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U.S. Humanitarian Demining Research and Development Program Provides "Reach-In" Technology

Chris Wanner
United States Department of Defense Humanitarian Demining Research and Development Program

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Wall collapses revealing AT mine.

When mine clearance operations closed down on June 12, 2004, for the last time in Honduras, U.S. Army Night Vision and Electronic Sensors Directorate (NVESD) prototype equipment on trial was there to help complete the work started nearly one decade ago. Progress in reaching this milestone had stalled in 2002. Lack of a solution to a troublesome combination of environmental and threat factors remained beyond the capability of normal clearance procedures at one of the last remaining mine-suspected areas left in Honduras. Conventional clearance methods had revealed evidence of a mixture of anti-personnel and anti-tank mines buried under a meter of highly mineralized sediments. The Honduran deminers and the Organization of American States (OAS) project sponsors contacted the U.S. Humanitarian Demining (HD) Research and Development (R&D) Team for assistance in clearing these deeply buried mines, which were undetectable and unreachable by ordinary means. To meet this challenge, engineers from the HD team devised a two-step mechanical process based on a specially adapted, multi-tooled "Sifting Excavator." The development and deployment of this system from start to end covered 18 months and is a useful case study in the U.S. HD R&D program's commitment to helping deminers and advancing the practice of demining through technology development.

The Problem

Even as Honduran deminers were closing in on their goal of creating a mine-safe Honduras, yet one more by-product of the 1998 visit of Hurricane Mitch to the country was realized. Devastatingly powerful, Mitch had brought 50 inches of rainfall in places and left 7,000 Hondurans dead, 20 percent of the country homeless, 70 percent of the transportation infrastructure wrecked, and 80 percent of the crops destroyed. Severe flooding left people stranded on rooftops for over a week, shifted the course of rivers, and caused mudslides, erosion and silting over of low areas. Such was the case of mined areas at Las Canoas along the banks of the Rio Negro dividing Honduras from Nicaragua. Although the mined area was not extensive, the challenge of discovering what remained of the mine threat fell to the members of Task Force Alpha of the Honduran army under the supervision of international observers from the Mission of Assistance for the Removal of Mines in Central America (MARMINCA). Due to highly mineralized soil, it was a struggle to clear the area to a depth of 20 centimeters using conventional clearance methods and evidence of additional mines buried up to 50 centimeters or more was discovered. The land at Las Canoas is used primarily for raising melons, and the prospect of turning over land to be worked with agricultural machinery was unacceptable because of the possibility of below-surface contamination. The degree of mineralization of the soil and depth of burial ruled out the use of better detectors or mine-detecting dogs to investigate the soil. In need of help and willing to try a developmental solution, the Honduran army turned to Colonel Allan Vosburgh of the Office of the Assistant Secretary of Defense for Special Operations and Low Intensity Conflict (OASD SO/LIC), who, as program manager for the U.S. R&D effort, led an on-site assessment of the problem in September of 2002.

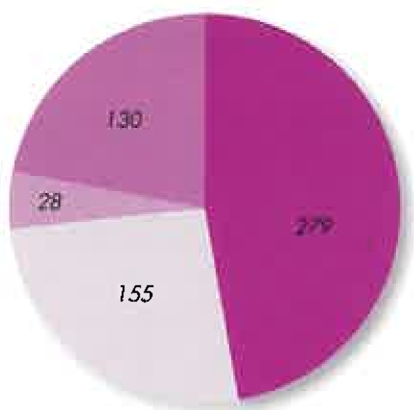
Operating Concept

The approach developed to meet the challenge at Las Canoas is a two-step mechanical process that is designed to advance an excavated trench face across a mined area and leave cleared ground in its wake. The process is based from a mine-protected excavator equipped with a standard bucket and four special-purpose tools. Clearance begins from a trench dug outside of the boundary of the minefield. The excavator "reaches in" to the hazardous areas from the safe side of the trench. One of the two special-purpose excavating tools is used to "rake" the vertical wall on the contaminated side of the trench. The objective of this step is to expose AT mines in the face of the wall and gently collapse the wall.


Sifting/Backfilling trench.

by Christopher Wanner, RDECOM

Shaving contaminated wall with vertical mill.



- Personnel productively occupied in mine-clearing operations.
- Equipment nonoperational.
- Operations prevented by weather.
- Personnel unavailable for administrative reasons.

Work productivity in hours (592 total).

Large mines exposed from this initial raking are destroyed in situ. The excavator works from one end of the trench to the other, excavating into the contaminated wall face between 40 and 60 centimeters with each pass. When sufficient spoils have accumulated at the base of the contaminated wall, the raking tool is exchanged for one of two special-purpose sifting tools. The loosened spoils on the mined side of the trench, which have already been scoured visually for large mines, are lifted in the sifter. The sifting occurs over the edge of the safe side of the trench with the sifted soil being used to back fill along the edge of the trench on the safe side. The residual materials in the sifter are emptied in an examination area for inspection and destruction of small mines. The trench depth extends 0.5 meters below the likely mine depth to permit the raking action to begin from below the mines and to allow a space for the excavated soils to fall and accumulate for collection with the sifting tools.

