U.S. Army Research, Development, and Engineering Command's Armament Research, Development, and Engineering Center (RDECOM-ARDEC) — Leveraging Foreign Technologies

Lu Ting

International cooperation in defense acquisition is mandated by DOD policy. According to *DoD Directive 5000.1*, acquisition program managers must "pursue international armaments cooperation to the maximum extent feasible, consistent with sound business practice and with the overall political, economic, technological, and national security goals of the United States." One objective of that pursuit is the leveraging of foreign technology. By leveraging the technology of our allies and strategic partners, DOD can develop the capabilities our warfighters need within a shortened acquisition cycle and at a lower cost.

Soldiers from the 2nd Battalion (Bn), 8th Field Artillery (FA), 1st Brigade, 25th Infantry Division (ID), fire an M777A2 Howitzer Oct. 2, 2008. The calibration took place at Camp Buehring, Kuwait, and was the last requirement for the Stryker Brigade Combat Team (BCT) to complete before heading into Iraq. (U.S. Army photo by PFC Alicia Torbush.)

A Lightweight Towed Howitzer

Possibly the best known and most successful examples of leveraging foreign technologies are the Excalibur 155mm Precision-Guided Extended Range Artillery Projectile, which has been described in an article on Page 16, and the M777 Lightweight 155mm Howitzer, which was based on foreign technologies in the beginning of its development.

In the early 1990s, in response to changes in the U.S. defense strategy — from a forward-based strategy to one of power projection — the U.S. Army initiated the Advanced Towed Cannon System project to develop a lighter weight towed howitzer. At the time, the U.S. Marine Corps (USMC) was also looking for a replacement for the M198, which is too heavy for strategic and tactical deployment. In October 1993, the Army and USMC signed a memorandum of agreement to Jointly develop a lightweight howitzer; and in 1995, a Joint operational requirements document was approved by both services. Meanwhile, in the United Kingdom (U.K.), privately funded development, trials, improvement, and demonstrations were already underway for lightweight field howitzers with a maximum weight of 4,000 kilograms.

In the hope to preclude the research and development (R&D) reinventing, the Army and USMC Joint Program Office conducted a competitive shoot-off to evaluate existing howitzers, with the winning candidate entering directly into engineering and manufacturing development (EMD). Three guns participated in the shoot-off and two of those were from the U.K.:

the ultra-lightweight field howitzer (UFH) of Vickers Shipbuilding and Engineering Ltd. (VSEL) and Royal Ordnance's light towed howitzer.

Both British howitzers advanced to the second round of shoot-off; however, in the end the VSEL UFH stood out and was awarded an EMD contract. In 1999, VSEL was merged into BAE Systems, which remains until today the prime contractor for production and post-production logistics support for this new howitzer.

Nonaircraft-Grade Titanium Alloys

The new howitzer uses titanium alloys extensively to reduce weight, but the titanium alloys and manufacture of the titanium components posed major technology challenges. To ensure the transfer of technology and know-how from the U.K. to the U.S., the acquisition strategy included a pilot production to produce the final two EMD howitzers in the United States.

Titanium is a major cost driver for the new howitzer. Despite its superior strength-to-weight ratio and corrosion resistance, titanium is limited for military armaments and platforms applications because of high cost. To overcome this restriction, RDECOM-ARDEC, with the support of the Army's Foreign Technology (and Science) Assessment Support (FTAS) program, is currently evaluating a specific foreign technology that can produce nonaircraft-grade titanium ingots suitable for military application, but at a lower cost.

The FTAS program was initiated in 2005 by the Deputy Assistant Secretary of the Army for Research and Technology (DASA(R&T)), the DASA for Defense Exports and Cooperation (DE&C), and the RDECOM Commander, to fund the assessment of emerging foreign technologies found by the RDECOM international technology centers (ITCs). The Army's ITCs provide the critical link between the U.S. technology developers and foreign academia, industry, and government labs.

