

UNMANNED ROBOTICS SYSTEMS: SBIR Technology Underpins Life-Saving Military Robots



MEET AN INTEGRAL MEMBER OF THE EOD TEAM

TALON robots have become an integral component of the Explosive Ordnance Disposal (EOD) team, finding and defeating deep buried Improvised Explosive Devices (IEDs), house-borne IEDs (HBIEDs), landmines, and other types of explosives, and putting themselves in harm's way to save the lives of soldiers and civilians.

These impressive robots—built by Foster-Miller Inc., now part of QinetiQ North America—have been developed over 17 years, with the support of multi-agency funding, and have been important contributors during missions in Iraq, Afghanistan, Kuwait, and Bosnia, as well as in New York City at Ground Zero.

Saving Lives in Theater - the TALON Robot: A Technology Development Story

Development of small robots for use in combat began at Foster-Miller, Inc. (FMI), a small business, in 1993 with the first Defense Advanced Research Projects Agency (DARPA) Small Business Innovation Research (SBIR) award for development of “Lemmings”—conceived as a solution to the countermine problem in the surf zone. The Phase I Award was for “A swarming approach to shallow water mine field clearance.” The Lemming system contained several unique technologies adaptable to a variety of commercial and other military applications. The unique search pattern could be used whenever search and exploration was required. The sensor designs could be used in a wide variety of manufacturing processes, or wherever object identification was needed. The vehicle design represented a first-time affordable means of carrying a range of payloads within the shallow, very shallow, and surf-zone regions.

The subsequent Phase II Award led to the Lemmings used by the Navy and the development of several new platforms, including the Sea Dog—capable of finding and destroying undersea assault obstacles—and eventually the Tactical Advanced Robot (TAR). TAR went on many missions, most notably in the Bosnian conflict, where they began to be used for surveillance and removal of unexploded munitions in remediation of former war zones. Along the way in these exercises, the users began calling the robots “Talons.”

FMI was acquired in 2004 by **QinetiQ North America**. Today, the company estimates that about 3,000 TALON robots are being used by U.S. forces around the world to support several mission areas—Explosive Ordnance Disposal (EOD), reconnaissance, communications, sensing, security, defense, and rescue. Many lives have been saved by these innovative, complex technologies.

With ten DARPA SBIR awards since the Lemming, and contracts from the Army and Navy’s EOD research and development (R&D) programs, FMI is an important SBIR success story that required multiple cross-agency partnerships and development of complex technical solutions for solving tough DARPA problems.



Development Statistics

- An estimated 2 out of every 3 robots being destroyed by IEDs in theater today are TALONs
- Funding awards and development have spanned 17 years, creating 4 products with 25 mission-related variants
- FMI received 10 DARPA SBIR Phase I and II awards for Robotics totaling ~\$4.7 million
- Private funding has totaled more than \$20 million
- Total revenues have exceeded \$800 million since 2004
- 3,572 TALONs have been purchased by customers as of 9/28/2010

Key Missions

“TALON robots have been in continuous, active military service since 2000 when they were successfully used in Bosnia for the safe movement and disposal of live grenades. They were the only American-made robots successfully used at Ground Zero in search and recovery efforts after the Sept. 11 attack on the World Trade Centre and the only robots to last through the entire mission without requiring a major repair. TALON robots were also the first robots taken into Afghanistan during action against the Taliban and Osama bin Laden in February 2002. They initially accompanied the Special Forces on a classified mission, and are still there now doing EOD work. They were on the ground in Kuwait when coalition forces massed in 2003.”

*Source: Gizmag Team, Talon robot soldiers shipped to Iraq, 9 November 2004
<http://www.gizmag.com/go/3550/>*

Bosnia/Herzegovina/Albania—1996-1999

Tactical Advanced Robots (TAR), a simple prototype of today’s platforms, went on many missions, most noticeably in the Bosnian conflict where they began to be used for surveillance and removal of unexploded munitions in remediation of former war zones.

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Ground Zero—2001

On the very day of 9-11-2001, LTC Blitch, head of the DARPA Tactical Mobile Robotics (TMR) program, was invited to exercise TMR at ground zero. TALON Gen I was on site in the rubble looking for survivors on the morning of 9-12.



Operation Iraqi Freedom (OIF)—2003-present

Early after the start of OIF, it became clear that IEDs were to be a key part of the opposition force’s toolkit. Several TALONs, sent to theater in late 2003 on a demonstration basis, were deemed extremely successful, and the production of Man Transportable Robotic Systems (MTRS) by the Navy was ramped up to fill a growing demand for robotic tools for EOD. Many EOD technicians’ lives were saved by this sequence of events.



