Success of Multi-tools in Mine Action: The Survivable Demining Tractor and Tools and the Mine-Clearing Survivable Vehicle

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The authors examine the various equipment and technologies that allow further effectiveness in demining achievements. Recent developments in demining tools allow for greater protection of deminers, in addition to improved search results. With technological advancements such as the Survivable Demining Tractor and Tools and the Mine-Clearing Survivable Vehicle, the authors express hope for demining centers worldwide.

T h e international demining community continues to seek reliable, efficient, and cost-effective mine- and vegetation-clearance equipment to assist in demining operations. The U.S. Humanitarian Demining Research and Development Program is responding to this need by focusing much of its effort on developing, demonstrating, and validating technologies that help the demining community clear mines and vegetation faster, safer, and more efficiently.

One of the ways in which the Humanitarian Demining R&D Program brings effective, reliable, yet affordable technologies to the field is through the adaptation of commercial off-the-shelf (COTS) equipment. In particular, one of its most successful strategies is using a COTS platform and adding tool attachments to create a multi-functioning vehicle. Through past efforts, the HD R&D Program has proven the concept that using a single prime mover with a toolkit comprising a well-thought-out selection of tools can reliably and rapidly perform the demining tasks of land preparation, mine removal, and area reduction and reclamation, leaving an area ready for quality-assurance proofing. Two such systems currently in use by demining programs are the Survivable Demining Tractor and Tools and the Mine-Clearing Survivable Vehicle (aka Mantis).

Both systems use COTS platforms and a variety of attachment tools to perform multiple demining operations, from vegetation removal to land preparation. The system mechanically assists the manual demining process by providing deminers numerous tools and an armament platform from which to perform the most hazardous tasks. The portability of the system allows deminers to work more efficiently.

The Survivable Demining Tractor and Tools

The SDTT was first developed in 1997 and is one of the earliest successes of the HD R&D Program. The system uses a modified commercial New Holland 160-90 farm tractor fitted with armor plating, optimal steel wheels and a variety of specialized implements used to clear heavily vegetated areas and support various demining operations from area preparation to quality assurance. Attachments include rollers, magnets, sladars, forestry tippers, rakes, hedge trimmers, sifters, light and heavy cultivators, large and small bucketers, large and small grubs, pallet forks, and light and heavy tree-pullers. The system mechanically assists the manual demining process by providing deminers numerous tools and an armament platform from which to perform the most hazardous tasks. The portability of the system allows deminers to work more efficiently.

The SDTT is currently in use by the Thailand Mine Action Center to clear vegetation and prepare the land for manual demining. From 2001 through 2005, the SDTT cleared over 8,662,350 square
Mine Clearing Survivable Vehicle

Based on the success of the multi-tool-attachment concept used in the SDTT, the HD R&D Program invested in the Matini mine- and vegetation-clearance system. As its platform, the Matini uses a modified and armored DCA’s Deere 6900 farm tractor capable of operating a number of specialized and commercial-off-the-shelf implements to address some of the terrain, vegetation, soil preparation, and minimization of personnel hazards.

The system is equipped with front and rear power take-offs, standard three-point-hitches in the front and rear, and a loader frame. The tractor was modified and armored and assembled under contract to the HD R&D Program by Pearson Engineering Ltd.

The purpose of developing a system such as the Matini is to provide deminers with a mine-survivable vehicle that has multiple functions and is based on a COTS technology (i.e., John Deere farm tractor). The tractor has been armored, fitted with a 180-degree rotating driver’s cab and anti-personnel-mine-survivable SETCO wheels with an innovative wheel-to-hub interface incorporating a dovetail and plate design. This design allows the wheel to separate from the axle on 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 earthmoving industries but also applicable to mine clearance and demolitions. Along with the mine-removal John Deere tractor, this toolset currently consists of a rotary mower, anti-entanglement roller, rotary mine comb, grab, four-in-one bucket, heavy cultivator, tree bucket, harrow, road dozer, road bucket, forminer, mine filler, tree extractor, magnet, and hedge cutters. Together with the prime-mover tractor, these two vehicles allow deminers with capabilities to perform their work effectively and efficiently.

In August 2004, the Matini and its complimentary tools underwent a thorough performance evaluation supported by 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 environment where the testing occurred, the results of the performance-demonstration assessment show the Matini 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 profiling and subsequent use.