Gunfire Detection Systems (GDS)

Excalibur and the new lightweight towed howitzer leveraged foreign technologies from the beginning and ran through the entire acquisition cycles. However, leveraging with the goal of rapid fielding can occur without an EMD.

In 1999, to counter sniper fire during operations in Bosnia and Kosovo, U.S. forces urgently needed a gunfire detection and localization capability. After surveying available technologies for rapid fielding, RDECOM-ARDEC and the RDECOM Army Research Laboratory proposed to the U.S. Special Operations Command (SOCOM) a foreign comparative testing (FCT) project to evaluate a French acoustic GDS: PILAR™. PILAR senses and analyzes the acoustic waves from gunfire to provide the relative azimuth, elevation, and range of small- and medium-caliber weapons.

PILAR performed well during FCT and subsequent evaluations. Urgent fielding and deployment of PILAR was authorized in the third fiscal quarter 2003, and 10 units each of the fixed-site (FS) and vehicle-mounted (VM) variant were deployed to Iraq for use by the 101st Airborne Division.

Soldiers from B Battery, 2nd Bn, 11th FA Regiment, 2nd Stryker BCT, 25ID, prepare to fire the M777A2 Lightweight 155mm Howitzer Jan. 2, 2008, at Camp Taji, Iraq. (U.S. Army photo by SFC Christina Bhatti.)

SOCOM approved the Milestone C and fielding and deployment release in May 2005 as M1 FS GDS and M2 VM GDS. Since then, more systems have been delivered to both SOCOM and the Army in Iraq and other theaters. Soldiers named both systems among the Army's Top 10 Greatest Inventions of 2005.

Remote Weapon Stations (RWSs)

GDS can be linked to an optical pan-and-tilt device that automatically points a day or infrared camera toward the sniper's position. For M2 VM GDS, it can be linked to an RWS and can help the Stryker vehicle commander to slew the weapon to that position and use the RWS's onboard day and night cameras to identify the target before engagement.

The Army's main RWS programs are other examples of leveraged foreign technologies. Stryker vehicles have been equipped with the Norwegian-developed M151 Protector RWS (Kongsberg Defence and Aerospace) since 2003. A variant of M151 Protector won a 2007 contract to deliver 6,500 XM153 RWS systems for the Army's multivehicle weapon-mounting and control system Common Remotely Operated Weapon Station (CROWS) II program.

The Protector RWS consists of a stabilized weapon station that can mount a variety of small- and medium-caliber weapons. RWS systems offer full, in-hull protection for the crew, much better fire-on-the-move capability, and the ability to use the RWS's advanced sensors at night or in obscured conditions.

Low Vulnerability Artillery Propellants

Although rapid transition into an EMD phase or fielding is the most cited outcome for the leveraging of foreign technologies, leveraging efforts more often start in the earliest stage of acquisition — the Technology Base phase. Foreign technologies help advance or expand the U.S. Technology Base where we are lagging or lack the funding for that specific R&D. Good examples are the cooperative projects on the R&D of low vulnerability (LOVA) artillery propellants with Japan and the insensitive high-energy density energetics with the Republic of Korea.

During the 17th U.S.-Japan Systems and Technology Forum (November 1995), which on the U.S. side was headed by the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (OUSD (AT&L)), International Cooperation, Japan proposed cooperation on the R&D of LOVA artillery propellants. Japan's proposal was based on the concept to use an energetic binder called cellulose acetate nitrate (CAN), instead of a nonenergetic binder, to increase the energetic output and, at the same time, to use CAN to replace some of the high-energy energetic filler such as RDX, to lower the sensitivity of propellants.

