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Saving Soldiers' Lives

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Engineering professor Brendan O'Toole and his team are driven to find ways to protect soldiers through the innovative use of research and technology.

By Tony Allen
Photography by Geri Kodey

It's an all-too-common headline in newspapers across the nation: "U.S. Soldier Killed in Roadside Blast."

Such tragic news reports cause many here at home to sadly shake their heads and turn the page. But, for Brendan O'Toole, these reports serve as added motivation to return to his laboratory.

The UNLV engineering professor is determined to find ways to help eliminate, or at least diminish the frequency of, such heartbreaking headlines.

O'Toole and a team of researchers from the Howard R. Hughes College of Engineering consider it their mission to develop new vehicle technologies that may one day protect soldiers from deadly roadside explosions.

Tucked in the recesses of the engineering building, the team–composed of 10 faculty members, five research professionals, and nine graduate students–is finalizing research in the fifth and final year of a $6.5 million grant from the U.S. Army Research Laboratory (ARL).

UNLV engineering professor Brendan O'Toole and his team conduct research on U.S. Army vehicles with the goal of maximizing crew survivability and electronics reliability.

"In recent years, the Army has begun looking more closely at how to develop future combat systems that are not only more mobile and technologically advanced, but that also maximize crew survivability and electronics reliability," says O'Toole, who serves as principal investigator on the grant.

O'Toole's interest in this area was piqued by more than a year of research he conducted at the ARL in Aberdeen, Maryland, starting in 2000. While there, he introduced Army researchers to the capabilities of UNLV's College of Engineering, developing a relationship that would soon bring the ARL to UNLV with a plan.

"There was, at that time, no university research being conducted with the ARL on improving the reliability of electronics used in Army equipment under extreme conditions," O'Toole says. "Our faculty expertise provided a perfect match for their needs."

Later, the war in Iraq caused the Army to also begin examining how improved vehicle structural design could reduce the rising casualties caused by improvised explosive devices, or IEDs. The Army's needs soon translated into multiple research projects and considerable grant funding for UNLV engineering faculty.

In all, the Soldier's Objective Future Force Electronics Reliability and Survivability (SOldier FERST) grant consists of 14 individual tasks that range from improving vehicle seat and frame designs to developing electronic component testing mechanisms and concepts.

The project is funded by the largest grant UNLV has ever received from the Army. While it has been successful on a number of fronts–producing nearly 70 journal and conference papers, 20 master's theses, and eight doctoral dissertations–perhaps its greatest impact is yet to come.

"Our successful five-year working relationship with the ARL has resulted not only in additional projects with the Army, but also in partnerships on related projects with private companies and universities throughout the nation," says Eric Sandgren, dean of the College of Engineering. "We have demonstrated that we have the expertise and facilities to attract and obtain top-notch competitive grants and government contracts." The magnitude of the project also spurred the formation of the Center for Materials and Structures, which formally houses the Army project and related work from faculty in engineering, physics, and chemistry.

"If you look at all the projects individually, we're doing great work," O'Toole says. "When you put them all together, we have a phenomenal group of faculty and excellent research facilities. Because of that, we've been able attract new research and fund an impressive team of graduate students."

O'Toole and mechanical engineering professor Mohamed Trabia (not pictured) are working to design vehicle armor joints that better absorb ballistic shock while maintaining structural integrity.

VEHICLES PROVIDED COURTESY U.S. ARMY


Mechanical engineering professor Georg Mauer conducts research on vibration testing in an effort to better understand real-life environmental stresses on electronic components in Army equipment.

Among the most notable projects funded by the grant is one involving mechanical engineering professors Brian Landsberger and Douglas Reynolds. The two are working to design a vehicle seat system that protects occupants from extreme shock acceleration transmitted through a vehicle during a roadside blast.

Current seat systems include a rigid frame mounted to the floor of the vehicle cab. This design provides little or no protection from the vertical forces produced by a blast. The system designed by Landsberger and Reynolds utilizes a wire rope spring and air bladder cushion to allow for limited vertical motion and, therefore, less force on the spine.

"The seat can be the critical component that saves a crew member's life," says Landsberger. "Even with good vehicle shape, size, armor, and frame design, the cab movement during a blast subjects a rigid-seat occupant to unacceptable forces. But these forces can be diminished to acceptable levels with the improved seat."

The UNLV seat design is one of four–and the only one from a university–to be accepted for blast testing by the Army this spring. Data from this test will be used to confirm lab test results and guide the Army's selection of seat designs for further development and production.

"Whichever seat concept the Army chooses, our research and development accomplishments have helped enhance understanding of different methods of crew member protection, and that's very rewarding," says Landsberger.

O'Toole concurs.

"It's exciting to consider that each and every project has produced something positive," he says. "We're doing research here at UNLV that will one day help the Army develop devices that will save people's lives. It doesn't get any better than that."

SOldier FERST incorporates the work of researchers from the departments of mechanical, electrical and computer, and civil and environmental engineering. All in all, nearly 50 faculty members, research professionals, and graduate students have worked on the Army project over the course of the last five years. Among the projects under way are the following:

Joint Design for Shock Mitigation in Vehicles
Brendan O'Toole and Mohamed Trabia,
Mechanical Engineering

Combat vehicles are exposed to great risk, and ballistic shock from the area of impact to locations of critical components can result in reduced effectiveness of a vehicle. This project focuses on designing armor joints that attenuate the shock across the vehicle while maintaining structural integrity.

Joint Design for Shock Mitigation in Projectiles
Mohamed Trabia and Brendan O'Toole,
Mechanical Engineering;
Samaan Ladkany, Civil & Environmental Engineering

Current developments in artillery shells include electronic sensors and controls for on-board systems that improve range, accuracy, and overall performance. However, in some cases, high frequency accelerations during launch conditions cause failures in electronic circuit boards. This project seeks to reduce vibration on electronic components mounted inside the projectile.

In Bore Recorder
Peter Stubberud, Electrical Engineering

Munitions systems testing relies on the ability of electronic systems to record and log very precise data. The goal of this project is to design and fabricate a recorder that fits within a 16mm cylinder by reducing the size of current sensors and conditioning components and combining them into a single integrated unit. The combination will not only reduce the recorder's volume; it will increase electrical efficiency and improve battery power consumption.

Design and Evaluation of Multi-Axis Shaker Concepts
Georg Mauer, Mechanical Engineering

Electronic components in Army equipment are often subjected to stresses from multiple directions, yet most mechanisms used in vibration testing utilize a single source. Through this project, a six-axis shaker system has been developed to more accurately model the stresses of a real-life environment. The success of this project may lead to future grants to develop a larger version of the prototype with a greater payload capacity.