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The U.S. Humanitarian Demining Research and Development Program

The U.S. Humanitarian Demining Research and Development (R&D) Program rapidly develops, evaluates and demonstrates equipment for humanitarian demining, hoping to improve the overall safety of the individual deminer and the efficiency of humanitarian demining operations worldwide. By collaborating with a number of different members of the humanitarian demining community, the R&D Program strives to cater to the needs of those in the field and effectively fill any technology gaps as quickly as possible.

by Nicole Kreger, MAIC

Introduction

History

The U.S. Humanitarian Demining R&D Program was conceived in late 1992 and early 1993, when the Director for Acquisition in the Office of the Assistant Secretary of Defense (OASD) for Special Operations and Low-Intensity Conflict (SO/LIC) developed several concept proposals for a rapid-prototype program. The Undersecretaries of Policy and Acquisition supported the proposal, considering it a logical and necessary technology initiative to be part of SO/LIC's tasks in the low-intensity and peacetime engagement arena. When the Assistant Secretary of Defense (ASD) SO/LIC requested support, funding was identified in the Defense Advanced Research Projects Agency and was scheduled to begin in Fiscal Year (FY) 1996. Deciding that there was a more immediate need for the program, Congress provided additional funds to the U.S. Army's Countermine Program to fund humanitarian demining for FY 1995. Congress has continued to support the R&D Program.

Since the program's beginnings, the Department of Defense (DoD) has been researching cost-effective technologies for the demining community. Since then, significant progress has been made in developing and improving tools and technologies for humanitarian demining. These devices assist in clearing, detect-

ing, marking, mapping and neutralizing mines, protecting deminers, clearing vegetation and promoting mine awareness. The most successful of these have been deployed in nations all over the world to undergo field testing.

The DoD Humanitarian Demining R&D Program is part of the Night Vision and Electronic Sensors Directorate (NVESD) at Fort Belvoir, Virginia. The Program strives "to provide suitable technology to detect and clear all landmines, improve operator safety, and provide special small and handheld tools for operators."¹ According to a video on the program's website, "The Humanitarian Demining R&D Program focuses on the testing, demonstration and validation of various equipments suitable for immediate use in various international humanitarian demining mission environments."²

How the Program Works

The program operates on a multi-year investment strategy as follows:

- Annual requirements workshops involving people from affected countries are used to identify system requirements.
- Data analyses and assessments determine the system requirements in two ways:
 1. Determining the performance capabilities of commercially available metal detectors to identify AP mines in countries where a significant number of mine-related injuries are occurring.
 2. Identifying where technology voids exist.
- Market surveys identify commer-

cially available items for detection and clearance, which are then sorted and stored in fully searchable databases. The databases are updated and maintained on the Internet, and they serve as the basis for identifying available equipment that may be suitable for Humanitarian Demining.

- Developmental tests are conducted at Fort AP Hill, which has the ranges to support live and inert mine testing. From these tests, changes are recommended and implemented, after which the tools are retested.

- In-country field-testing is performed and support training is conducted for indigenous personnel with multi-lingual multimedia on equipment operation.

The real driving force behind the R&D Program is its Annual Requirements Workshop, held in northern Virginia. Deminers from non-governmental organizations (NGOs) and Mine Action Centers (MACs) attend this event to give an update on their programs' technology requirements. This is the best way for the R&D Program to get feedback on current projects and ideas for the future. It also gives deminers from all over the world an opportunity to interact and discuss their successes and lessons learned with one another. In-country assessments—also known as operational field evaluations—are another key to rating the needs of specific demining operations. A team of the R&D Program's engineers perform the assessments, after which the host nation submits a formal request for specific tools.

The R&D Program interacts with private industry, academia, other U.S. and foreign government laboratories and Army in-house laboratories and workshops in a slew of countries in order to identify emerging technologies that may be suitable for humanitarian demining missions. Once a new tool or technology has been successfully analyzed, it is deployed to demining organizations worldwide so

that it can be extensively tested in operational field evaluations. These evaluations require coordination with host nation demining officials, demining NGOs, and U.S. State Department and DoD officials within the country in which field evaluations are to take place. So far, over 40 prototype technologies for demining have been developed by the R&D Program; 18 of them have been sent to nearly 30 countries for operational field evaluations.

Funding for the program is provided by ASD SO/LIC, who also offers direction and oversight. The Army's Humanitarian

of the countries burdened by mines.

The tools and technologies developed by the Humanitarian Demining R&D Program fall into one of the following categories: mine detection, mine awareness and training, mine/vegetation clearance and neutralization, and deminer tools and individual protection. This article touches on some of the major developments in each area as well as some of the future prospects of the R&D Program.