A series of CAN compounds had been manufactured in Japan since 1992. Japan proposed to offer various CAN samples in exchange for different U.S. plasticizers so that both sides could independently design and fabricate a few energetic formulations with Japanese CAN, U.S. plasticizers, and common RDX fillers and stabilizers, and then test for vulnerability, energy, erosivity, combustion, and aging characteristics. RDECOM-ARDEC accepted the proposal in 2000 and signed a cooperative R&D memorandum of understanding with the Technical Research and Development Institute (TRDI) of the Japan Defense Agency. It was a 4-year program and, at the end, both countries leveraged each other's technologies; gained mutual trust and respect; and understood each other's plans, programs, and approaches for insensitive energetics R&D.

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As a follow up, in 2005, Japan TRDI sent a scientist working on the CAN to RDECOM-ARDEC as an exchange scientist under the Engineer and Scientist Exchange Program (ESEP). The OUSD (AT&L) and DASA (DE&C)-run ESEP has been a very fruitful mechanism for leveraging foreign technologies for RDECOM-ARDEC. During her 1-year assignment at RDECOM-ARDEC, the Japanese exchange scientist experimented with a new type of calorimeter. Followed by another exchange engineer from a different country, RDECOM-ARDEC now has a new capability for aging surveillance of a specific group of propellants.

Insensitive High-Energy Density Energetics

While the LOVA cooperative project led to further leveraging of foreign technologies through ESEP, the ESEP will also lead to a follow-on cooperative R&D project. For example, a Korean scientist from the energetics laboratory of Korean Agency for

SGT Thomas Dieter, 688th Engineer Co., 890th Engineer Bn, monitors his CROWS from the protection of a Buffalo mine resistant ambush protected vehicle during a route-clearance mission in Baghdad, Feb. 22, 2009. (U.S. Army photo by SSG Mark Burrell.)

Defense Development (ADD) sent to RDECOM-ARDEC in 1997-1998 under ESEP earned such respect for his knowledge and skill in the synthesis of energetic materials that the U.S. initiated a cooperative R&D project with Korea on the design, synthesis, test, and evaluation of various novel energetics molecules.

Korean ADD has great capabilities in the theoretical calculation of energetics properties, modeling, and synthesis of novel energetics molecules; RDECOM-ARDEC has a wealth of experience in the R&D and scale-up of novel energetics. The cooperative 5-year project narrowed down the pool of promising energetics candidates, with reduced sensitivity but without degradation in performance.

In 2004, this cooperative project was extended to complete the study on several promising polynitro polyaza heterocyclic compounds. The 3-year extension will investigate the alternate synthesis routes to improve yields, the scaling up processes, and the formulations of energetics with these compounds.

As a result of this project, RDECOM-ARDEC scientists recently designed and successfully synthesized a few novel melt-cast explosive ingredients. This material has higher energy compared to TNT and Comp-B, which are used in artillery and mortar shells, respectively. In addition, the project has elicited theoretical models for *a-priori* prediction of the densities and sensitivities of compounds. This has allowed RDECOM-ARDEC scientists to concentrate on the synthesis of new compounds that are predicted to have higher performance and lower sensitivity.

The Challenge

International cooperation is an integral part of the acquisition program, and the leveraging of foreign technologies is the underlying objective of that cooperation. By leveraging foreign technologies, the U.S. Army's international communities have been able to help acquisition managers develop or acquire the required capabilities, shorten the acquisition cycle, and lower acquisition cost. Past programs have made great contributions; however, in light of the ever-changing warfighting environment, and with the rapid advancement of technology and ubiquitous technology sources, how to effectively and efficiently leverage foreign technologies remains an enormous challenge.