Equipment Description

The Sifting Excavator is developed around a specially converted Liebherr-904 rubber tired excavator. Significant survivability and operator protection features are incorporated into the excavator. Solid tires constructed of a composite of rubber and steel fibers are installed in order to minimize fragmentation and blast damage from direct contact with most AP mines. The operator's cabin has been replaced with a custom-built shell constructed of one-half-inch hardened aluminum with lexan laminate windows. In addition to the cabin shell, a one-half-inch steel blast deflector with transparent armor windows was installed in front of the cabin to provide AT mine blast protection from the forward direction. The two-stage protection scheme (blast deflector and aluminum shell) provides protection to the operator in the event of an AT mine detonation in the working environment in front of the vehicle as well as AP mine blast and fragmentation coming from any direction.

The excavator is additionally equipped with a rear-mounted hydraulic power unit (HPU) capable of supplying 220 kW of hydraulic power to attachments on the excavator.

In addition to the standard quick-release digging bucket, four special purpose tools are fitted for use with the Sifting Excavator. The vaned bucket is used for picking and raking at the base of the contaminated wall in order to collapse the bank and expose AT mines. In addition there is a "vertical mill" for shaving the bank with a horizontal milling action. The vertical mill is intended as an alternative to the vaned bucket for use in heavily rooted soils, hard soils (which are resistant to collapse) or locations where precise control of the digging action is required. The first of the sifting tools is the Rotar sifting bucket for scooping up loosened soils and separating soil from mines and other unsiftable debris. The second sifting implement is the Bertani Bucket, originally designed and sold commercially for harvesting beets. Because of a larger volume and more aggressive sifting action, the Bertani is capable of reducing piles faster than the Rotar; however it does not pick up material as cleanly, nor does it have provision for retaining granular materials inside the bucket until the sifting action has begun.

Operations

NVESD designed, fabricated and tested the equipment over a six-month period in 2003; the equipment sailed for Port Cortez in October; and formal training of the Honduran operators began on-site in December. Training was completed in January, and with much ceremony and optimism, the equipment was formally turned over to the Honduran army for use. The Sifting Excavator was employed in minefield clearance operations steadily between February and June 2004 under the supervision of MARMINCA observers. The originally conceived process was used in tandem with a manual demining team. Testing had shown the equipment effective in removing randomly laid mines to a depth of 50 centimeters with 99.38 percent efficiency when employed alone. In conjunction with manual checks of the area using detectors, the test efficiency was perfect. The manual deminers perform frequent checks of the excavator's area of operations and inspection of the residual materials that are produced in the sifting operations. Operation in areas previously cleared to 20 centimeters was modified from the originally conceived process to use the machine for digging "sampling trenches." Digging/ clearing efficiency with the excavator is not as high with the sampling technique, but overall process efficiency is improved because each sampled unit of area represents a larger parcel.

Children of Las Canoas greeted the HD training team each afternoon.

Minefield operations at Las Canoas.

During the 592 working hours available during the evaluation period, deminers were productively occupied in mine-clearing operations 279 hours. For a short-duration project in which personnel not only were becoming acquainted with the equipment but were also standing up a mechanical capability where it did not exist previously, this total is creditable. Personnel were unavailable for various administrative reasons (MEDEVAC down/communications down/insurance lapse/vacations, etc.) for a total of 155 hours, weather prevented operations 28 hours, and the equipment was non-operational for 130 hours. Most of the equipment non-availability was the result of a broken axle on the excavator, which required two and a half weeks to get repair parts on site.

The use of the equipment and the steady improvement in efficiency during the operations were gratifying. Between February and May, the equipment was kept busy almost 64 percent of the hours during which deminers were actively engaged in mine-clearing operations. During this time, the productivity of the operators improved over fivefold. Although this process still remains slow and deliberate, innovations by the users and sampling techniques have squeezed the best productivity out of the machine in performing a job that was otherwise imposible. Through mid-May almost 2,000 sq m of ground were directly excavated and sifted with the machine during 181 hours of operation. Analysis of the sampled area has yet to be reported as an amount of land freed up by the process. Due to the depth of clearance, reporting on the basis of surface area under-represents the amount of work performed in comparison with other clearance operations. An estimated 4,000 to 5,000 tons of Honduran earth have been painstakingly sifted and examined to very high standards. The process used and the resulting product are of the highest quality. Few mines were found in the process, but the goal of removing the perceived threat is a reality, and restoration of the use of the land is now possible.

Conclusions

The mine situation in Las Canoas is unique in many respects. The clearing method used is a slow and deliberate process that would not be competitive under ordinary circumstances. It was not intended to be competitive; instead it was meant to perform a task that otherwise could not be done. The techniques used in the project, however, are transferable to other clearance projects of similar threat composition, perhaps investigating areas in and around bridge abutments, long-standing minefields with flooding and erosion conditions, or "lost mines" from operations in patterned minefields. The equipment has proven its worth, and many of the tools developed and used at Las Canoas are compatible with a variety of clearance processes that may be very competitive with alternatives. NVESD has increased its investment in reach-in technology throughout this year and the year to come and looks forward to sharing the resulting developments with the demining community.

** Photos c/o author.*

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Contact Information

Christopher Wanner
RDECOM
Fort Belvoir, VA 22060
USA
Tel: 703-704-1076
Fax: 703-704-3001
E-mail: chris.wanner@nvl.army.mil