U.S. Humanitarian Demining Research and Development Program (HD R&D)

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functions and is based on a COTS technology by Pearson Engineering Ltd.

Bucket, the heavy cultivator, spring-tine cultivator (mine-survivable SETCO wheels with an innovative wheel-hub interface incorporating a dowel and plate design. This design allows the wheel to separate from the axle in the event of an anti-tank mine detonation, thus reducing the shock effect through the axle. The tractor acts as the prime mover for a toolbox of COTS and specialized implements generally used by the construction and earth-moving industries but also applicable to clearing and vegetation operations. Along with the mine-removal John Deere tractor, this toolset consists of a rotary mower, area-reduction roller, rotary mine comb, grub, four-in-one bucket, heavy cultivator, spring-tine cultivator, bud formers, mine fitter, tree extractor, magnet and hedge cutter. Together the prime-mover tractor, these devices provide mine-deminers with capabilities to perform their work effectively and efficiently.

In August 2004, the Mantis and its complimentary tools underwent a thorough performance evaluation, organized by the HD R&D Program staff members and supported by engineers from the United Kingdom under the auspices of the International Test and Evaluation Program for Humanitarian Demining. For the soil and vegetation within the environment where the testing occurred, the results of the performance-demonstration assessment show the Mantis and its demining and area-preparation tools can prepare an area for demining, remove anti-personnel mines and leave an area ready for quality-assurance proofing and subsequent use.

Based on the positive results from the evaluation, the HD R&D Program deployed the Mantis to Nicaragua in spring 2005 for an operational field evaluation. Under the direction of the Nicaraguan Army Demining Units, the Mantis is currently performing in a minefield 6 kilometers (4 miles) long with Class II (medium to severe) vegetation and terrain near the town of Jinotepe. In the first four months of operation in Nicaragua, the Mantis removed 9,600 kilograms (21 tons) of metal with the magnet attachment and cleared 64,050 square meters (16 acres) of land (clearing vegetation, and cultivating and sifting soil). NADU members also reported the blast-resistant SETCO tools were extremely effective in encounters with PMN mines, not incurring any damage to the tractor when hit. In addition, the roller attachment has encountered and demolished 10 PMN mines and the cultivator has unearthed numerous UXO items. To date (in combination with the Hitachi excavator), NADU members have removed 14,529 mines and cleared 436,175 square meters (108 acres) of land for further manual and mine-detection
demining/quality assurance. In fact, after the mechanical clearance process with the Hitachi and Mantis, five mines remained in the entity area. Further investigation is underway to determine why these mines were left in the ground. Early indications suggest the mines were outside of the area worked by the machines, their fuses were non-functioning, or they were deeply buried.

In the right conditions, mechanical de

The DCA Approach

The anti-tank mine threat on access roads in eastern Angola is the greatest impediment to infrastructure rehabilitation, economic recovery, and social development in that area. The authors discuss the method and equipment used by DanChurchAid to verify and clear roads in Mexico and Lundu Sul provinces.

By Marcel E. Duschen and Anders Jansson [DanChurchAid]

During three decades of internal conflict, much of Angola’s infrastructure was destroyed. Within Mexico and Lundu Sul provinces, the constant ebbs and flows of military forces left the majority of bridges destroyed, a high number of principal roads mined and access to towns and villages restricted because of defensive minefields. In 2004, DanChurchAid conducted a general assessment of the mine situation within Lundu Sul and province in eastern Angola. Even though many mines were impacted by minefields obstructing construction or hindering agriculture, the ever-present anti-tank mine threat on the major and minor access roads was determined to be a far greater impediment to the rehabilitation of refugees, relocation of internally displaced persons, re-stabilization of infrastructure and distribution of essential supplies to isolated villages.

Because there was no road-verification capability in Mexico and Lundu Sul provinces, DCA investigated existing verification and detection systems that had been or were being used elsewhere. A similar system to the Kinematic Induction Magnetic Survey, developed by UFX Africa in 2002 to verify roads in the Temporary Security Zone along the border between Ethiopia and Eritrea, was deemed appropriate. In mid-2004, DCA decided to fund the design, construction and testing of a second-generation wide-area detection system (WADS), which was to be used in conjunction with a road-clearance team (RCT). The DCA WADS was built in the Republic of South Africa with the assistance of Rega Trading International. Its arrival in Luena, Mexico province, in June 2005 was followed by the recruitment and training of the WADS team and the RCT, and the WADS static and dynamic system calibrations. In October 2005, the WADS conducted

Figure 1: DCA wide-area detection system.

Figure 2: WADS’s electronic control module.
target attribute data collected during reacquisition and target reacquisition is carried out by a two-person team that is part of the RCT. One of the team members is equipped with an Omnistar RD-132, 12-channel GPS receiver and Omnistar Pion Datalogger, which contains target coordinates for a given section of road. When receiving differentially corrected satellite data, sub-metre accuracy is possible and the Pion DataCorset is used to navigate to within 20 centimetres (8 inches) of the target location.

