

# BALANCING ACTS

SBIR-SUPPORTED INNOVATIONS IN SENSOR TECHNOLOGY LEAD TO IMPROVEMENTS  
IN ARMY VR TRAINING SYSTEMS, OTHER ADVANCEMENTS

For the U.S. military, the positioning and orientation of technologies—from weapons systems to communications platforms—is critical. Imagine a satellite orbiting the Earth. A few degrees of incorrect rotation on its axis could result in missed transmissions. Weaponry, too—both real world equipment and virtual versions used in applications such as training exercises—relies on extremely precise angles and calculations based on exactly where the weapons exist in physical space. For projectiles launched over miles, the difference of less than a degree at the point of release might mean the difference between a direct hit and a wide miss.

That is why the Department of Defense (DoD) has invested heavily in gyroscopic sensors and accelerometers. Industry in this area typically refers to six-degrees-of-freedom (6DOF), which is defined as the freedom of movement of a rigid body in three dimensional space: backward and forward, up and down, left and right, as well as rotation around three axes. In recent years, instruments that can measure 6DOF position and orientation have typically used Microelectromechanical systems (MEMS), which consist of small processing units and individual sensor components. But these types of technologies have downsides. For one, as they get smaller, they tend to be less

accurate. And due to their size, they are often difficult and expensive to manufacture.

In 2003, the U.S. Army solicited proposals for a Small Business Innovation Research (SBIR) funding opportunity to develop a high-precision, expendable 6DOF sensor that was not dependent on MEMS technology. The SBIR was awarded to Inertial Labs, Inc., a Virginia-based navigation solutions company that specializes in orientation sensors, gyroscopes, motion reference units, and other related solutions.

Under the SBIR, the company adopted a novel approach—developing an inertial measurement unit using a sensor based on the detection of movement of a single proof mass suspended in a ferrofluid, a liquid that is attracted to the poles of a magnet. Through the SBIR Phase I contract, the company demonstrated the technology's ability to act as an angular and linear accelerometer in a 6DOF application. The initial award led to a Phase II contract in 2005 wherein the Inertial Labs team took the tech and optimized it for size, power consumption, performance, and cost, for use in an Army virtual reality (VR) training system, a system which eventually became a Program of Record.

Along the way, the company was forced to overcome several hurdles,



according to Jamie Marraccini, President and CEO of Inertial Labs.

“How do we get the weapon position precise? How do we get the warfighter orientation precise? To make it more realistic, you have to have more than getting the line of sight right,” Marraccini said. “We excelled in being able to tell the orientation of these large weapons to where you could know where it would land based on where and how the tube was mounted.”

Through the same SBIR contract, the company also worked with the Army on a combatant ID system, which could help identify whether a target was friendly or not based on how their weapon was pointed, thereby potentially reducing friendly fire.

“All of this is dependent on position and orientation, and that’s our area of specialization,” Marraccini said.

According to Brian Geigert, Branch Chief, Dismounted Fire Control Systems for U.S. Army Combat Capabilities Development Command (DEVCOM), the company’s technology “showed enough promise” that the agency put in place follow-up efforts through the DoD Ordnance Technology Consortium to further develop it for military use.

“The primary goal of those efforts was to advance the technology to ultimately develop a pointing device that could be used on U.S. mortar weapon platforms. This pointing device would be integrated into a U.S. government-designed system to allow end users the ability to improve lethality and responsiveness in the field,” Geigert said. “The core technology is still being improved today with ongoing agreements, and it is being evaluated by the U.S. government in an upcoming technology down-select.”

Also through that SBIR work, the company developed a fire control solution for



mortar tubes, a technology that will be used to automate the firing process, reduce time to fire, improve accuracy and decrease the reacquisition time of targets. Using and calibrating these systems is easy for the warfighter, Marraccini said, requiring little time and training, and only small adjustments. The systems are also incredibly accurate: Under the SBIR contracts, Inertial Labs’ tech had to achieve North Finding, North Keeping, as well as precise positioning and navigation with and without GPS.

To do this, the company utilized a combination of several different techniques in its sensors: celestial monitoring, gyrocompassing, Global Navigation Satellite System GNSS/GPS, magnetic compassing, and kinematic alignment. This novel, all-of-the-above approach is what Marraccini believes sets the company’s solutions apart and makes them ideal for the military’s needs.

“We’ve been trained by the SBIR program on how to think properly: Think modularly, don’t be rigid,” he said. “We aren’t the kind of people who say we’re going to solve the problem with only this one solution.”

From that initial 2003 SBIR, Inertial Labs spun out three different types of sensors that fit into three different DoD Programs of Record, according to Marraccini. The company has also managed to commercialize several of its sensor products that were developed as a result of the SBIR contracts for use in satellites, antennas, and cranes among industry.

“You’re building off of something, and you have to be willing to do that custom integration and have that solution mature,” Marraccini said. “I’m a big fan of the SBIR program. It’s a smart idea to mature these technologies and get them to where they can be used by both the military, as well as these larger integrators.”

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Modernization Priorities: Microelectronics, General Warfighting Requirements  
SBIR Contract: N61339-05-C-0134 • Agency: Army • Topic: A03-202 High-Precision, Expendable, Six Degree-of-Freedom Sensor  
National Defense Strategy Pillar: Force Readiness and Lethality

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