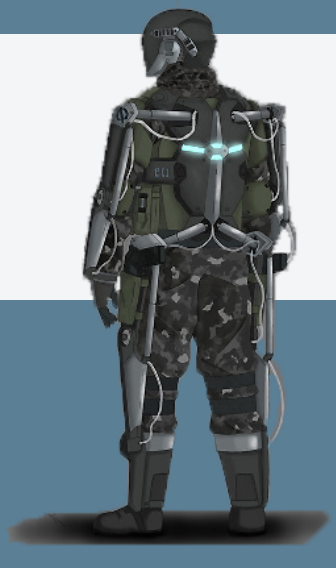
Accelerating Exoskeleton Innovation

How Collaboration among Government, Soldiers, and Industry Advances Military Readiness



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U.S. collaboration with industry and academia is central to maintaining America's military superiority. The U.S. Army is applying this blueprint for innovation as it evaluates exoskeletons to contribute to Soldier readiness and response.

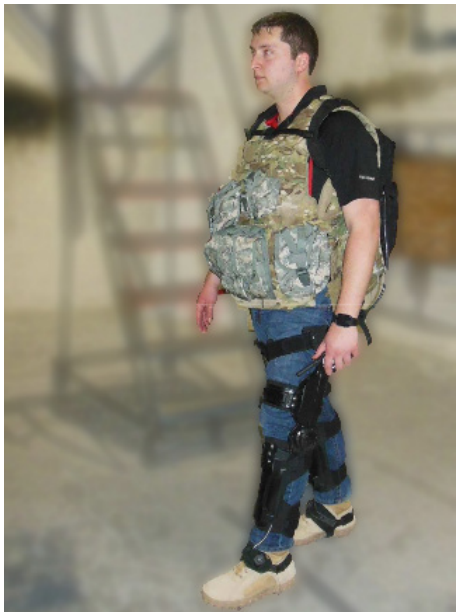
Since the 1990's, the U.S. Army has been monitoring and exploring how exoskeletons can give Soldiers a greater advantage. In 2017, a U.S. Army directive to further evaluate exoskeletons led to an independent analysis of candidate products to better understand their mechanical properties, how they integrate with Soldier systems, their operational utility, and how Soldiers will use them.

To support this exoskeleton effort, the U.S. Army Combat Capabilities Development Command Soldier Center (CCDC-SC) has been applying its science and engineering expertise in collaboration with industry, DOD, and academia to advance Soldier and squad performance. And, Boston Engineering is proud to be a part of this mission.

Evaluating Commercial Exoskeleton Technology for Military Applications

Boston Engineering's supporting role in exoskeleton analysis includes:

- Conducting third-party exoskeleton product evaluations for defined military applications
- Gaining Soldier feedback regarding exoskeleton performance, ease of use, etc.
- Mapping current exoskeleton capabilities to Soldier requirements
- Supporting future program phases, such as optimizing exoskeletons to address military needs



Boston Engineering Captures Exoskeleton Sound Levels at a Nationally Recognized Testing Laboratory (NRTL) for the CCDC-SC. (Photo Credit: Boston Engineering)

At a high level, the CCDC-SC's program uses a defined process to determine if and how the technology will improve specific Soldier capabilities. The team working closely with Soldiers on this initiative includes Boston Engineering, University of Massachusetts at Lowell, Massachusetts Institute of Technology (MIT), and other academic, industry, and government partners.

Exoskeletons for Combat Arms

The first project addressed enhanced mobility and stamina for infantry. Boston Engineering analyzed exoskeletons designed to assist in "movement and maneuver" tasks to reduce burden on ankles, knees, and hips.

Exoskeleton testing and evaluation covered ruggedness and reliability, risk/hazard assessment, and power consumption analysis. To measure acoustics at various stages of product power and energy use, Boston Engineering used reverberation test rooms at a Nationally Recognized Testing Laboratory (NRTL) to conduct its research. And, usability/operational focus areas included the ability for Soldiers to put on and take off the exoskeletons quickly.

In addition to running numerous objective lab-based exoskeleton performance tests, the CCDC-SC also conducted considerable user feedback assessments to better gauge performance benefits for Soldiers. These assessments, or Soldier Touch Points (STPs), are critical to the Army Futures Command principles for improving technology transition from research and development to fielding. This first round of STPs involved the evaluation of two products: the Dephy ExoBoot and Lockheed Martin's ONYX.