Mine Detection

performance of the company's full-size AN-19 handheld metal detector. Now part of Schiebel's product line, the MMD has been deployed in three countries to undergo operational field evaluations.

Camcopter

The Camcopter, another product made by Schiebel, is a small radio-controlled helicopter that can detect mines over a large area in comparison with standard handheld detectors. It can be used to detect, identify, map and mark mines and minefields, and it is operated either manually or automatically if programmed. In several tests at Fort Belvoir, the Camcopter demonstrated the ability to detect both AT and AP mines, using IR sensors and an on-board global positioning system (GPS). It is capable of reaching speeds of up to 90km/hr and altitudes of 2000 m. An evaluation is currently underway by the U.S. Joint Area Clearance Advanced Concept Technology Demonstration (JAC-ACTD) to determine the Camcopter's potential to detect mines along routes.

The Future of Detection

For the past few years, R&D efforts in the realm of mine detection have focused on honing the skills of finding and identifying mines. Additionally, the Program has been looking for ways to decrease the amount of false alarms in detection. Examples of current R&D projects in detection are different forms of GPR, IR and technologies to detect explosive vapors.

Mine Awareness and Training

Mine awareness and training are important aspects of mine action because they have a direct effect on the civilian populations of mine-affected countries. The humanitarian demining R&D Program is dedicated to improving the quality of mine awareness programs and deminer training courses. Their mission for mine awareness and training is as follows: "The Humanitarian Demining R&D Program is committed to continue working on information aids and technologies that support demining missions,

mine awareness training and mine risk education." To fulfill this mission, the Humanitarian Demining R&D Program has developed a number of informational aids. One of the most significant of these aids is the Demining Support System (DSS). The DSS includes five fundamental training modules, specifically mine awareness, demining training, medical training, mission planning and landmine database.

Mine Awareness Materials

The R&D Program's mine awareness materials include graphics for posters and handouts, a debriefing guide for demining teams to use when a landmine incident occurs, and a database of landmine information. The posters are mostly aimed at children, who are very susceptible to severe mine injuries because of their height and their natural curiosity. The debriefing guide gives an overview on how to treat a landmine survivor so that he or she can overcome the psychological trauma of the event. The landmine database is an online searchable database that allows the user to identify a mine using several factors, such as size, shape, material and manufacturing location. All of these tools are available online at the R&D Program's website (see contact information below).

Demining Training Materials

There are 19 lessons covered in the demining training module. The lessons include the following topics:

- Demining Training Objectives
- Identifying Likely Mined Areas
- Locating Tripwires
- Marking Mines and Tripwires
- Assembling the Mine Detector
- Identifying Mines in Bosnia
- Visually Detecting Mines in Likely Areas
- Locating Mines by Probing
- Unpacking the Mine Detector
- Locating Mines Using the Mine Detector
- Marking, Recording and Reporting Minefields
- Directing a Demining Team
- Demolition Safety
- Using and Maintaining Demolition Equipment
- Identifying UXO



■ The Mine Clearing Cultivator is a vegetation clearance/ mine removal machine that is remotely controlled as well. This tool has been one of the R&D Program's most successful developments so far.

- Constructing a Non-Electric Initiating Assembly
 - Priming Explosives Non-electrically
 - Priming Explosives with Detonating Cord
 - Constructing a Ring Main
 - Radio Procedures
- Information on each of these lessons can be downloaded from the R&D Program's website (see contact information below).

Medical Training Module

The following six procedures are covered in the medical training module:

- Bleeding and Shock
- Environment Assessment
- Instructor's Guide for Leg Injury Treatment Program
- Instructor's Guide to Buddy Aid: Training Program for Treating Arm, Eye and Face Injuries
- Introduction to Planning Module
- Medical Trauma Kit: Airway

There are also 27 more detailed lessons in emergency medical procedures available from the Combat Lifesaver Courses. All of this information is available on the R&D Program's website (see contact information below).

Mission Planning Module

The following 12 procedures are covered in the Mission Planning training module:

- After Action Report Format
- Demining Status Report
- Demining Team
- Humanitarian Demining Operation

- (HDO) Training Aid Device and Substitute Summary
- HDO Program of Instruction Summary
- Medical Information Collection Form
- Mission Concept Brief Format
- Policy: The DoD Humanitarian Demining Program
- Pre-mission Checklist
- Route Reconnaissance Report Format and Procedures
- Trip Report Format
- Unit Status Report

Information on each of these topics is available for downloading from the R&D Program's website (see contact information below).

