an entire event that occurred at an unknown time and place."

In search of a solution, Beckage and fellow DTS co-founders Tim Kippen, CTO-Engineering, and Steve Pruitt, CEO, worked with their team to design the initial PHRDR prototype. The prototype validated the circuit board concept, instrumentation, and ultra-small, wearable size. It also demonstrated the ability to collect data at one million samples per second per channel. DTS proved that the PHRDR could be small, lightweight, low power, and robust, with sufficient memory to record multiple events.

Beckage said, "We worked with Fort Rucker in Alabama on the pressures and forces soldiers were exposed to when doing things like breaching buildings. The Army needed to better understand these forces to better protect the soldier."

The work DTS did for the SBIR awards ultimately led to DTS's core technology. "All of the current generation of DTS's products owe a debt to the SBIR Phase I and II," Beckage said.

He added, "We started out with a clean slate, came up with the concept for a physical device and made iterative improvements, meeting the Army's need. We proved the electronic performance requirements in Phase I. It could fit in the palm of your hand and had a battery that would last all day. It also had waterproof connectors and the sensors could be placed on a helmet or in clothing."

Under the Phase II SBIR effort (2010-2012), DTS developed and delivered two working systems. "We developed the packaging methods, waterproofing methods, and conducted field tests. We successfully delivered the systems, and the Army is still using them today," Beckage said.

Steve Pruitt, Tim Kippen, and Mike Beckage, founders of DTS.

The most challenging part of the process, according to Beckage, was to develop the enhanced core technology to collect data at higher frequency rates and to process the data at one million samples per second. "The original unit had nine channels, so the device could measure up to nine million data points per second. We also wanted it to be programmable and have the capacity to support many types of sensors," he said.

With this new technology, the Army gained novel measurement capabilities that allow researchers to better understand the warfighter's exposure, resulting in improved protection countermeasures. The SBIR also helped DTS advance the state-of-the-art for autonomous data recorders

Personal high rate data recorder from DTS, above, and a combat helmet smart-sensor, inset.

that are used worldwide in a variety of applications.

The work DTS did for the SBIR awards ultimately led to DTS's core technology. "All of the current generation of DTS's products owe a debt to the SBIR Phase I and II," Beckage said. "The SLICE PRO product line started from the PHRDR work and was used for much of the Army's Warrior Injury Assessment Manikin (WIAMan) program. WIAMan is a 'biofidelic, warrior representative engineered to assess potential skeletal injuries of soldiers exposed to underbody blasts.' WIAMan has been used extensively in blast mitigation work."

DTS was founded in 1990 by three crash-test engineers. Based in Seal Beach, California, DTS currently employs 100 people, and has Technical Centers in Michigan, China, Japan, Europe, and the U.K. Their data recorders and sensors are used worldwide in crash, blast, and injury biomechanics testing by top automotive, aerospace, and research facilities. The U.S. Army named a DTS helmet sensor one of "The Greatest Inventions of 2011."

Thanks in part to the SBIR PHRDR work, DTS's product line has expanded to include technology used for warfighter biomechanics research and vehicle safety for the commercial automotive sector. "At least 50 percent of our business is commercial," Beckage said. "There are huge benefits to the economy, and we feel proud that our products are used to save both civilian and soldier lives."

As a result of DTS's contribution to the understanding of blast mechanics, warfighters can now conduct training exercises and combat operations with greater confidence. Increased knowledge about personal safety and security concerns in dangerous situations allow soldiers to take calculated risks while still focusing on the task at hand.

Diversified Technical Systems, Inc.
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