Based on the positive results from the evaluation, the HD R&D Program deployed the Matini to Nicaragua in spring 2005 for an operational field evaluation. Under the direction of the Nicaraguan Army Demining Unit, the Matini is currently performing in a minefield 6 kilometers (4 miles) long with Class II (medium to severe) vegetation and terrain near the town of Jinotega. In the first four months of operation in Nicaragua, the Matini removed 5,600 kilograms (12 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 tires were extremely effective in encounters with PMN mines, not incurring any damage to the wheel when hit. In addition, the roller attachment has encountered and detonated 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 mining and mine-detector dog-assisted quality assurance. In fact, after the mechanical clearance process with the Hitachi and Matini, five mines remained in the entire 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-mining with versatile mechanical systems such as the SDTT and Matini allow for faster, safer and more efficient mine clearance. However, minefield locations and conditions often preclude the use of such machines. For example, the Matini is not intended for use in minefields with the threat of anti-tank mines. The Nicaraguan mechanical roller-clearance effort has not proven to be completely effective because of this factor. However, with continued effort in developing operating procedures and development of attachments for multi-tool systems like the Matini and SDTT, the HD R&D Program is confident the SDTT and Matini, with their associated tools, will provide the humanitarian-demining community with highly reliable, cost-effective systems augment current catalogs of de-mining tools and expand area-reduction and demining capabilities.

The DCA Approach

The anti-tank mine threat on access roads in eastern Angola is the greatest impediment to infrastructural 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 Moxico and Lundu South provinces.

During three decades of internal conflict, much of Angola’s infrastructure was destroyed. Within Moxico and Lundu South provinces, the constant and frequent flow 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 2002, DanChurchAid conducted a general assessment of the mine situation within Lundu South and Moxico provinces in eastern Angola. Even though many anti-tank mines have been removed and other anti-personnel mines have been left untouched, all UXO items were left in situ and to be used in conjunction with a road-clearance team (RCT).

Because there was no road-verification capability in Moxico and Lundu South provinces, DCA, in conjunction with on-site reconnaissance surveys, developed by UBX 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 Regina Trading International. Its arrival in Luena, Moxico 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 2414.5 kilometers (133.5 miles) of preliminary road surveys in 45 hours in Moxico province. More than 28,000 targets were detected during the survey, and the survey area of approximately 1,812,800 square meters (48 acres) were searched down to a depth of one meter. The combined WADS-RCT operation successfully completed two days of acceptance field trials in the Luena area in mid-2006 and was accredited by the Comissão Nacional Intersectorial de Deminagem e Assistência Humanitária/United Nations Development Programme.

DCA Approach

The DCA approach to road verification and clearance in eastern Angola is comprised of five stages:

1. Road reconnaisance
2. Road survey and target definition
3. Target prioritisation
4. Target investigation and clearance
5. Quality-assurance survey

Road reconnaisance

Prior to undertaking survey, verification or clearance activities along a given road, DCA compiles available data on the conflict history in the area and mine incidents along the road to determine the nature of the threat. Road and road-environment attributes impacting subsequent activities such as road type, road width, road-surface condition and degree of vegetative encroachment are considered during a reconnaisance survey. The data collected during this phase is stored in a geographic-information-system database and is used to produce WADS and RCT work plans and maps.

Road survey and target definition

Roads are surveyed using the vehicle-mounted DCA WADS. The system is pictured in Figure 1. It is modified to protect the sensors and the sensor array can be set up with one to eight Ehringer Uxps 740 sensor coils in different configurations, depending on road attributes, the type of survey task and the nature of the mine threat. In Moxico and Lundu South provinces, 5-75 meter wide sensor arrays in the 1.0-meter by 1.0-meter and/or 0.5-meter by 0.5-meter configuration are adequate for most survey tasks.

As a survey speed of five kilometers per hour (three miles per hour), metal-jacketed anti-tank and anti-personnel fragement mines and some of the larger anti-personnel mines, such as the PMN and PPM-2, are easily and consistently detected by sensors in the 1.0-meter by 1.0-meter configuration. Survey speeds of up to 10 kilometers per hour (six miles per hour) for the smaller metal-jacketed targets are being sought. Minimum-metal mines cannot be consistently detected with this configuration.

Incoming data streams acquired during the receiver phases of the TRX cycles of the sensor coils are acquired by in-vehicle electronic

Figure 1: DCA wide-area detection system.

Figure 2: WADS electronic control module.