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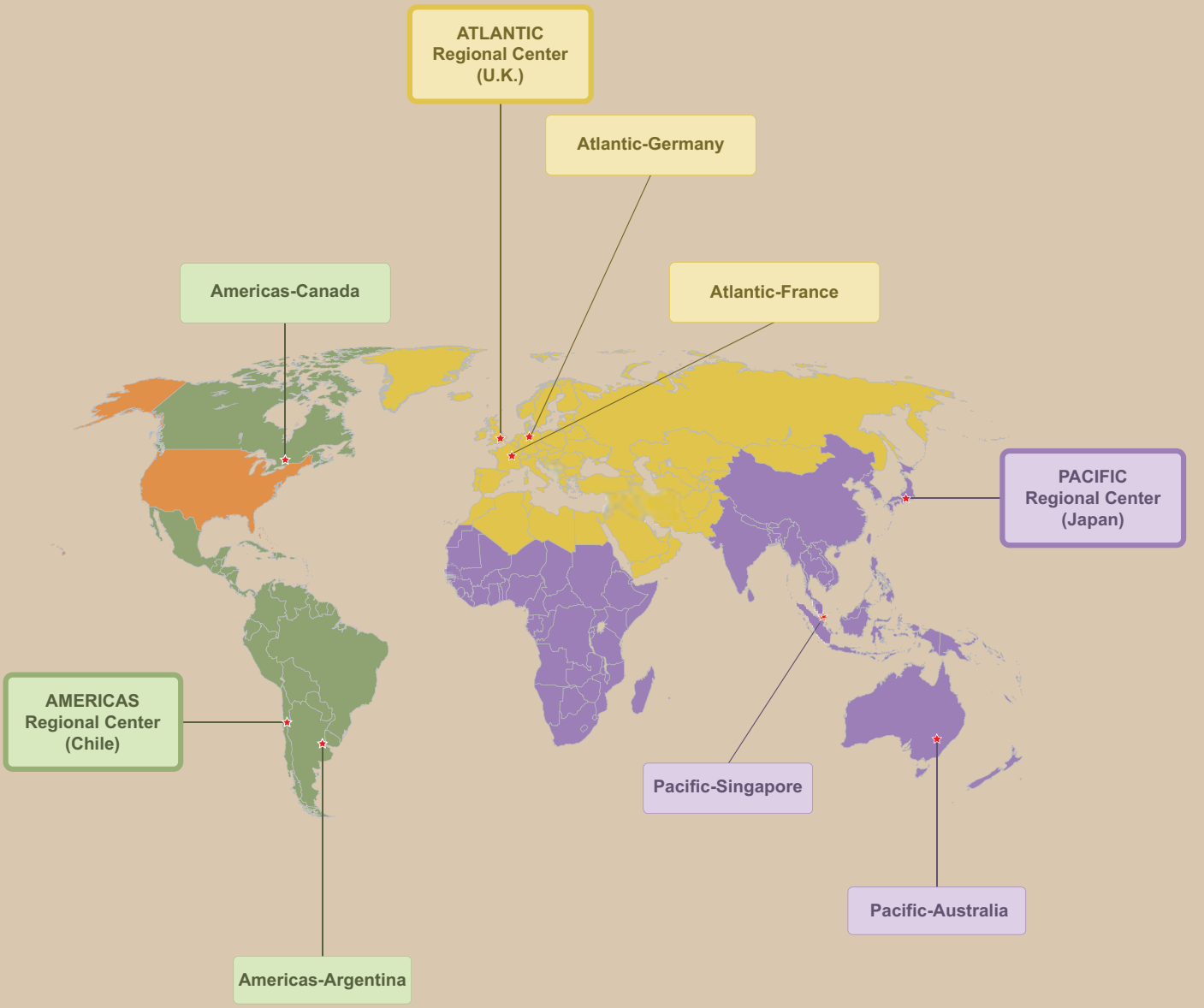
RDECOM ITCs

RDECOM has nine ITCs organized across three regions. The Atlantic regional office is in London, with two ITCs in France and Germany. The Pacific regional office is in Tokyo, with two ITCs in Singapore and Australia. The Americas regional office is in Santiago, Chile, with two ITCs in Canada and Argentina. Many of these offices are collocated with the U.S. Navy's Office of Naval Research and the U.S. Air Force's Office of Scientific Research. Collocation allows the Army to share information and leads with its sister services.