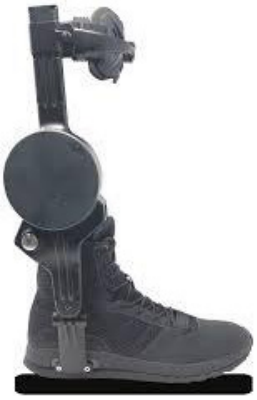
Soldier Testing

Testing of the two "movement and maneuver" exoskeletons took place at Ft. Drum, New York with the 10th Mountain Division (light infantry), and at Ft. Devens in Massachusetts. More than 250 Soldiers wore the systems as part of this first robotic exoskeleton vetting phase that kicked off in 2018 and concluded in 2019.

Soldier Military Touch Point (Photo Credit: U.S. Army Combat Capabilities Development Command Soldier Center)

The exoskeleton STP provided operational and technology immersion on both infantry maneuvers and technology demonstrations. The team observed Soldiers wearing exoskeletons while performing standard Soldier and occupational tasks. And, it provided an interactive forum to get Soldiers' candid feedback.

While evaluating how exoskeletons reduce the physical burden of combat-duty Soldiers, the exercises also served to introduce the concept of exoskeletons in relationship to reducing physical and cognitive load. And although responses from individuals are subjective, Boston Engineering and CCDC-SC use a standard model to measure feedback.



Dephy ExoBoot (Photo Credit: Dephy Inc.)

In addition to CCDC-SC and Boston Engineering, teams from the public and private sectors attending the STPs included the Program Executive Office-Soldier, the Maneuver, Aviation, and Soldier Division at Futures and Concepts Center, Army Futures Command, the Maneuver Center of Excellence and Maneuver Support Center of Excellence, CCDC Army Research Labs, Dephy Inc., and Lockheed Martin Missiles and Fire Control.

The CCDC-SC and other military teams will continue STPs to further refine exoskeleton requirements and capabilities for infantry applications. Importantly, STPs provide an opportunity for other areas of the military to participate and provide feedback, including the Solider Lethality Cross-Functional Team (CFT).

Exoskeletons for Sustainment & Logistics

Under CCDC-SC's direction, Boston Engineering is also conducting similar analysis for "sustainment" and/or "logistics" exoskeleton applications. Tasks such as

lifting, carrying, manual and overhead work are critical to supporting missions. Exoskeletons that best meet these needs typically focus on providing support to the upper body, lower back, and hips.

Phase I of this new program includes procuring relevant exoskeleton/exosuit products; working with vendors to understand and test their capabilities; and performing a comprehensive engineering analysis.

In addition, Boston Engineering is developing test plans to evaluate the performance of the exoskeleton by quantifying the biomechanical and physiological demands on the Soldier while using the product.

This effort will include collaboration with the UMass Lowell NERVE Center, a robotics testing and research facility to help evaluate robotic capabilities, human performance, and human-robot interaction. These 2020 efforts will be critical in determining which designs will be implemented in future exoskeleton STPs.

The Path Forward

Military agencies continue to gain valuable insights based on Soldier feedback. And, additional testing to measure the physiological demands on Soldiers using exoskeletons will help to refine Technology Readiness Level (TRL) requirements for defined exoskeleton applications.

Additionally, the exoskeleton analysis supports a broader focus on advancing related technology standards:

- ASTM F48 Committee on Exoskeletons and Exosuits
- ASTM ET CoE (Exoskeleton Technology Center of Excellence)

To help ensure that the military capitalizes on the latest technology to achieve its vision, Boston Engineering is working across the commercial, industrial, and academic fields to keep pace with early-stage R&D, new prototypes, and enhancements from established exoskeleton manufacturers.

Under the direction of CCDC-SC, Boston Engineering and other collaborators also continue to incorporate Soldiers' feedback to enhance battlefield lethality, survivability, readiness, and mission performance. This process of "accelerating innovation" – by actively aligning military leadership, industry & academia, and Soldier insight to achieve a common goal – will help enable the U.S military to capitalize on exoskeleton capability advances more effectively.

Authors

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About Boston Engineering

Boston Engineering provides product design and engineering consulting from concept through commercialization and connectivity. Boston Engineering is also the Northeast's largest PTC software reseller, is a ThingWorx IoT partner, and is an ANSYS reseller. Certified for ISO 9001 and ISO 13485, the company's industry expertise includes commercial, defense, and medical. Founded in 1995, Boston Engineering is headquartered in Waltham, Mass.

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