The care-mapped GPS antenna allows the reacquisition team to safely approach to within two metres of the targets (Figure 4). After the team reaches the target location, the metallic road marker is placed on the ground surface. The second team member then marks a 2-metre by 2-metre search box around the target marker by placing red and white triangular marked stakes at each corner of the search box. He also assists in the navigation to the different targets using the maps, and records the time of the target reacquisition and several GPS key position-fix parameters such as the number of satellites and Position Dilution of Precision (PDOP) values (Figure 5).3

The rationale for selecting a 2-metre by 2-metre search box is based on GPS data recordings at the DCA GPS base station in Luanda and on offsets recorded during target reacquisition activities. GPS readings were collected over a period of five days in September 2005 to monitor daily variations in DGPS position fixes. Between 5:00 and 11:00, the position drifts are less than one metre, whereas between 11:00 and 17:00 they range between six and four metres. Position-fix offsets for 1,920 readings in the 5:00–11:00 window are presented in Figure 6. Ninety-nine percent of the position-fixes are within one metre of the station location. Less than 1% of the position fixes were more than one metre from the station location. One of the reasons for choosing a 2-metre by 2-metre search box is that on average the GPS position fixes on the DGPS setup containing 1,296 targets, 2% percent were at distances greater than one metre from the calculated positions. On the basis of the above data, it was decided to conduct survey and acquisition activities only during the 5:00–11:00 window and to use a 2-metre by 2-metre search box for mapping and clearance.

Target investigation and clearance. The pinpointed and marked targets are investigated by the road-clearance team. The presence of the target within the search box laid down by the reacquisition team is confirmed by using handheld metal detectors (Figure 7). If the target is on the surface, the nature of the target and the threat level are assessed and the target is subsequently neutralized by the manual deminer. If no targets are located within the search box with the handheld detectors, the search box is then searched with a Uned viruses large loop probe (Figure 8) and the exact position of the target is marked.

Buried targets are investigated using an armored mini-excavator (Figures 9 and manual deminers). Small buried targets are located, marked and then directly excavated. The spoils are then spread out on the ground beside the excavation and inspected by a manual deminer. After the target has been localized, neutralized and removed, the hole is filled in and the excavator moves on to the next target. When investigating deep targets or suspected anti-tank mine targets, the targets are marked as shown in Figure 10. The target is then investigated by excavating a V-shaped trench on the outside of the marker sticks on dirt roads or painted lines on asphalt roads.

The excavations, the area between the excavations and the spoils are checked by a manual deminer (Figure 10) with handheld metal detector to confirm the target location and to determine if additional excavation is required. The manual deminer then investigates the target by approaching it literally using manual demining methods. Once the target has been identified, neutralized and removed, the excavation is filled in and the excavator moves on to the next target.

Even with a 2-metre by 2-metre search box for each target, the area requiring additional re-examination for the above-mentioned mine types is reduced by 98%. Using this methodology, the eight-person RCT has been able to verify and clear up to two kilometres (one mile) of road, or 18,000 square metres (four acres) of land, per day.

Quality-assurance survey. After completion of clearance activities for a given road segment (five to 10 kilometres) the WMDs team resurveys the road segment. System configuration and survey parameters during the road survey activities are exactly the same as during the initial road survey. Maps from the two survey runs are compared to determine if all targets have been removed. A 50-metre section of the Luambe–Luambe road is presented as an example in Figure 11. Missed targets and targets for which the collected target attribute data is not satisfactory are re-investigated by the clearance team. The two map sets, as well as the digital data for the two surveys, are saved for future reference.

Future Plans.
In a 10-kilometre (six-mile) stretch of surf-
ory road containing 1,296 targets, 82 percent were comprised of scrap metal on the road surface, 15 percent were comprised of scrap metal embedded in the road surface and 3 percent were buried in the road base and required investigation with the mini-excavator. It is clear that by reducing the number of scrap-metal targets requiring investigation by the RCT, the RCT will result in significant productivity gains. In 2006, several options are being considered to improve the productivity of the RCT. Some of the options under consideration include:

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Figure 4: RCT reacquisition team marking a buried target location.

Figure 5: RCT reacquisition team navigat- ing to a target using work maps and DGPS.

Figure 6: Plot showing the variability of DGPS data.

Figure 7: Manual deminer investigating a surfaced target.

Figure 8: Manual deminers locating a shallow target.

Figure 9: Armored mini-excavator used to investigate buried targets.

Figure 10: Manual deminer investigating a deep target.

Figure 11: Example of initial survey (left) and post-clearance quality-assurance survey (right). Reference point is “x” symbol in center left.
Explosive-sniffing Goats Avoid Offending Muslims

In an effort to protect security forces in the Muslim world, 25-year-old Geva Zin, an Israeli K-9 security trainer, turned to an unconventional ally. Zin began training goats to detect explosives in vehicles and on citizens examined at checkpoints.

Dogs, although prevalent and adept at explosive detection, are offensive to many Muslims because they are considered unclean. Unclean forces around the world were often left with the choice of offending local Muslim populations or exposing humans to incredible risk at checkpoints. Zin’s work sought to solve that problem by using one of the most common animals in Muslim life - the goat.

Zin already has had great success training dogs and even tiny pigeons to detect explosives and uncover mines, but goats offer a unique solution to security situations in the Muslim context. First, there is a decreased chance of security forces humiliating Muslims with searches by dogs. Second, goats are able to search any area, be it in the town or in the rural areas. Third, their use protects lawmen by allowing them to keep a safe distance. Third, they are able to search every suspect and vehicle. Third, their use protects lawmen by allowing them to keep a safe distance. Fourth, the goats are offensive to many Muslims who consider in the use of dogs in the Muslim world.

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Endnotes

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   2. After 23 years of civil war, a Comprehensive Peace Agreement was signed on 9 Jan. 200
   3. The authors would like to thank DanChurchAid for assistance in the preparation of the manus-
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