Timeline:

Product Evolution, Funding and Key Development Milestones

Lemmings



Targeted Customer: Navy
Technical Challenge: Countermine in the surf zone; single robot per mine
Milestone: Demonstrated a short-life, disposable, explosive robot
Funding: DARPA SBIR

PROGRAM DESCRIPTION:

Lemmings were developed as a solution to the countermine problem in the surf zone. A large, parallel swarm of small, cheap “countermine” robots autonomously roam around in the surf until they encounter a mine-at which point the robot gets close to the mine, waits for a signal, and then detonates - exploding both itself and the mine.



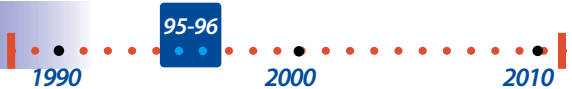
Sea Dog, Sea Cow, Sea Snoop



Targeted Customer: Army and Navy
Technical Challenge: Size-variant robots and ad hoc system integration
Milestone: Successfully demonstrated multiple missions with multiple robots, and conducted rapid design to test experiments for prototyping
Funding: Army and Navy

PROGRAM DESCRIPTION:

Larger variants of the Lemmings were implemented and demonstrated under several Army and Navy programs. The Sea Dog, for example, was capable of finding and annihilating undersea assault obstacles, such as dragon’s teeth, which are reinforced concrete barriers.



Special Operations Lemming (SOLEM)



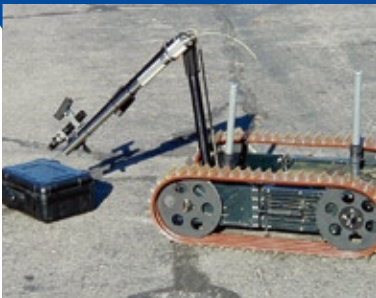
Targeted Customer: SOCOM
Technical Challenge: Covert ISR
Milestone: Successfully demonstrated missions to users
Funding: FMI Independent Research and Development (IR&D)

PROGRAM DESCRIPTION:

The SOLEM amphibious platform was used for off/onshore surveillance.



Tactical Advanced Robot (TAR)



Targeted Customer: Army and Navy
Technical Challenge: Upgraded chassis
Milestone: Rugged and reliable platform to support mission requirements during the Bosnian War
Funding: Multiple DoD sources, including DARPA

PROGRAM DESCRIPTION:

The robots were to be flexible enough to address diverse missions with minimal hardware modification.



Tactical Mobile Robotics Program (TMR)



Targeted Customer: Army and Navy
Technical Challenge: Soldier-centric subsystem development of platforms, mobility, control software, perception, and mission payloads
Milestone: Demonstrated Urban Operations at Fort Sam Houston; DARPA highlights mobile robots as a historical 50-year achievement
Funding: DARPA

PROGRAM DESCRIPTION:

This program is regarded as the beginning point of “soldier-centric” robotic tools. Subprograms on platforms, mobility, control software, perception, and mission payloads were all coordinated in a series of well-attended demonstrations.

C-TAR / C-TALON



Targeted Customer: Navy
Technical Challenge: Integration of communications, semi-autonomous navigation, shallow water mine detection, and mine marking
Milestone: Two classes of waterproofed vehicles were developed for operation under difficult shallow water conditions to demonstrate hybrid platform coordination with REMUS-class swimming UUVs
Funding: Principally Office of Naval Research (ONR), with additional input from FMI IR&D

PROGRAM DESCRIPTION:

Primarily in response to the inability to land forces in a direct beach assault in Desert Storm, a swarm of six TAR-class robots were waterproofed and instrumented for mine detection and neutralization. A later vehicle class improved upon this design by incorporating TALON technology.

TALON I, II and III



Targeted Customer: Army, Navy, Special Forces, and Law Enforcement
Technical Challenge: Integration of communications, semi-autonomous navigation, mine detection, and mine marking.
Milestone: Three classes of ruggedized land vehicles were designed to operate under varying conditions to demonstrate tactical uses of small robots deploying payloads (weapons, EOD tools) and casualty rescue with Ethernet protocol-based radio control
Funding: FMI internal R&D, and Tank Automotive and Armaments Command (TACOM) / TACOM Research, Development & Engineering Center (TARDEC) SBIR’s

PROGRAM DESCRIPTION:

The TAR technology was vastly improved by incorporating lessons learned, new microprocessors and radio subsystems. This new platform was called the TALON, and evolved through three generations (TALON I, II & III) during this period.