Landmine Database

The landmine database module is called MineFacts and can be used as a reference tool. Many users find it helpful in identifying types of mines and in providing training materials to demining newcomers. It includes text and images to assist the user in identifying and understanding items in the database. More information is available on the R&D Program's website (see contact information below).

Mine/Vegetation Clearance and Neutralization

The Humanitarian Demining R&D Program's biggest successes have been in the area of mine/vegetation clearance and neutralization. Of the Program's recent technological developments, three vegeta-

■ The remotely controlled Camcopter is a fully autonomous tool used to detect, identify, map and mark landmines while allowing the operator to be a safe distance from the minefield.



itarian Demining R&D Program Office at communications and electronics command (CECOM) NVESD carries out the program with a program manager, two deputies and a staff of approximately 20, which consists of government engineers, logistics specialists and contractor support personnel. This team has a broad range of skills, including extensive backgrounds in countermine technology development, acquisition and contract management. As Sean Burke, Program Manager of the Humanitarian Demining R&D Program, put it, "All of the team members... know the mine problem inside and out."³ Extensive travel to mine-affected areas of the globe is another must for all staff members. This enables them to demonstrate the latest technologies to native citizens

The process of detecting mines is vital to demining yet presents a number of challenges. The most prominent difficulties are detecting mines with low metal content and distinguishing mines from scrap metal. In order to address these issues, the R&D Program has assessed several prototypes using technologies ranging from Ground Penetrating Radar (GPR) to the use of dogs to infrared (IR) and ultraviolet sensors. Two of the program's most successful developments are the Mini Mine Detector (MMD) and the Camcopter.

Mini Mine Detector

The MMD is a version of the traditional metal detector that is small enough to be fitted onto a belt-mounted pouch. It is made by Schiebel and matches the

tion clearance systems have been highly successful: the Survivable Demining Tractor and Tools (SDTT), the Mine Clearing Cultivator (MCC) with the Sifter and the Rhino Earth Tiller. Two neutralization products have flourished as well.

Survivable Demining Tractor & Tools

The SDTT is a modified version of a commercial farm tractor. An assortment of specialized vegetation clearance tools can be incorporated into the system for use in a range of humanitarian demining situations. The system is armored and has mine-survivable steel wheels that can withstand AT mine blasts; however, it is specifically intended for use in areas with AP mines, since it can endure AP mine explosions with no damage to the system or its operator. In 2000, the SDTT underwent an operational field evaluation in Cambodia, which was highly successful. Following the system's success in Cambodia, neighboring Thailand made a formal request for a similar operational evaluation. The system now supports the efforts of the Thailand Mine Action Center (TMAC).

Mine Clearing Cultivator

The MCC is designed to expose and remove AT mines and large bounding AP mines from the ground in both urban and rural locations. While removing mines from the soil, it also avoids creating a contaminated berm and allows the ground to be used for agricultural purposes, something that is often not possible after demining operations. The system utilizes remote controls to decrease the amount of training necessary and increase the safety of the operator. An operational field test of the MCC was conducted in Egypt in 2000. At present, it is being prepared for deployment in Angola.

Rhino Earth Tiller

The Rhino is another remotely controlled machine that crushes and

neutralizes AP and AT mines as well as any other objects in its path. Its protective shields on the driver cabin and other sensitive components allow it to survive the blasts of both AT and AP mines while suffering little damage. The Rhino can accomplish its goals of mine neutralization and destruction in varied terrains, including those with vegetation. Croatia, South Korea and Cambodia currently use the Rhino, and it has just successfully completed operational field evaluations in Jordan and Israel. It is also being considered for use in Azerbaijan.

Neutralization Products

The two successful neutralization products that have come out of the R&D Program are LEXFOAM and the Thiokol Demining Flare. LEXFOAM is a nitro-methane-based explosive foam that is used to neutralize mines and some types of UXO. The explosive is activated when it is mixed with a liquid propellant; however, each of its components are individually classified as either inert or Class Two flammable liquids. Thus, their transportation is much easier and safer than that of Class One explosives.

The Thiokol Demining Flare is a pyrotechnic device used to defuse landmines without explosives. After a mine has been detected and partially uncovered, a flare is placed near it and triggered from a safe distance. The intense

flame from the flare penetrates the casing of the mine or UXO and ignites the main charge. The mine does not detonate; instead it burns. Even if the mine detonates before all of the explosive has burned, the explosion is significantly reduced. Both the Thiokol Demining Flares and LEXFOAM have been deployed in the field, most recently in Kosovo.