Man Transportable Robotic System



Targeted Customer: Naval Explosive Ordnance Disposal Technology Division (NAVEODTECHDIV) and Robotic Systems Joint Project Office (RSJPO)
Technical Challenge: Affordable, man-portable, reliable, full-mission endurance, and user-friendly operator control
Milestone: Deployment into combat during the initial invasion of OIF
Funding: Naval Explosive Ordnance Disposal Technology Division (NAVEOD) including joint service funds

PROGRAM DESCRIPTION:

TALON III evolved into Gens III-b & IV under the Man Transportable Robotics System (MTRS) Program. These 100-lb robots, developed for EOD applications, are successfully used to counter IEDs in military theaters of operations saving many EOD technicians’ lives.

Insight from an End User: “Gordon” TALON Defeats IEDs and Saves Lives in Baghdad

Submitted by EOD operator, Summer 2007, Iraq

Master Chief,

Sorry for the late report on Gordon the robot.

I got here around 25 June. Started the RIP* and was in the truck operating around the 1st of July. While I was in direct control of Gordon:

- 8 deep buried IED's were disposed of
- 7 houses were cleared of possible HBIED's.
- 13 Unexploded Ordnance's (UXO) found in houses that were to be placed as IED's
- 18 landmines
- Approximately 300 lbs of HME* was disposed of



On Gordon's final days, he was launched out of the truck and was searching an intersection for a possible deep buried IED. As he was on his way to the intersection, the IED was detonated about 10 ft from his location. Still functioning, he continued to search the area. On the opposite side of the road, another IED was detonated and had turned him up side down. Everything was still working until a fire fight started.

Gordon took 7 rounds to the underside and was done for the day. I took him to the robot shop for repair. It took 3 days. When he was returned to us, I put him back in the truck to get him back on duty. But this was shortly lived as he was searching a gate at a house for possible booby-traps that detonated directly next to him. Gordon was mangled beyond repair.

Now his replacement "Flash" is here to finish his job.

Source: QinetiQ North America:
<http://www.qinetiq-na.com/Collateral/Documents/English-US/QDS09-057-Gordon.pdf>

Using Talons is extremely important to the Soldier because it, and its family of various robots, takes the place of putting a Soldier in harm's way, in close proximity to an IED, in an extremely dangerous job. Let the Talon do the dangerous work.

- Sgt. 1st Class Benjamin Culver, noncommissioned officer-in-charge and IED-Defeat master trainer at the 1/338th

Source: <http://www.army.mil/news/2010/07/23/42723-new-robotics-obstacle-course-at-fort-mccoys-trains-soldiers-in-vital-safety-skill>

* RIP: Relief in Place
* HME: Homemade Explosive

Lessons Learned

“There has been a lot learned about the whole issue of robotics and mechanical walkers [and] they all contribute to the store of knowledge...”

- Larry Lynn, DARPA director, 1995-1998

- **Manufacturing during a time of war requires flexibility: war timelines are imprecise, resulting in uncertainty in procurement and delivery schedules. However, quality and speed of delivery are paramount once the order is received. To address this issue, QinetiQ North America used an outsourced manufacturing model and a qualified supplier network to meet war-time delivery schedules and was able to meet requirements without having to enter into long-term contracts.**
- **Development takes many iterations and requires comprehensive feedback from end users: the current products were a result of listening to detailed end-user needs.**
- **Addressing tough technical challenges that are common to multiple DoD services requires diverse partnerships across many agencies to ensure that the requirements of each stakeholder are met.**

ABOUT QINETIQ NORTH AMERICA

QinetiQ North America delivers world-class technology, responsive services, and innovative solutions for global markets, focusing on US government and commercial customers. More than 6,000 QinetiQ North America engineers, scientists and other professionals deliver high quality products and services that leverage detailed mission knowledge and proven, reliable tools and methodologies to meet the rapidly changing demands of national defense, homeland security and information assurance customers. Headquartered in McLean, Virginia, QinetiQ North America had annual revenues of more than \$1 billion in the fiscal year that ended March 31, 2010. QinetiQ North America is part of QinetiQ Group PLC (LSE:QQ). For more information, please visit www.QinetiQ-NA.com.



The TALON combat-ready robot, developed from platforms funded by several DARPA SBIR Awards

Product Profile

TALON robots are powerful, durable, lightweight, tracked vehicles that are widely used for explosive ordnance disposal, reconnaissance, communications, sensing, security, defense, and rescue. They can operate in all weather as well as day and night; they have amphibious capabilities and can navigate virtually any terrain, including climbing stairs, negotiating rock piles, and plowing through snow.

Fast—TALON robots can easily keep pace with a running soldier.

Rugged—TALON robots have a proven in-theater survivability rate under a variety of conditions. One was blown off the roof of a Humvee in Iraq while the Humvee was crossing a bridge over a river. It flew off the bridge and plunged into the river below. Soldiers later used its heavily damaged operator control unit (OCU) to drive it back out of the river.

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