Future Plans in Mine/Vegetation Clearance & Neutralization

The Program is currently working on several projects to improve this aspect of their efforts, especially in vegetation clearance. The challenge in clearing vegetation is to create a device that has a high performance level but comes in a more compact package than current machines. An up-and-coming tool in this field is the UK Development Technology Workshop's (DTW's) Tempest. The Tempest is a small remote control vegetation clearance tool/mine flail. The tool has been undergoing operational field evaluations in Cambodia and Thailand and will be modified and tested again early next year.

Deminer Tools and Individual Protection

Because manual demining is still the most widely used mine clearance method, improved tools and deminer safety are important considerations. The R&D Pro-

gram involves developing tools that improve the efficiency of demining operations. In terms of protective equipment, visors, boots, vests and other gear for deminers are created as well. The AIR-SPADE is an example of a tool for deminers developed by the Program, while the Lower Extremity Assessment Program (LEAP) was a program to improve individual deminer protection.

AIR-SPADE

The AIR-SPADE is a tool that allows a deminer to excavate AP and AT mines in hard soil conditions with increased safety. The system integrates a commercial off-the-shelf air compressor, a gasoline or diesel power engine, and a specially designed air nozzle that creates a focused jet of air that flows at a supersonic velocity. It separates and removes the hard-packed soil or clay from around a mine faster than existing digging techniques. The air jet will not detonate the mines because it does not exert enough pressure to do so. Operational field evaluations have been conducted in Afghanistan and Cambodia, and the AIR-SPADE is used to support mine clearance operations in Angola and Ecuador.

Lower Extremity Assessment Program

LEAP was a joint program initiated in 1998. The program's purpose was to assess the effectiveness of various types of protective footwear against several different AP mines. Using cadaver legs, the strain exerted on a deminer's leg from a mine detonation was studied. Also, the study was designed to observe injury patterns and medical outcomes to determine the development of injury criteria. This program determined that the U.S. Army Blast Boot and the U.S. Army Blast Overshoe were the best combination to reduce lower leg amputations and decrease the chance of infection.

Continued Progress

Researchers at the Humanitarian Demining R&D Program have put a lot of work into understanding the effects of mine blast explosions on the human body. As they acquire more knowledge, it enables the industry to design more effective Personal Protective Equipment

(PPE) for the humanitarian demining world. It also allows more valuable tests for predicting how PPE items will work in certain mine incidents.

Lessons Learned

Mr. Burke spoke of some of the lessons learned by members of the program. He said that one of the most important lessons was "the importance of talking directly with deminers to fully understand their capabilities, their environmental constraints and most importantly, their immediate technology needs."³ The Requirements Workshops have been instrumental in doing this by helping the Program "focus on [deminers'] most immediate and significant needs."

Mr. Burke also mentioned that pre-deployment visits are vital requirements to operational field evaluations. Before the Program will deploy prototype tools, these visits must be conducted to verify that the most appropriate equipment is being sent to the country requesting it. If the technology requested is deemed inappropriate for that location after the pre-deployment visit, the Program suggests other possibilities until a satisfactory arrangement is made.

Another essential lesson learned at the R&D Program is "to stick with those technologies showing promise that have high potential payoff down the road." While projects may at first seem costly with no immediate rewards, they often have benefits that can only be gained from long-term investment. Mr. Burke cited the MCC and the Floating Mine Blade (FMB) as two examples, stating that after a few years of research and modifications, "these designs have matured into robust mine clearance systems."³

Lastly, Mr. Burke comments that "the oldest lesson learned is to recognize when it is time to stop or eliminate a project that is no longer viable or needed."³ This is an important aspect of the program so that time and money are best spent on the projects that will yield the most productive results. Test results on these tools are kept to help make the program more efficient in the future.

Conclusion

Building on past successes and always expanding their repertoire, the U.S. Humanitarian Demining R&D Program is paving the way for improved humanitarian demining tools and technologies. Mr. Burke points out that the Program's work is never done: "...what if there is something out there we have not uncovered? In addition to someone's new idea or existing technology that is sent into our program for consideration or evaluation, we are always actively looking for possible solutions in areas not traditionally linked to countermine."³ The Program staff must be ever-vigilant in order to ensure that the humanitarian demining community is getting state-of-the-art equipment that will increase the speed and efficiency of eradicating the world's landmine problem. ■

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**All photos courtesy of Humanitarian Demining R&D Program.*

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■ Developing Personal Protective Equipment (PPE) is important since manual demining is still the most widely used clearance method. Testing done by the R&D program has allowed for more effective PPE to be developed.



■ The AIR-SPADE is a safer way for deminers to excavate landmines proving itself especially useful in hard soil conditions. The airjet, which travels at a supersonic velocity, is powerful enough to break up tough soil, yet will not detonate mines.

