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# Evaluating the Mini MineWolf

Phil Straw
*U.S. Department of Defense Humanitarian Demining Research and Development*

# Evaluating the Mini MineWolf

The U.S. Department of Defense Humanitarian Research and Development Program conducted operational field evaluation to assess the capabilities of Mini MineWolf technology.

by Phil Straw [ U.S. Department of Defense Humanitarian Demining Research and Development ]

The Mini MineWolf System.
*Photo courtesy of MineWolf Systems.*

From 2010 to 2011, the U.S. Department of Defense (DoD) Humanitarian Demining Research and Development (HD R&D) Program conducted an operational field evaluation (OFE) of the Mini MineWolf tiller in Tajikistan. In early 2013, the evaluation expanded, and a second unit, operated by the Thailand Mine Action Centre (TMAC), deployed to Thailand.

The OFE assessed the following aspects of the Mini MineWolf:

- Performance, including ground-processing rates and fuel usage
- Limitations in operating across varying terrain, vegetation and weather
- Reliability of the unit, including field repairs, maintenance and modifications
- Clearance capacity, including ability to clear or render mines and unexploded ordnance (UXO) inoperative as well as ability to withstand detonations

Once operators and supporting deminers completed the training phase, the TMAC team conducted standard operating procedures in a low-threat area, integrating them into the OFE. This allowed the TMAC team to become proficient and confident with the Mini MineWolf operations prior to working in high-threat areas.

## Terrain

The area of operation is southeast Thailand, close to the Cambodian border, in Trat province—a wet, heavily vegetated region. Situated within semi-mountainous terrain, the mined areas presented challenging conditions. With a combination of minefields laid by Khmer Rouge and Vietnamese forces in Trat province, the range and types of mines encountered can be quite varied; the Khmer Rouge predominantly laid Chinese mines, while the Vietnamese used mostly Russian mines.

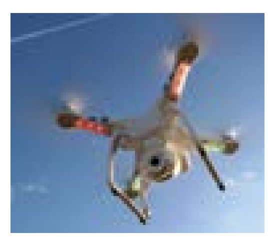
A 2012 *Anti-Persoonsmijnen Ontmijnende Product Ontwikkeling* (APOPO) survey of 39 confirmed hazardous areas in Trat and Buriram provinces yielded 18.47 sq km (7 sq mi) of mine-affected areas and identified an additional 15.96 sq km (6 sq mi) in need of further investigation.[1] The challenging ecological conditions and presence of varying types of mines presented an ideal opportunity to test the Mini MineWolf's performance.

## OFE Procedures

Gleaned from lessons learned during the Tajikistan OFE, the HD R&D team developed a set of operational deployment and OFE phases for the Mini MineWolf:

- Phase 1—Area survey by aerial drone
- Phase 2—Mini MineWolf technical survey
- Phase 3—Full mechanical clearance of mined areas
- Phase 4—Manual clearance (behind the machine) for data analysis and recording

**Phase 1.** With use of an inexpensive and commercially available quadcopter drone, operators collect detailed photographs of terrain prior to deploying mechanical units. Given the remote controllability of the Mini MineWolf and operators' limited vision (remote camera feed) relative to the machine's path, the ability to pre-plan lanes to avoid obstacles proved invaluable. The drone system used for this task was the DJI Phantom II, a global positioning system (GPS)-stabilized quadcopter with a high-definition camera capable of taking still imagery and videos. In addition to recording photographs, these drones can also record GPS data, thus allowing for photographs to be linked or overlaid with mapping data.



A quadcopter drone.
*Photo courtesy of HD R&D.*

**Phase 2.** Directed remotely by an operator, the Mini MineWolf conducted a mechanical technical survey. Lanes were cut every 25 m (82 ft), perpendicular to each other. This formed a grid pattern across the lower threat areas and led into the higher threat zones. The technical survey lanes were closely monitored for any mine indicators.

In Phase 2, lanes are cut every 25 meters, perpendicular to each other to form a grid.
*Photo courtesy of HD R&D.*

The tiller of the Mini MineWolf is capable of detonating AP mines without sustaining any damage.
*Photo courtesy of HD R&D.*

When the machine located mined areas, clearance was conducted from the central area of the minefield outward. This technique has since surveyed 2 million meters (494 acres) of land. Although generally opposite of conventional clearance, this process proved more efficient.

**Phase 3.** Full mechanical clearance was conducted on the mined areas located during the technical survey phase. Tilling the soil to a depth of 25 cm (10 in), clearance pushed 75 m (246 ft) outward to a distance of a 75-m (246-ft) radius from the last known mine location, which could be adjusted if necessary after the manual data-collection phase. This ensured a 75-m (246-ft) buffer zone around the minefield and that the entire mined area was covered.

**Phase 4.** Collecting the clearance performance data was critical to the OFE's success. One of the major questions within the OFE was whether the Mini MineWolf could consistently destroy or otherwise render mines inoperative. To this end, the painstaking process of recovering every piece of the remaining mines left behind by the Mini MineWolf has been paramount. All items were photographed, recorded and inspected for functionality.

The search process involved three steps. Firstly, a deminer equipped with a Minelab F3 searched the area for all metallic components. Next, the soil was raked to locate any metallic components. Lastly, a deminer conducted a deep search with a Large Loop Detector (LLD) to locate any deeply buried UXO.

## OFE to Date

Since the start of the OFE (April 2013), focus was placed on accurate data collection and analysis. While greater area clearance could have been achieved, this shift in focus would have detracted from the OFE's goal.

In terms of the Mini MineWolf's overall performance, the device proved highly effective as a mechanical clearance tool. The machine has yet to leave a single, functioning mine after

Recovered items are photographed, recorded and inspected for their state of function.
*Photos courtesy of HD R&D.*

tilling an area. All of the mines encountered during inspection were detonated, initiated (but failed to function) or otherwise rendered inoperative.

### Survivability

During the OFE from 2013 to 2014, the Mini MineWolf tiller detonated three TM46 anti-tank (AT) mines. These were rogue mines laid in conjunction with anti-personnel (AP) mines. On each occasion the tiller suffered considerable damage, which required comprehensive repair to return it to operation. Local staff conducted these repairs on site under the supervision of the HD R&D field officer. The Mini MineWolf was not designed for use against AT mines, which were not anticipated to be within the area of operation. The machine, however, detonated many AP mines without sustaining any damage.

### Upgrades

One of the main tenets of the HD R&D Program is to improve demining systems wherever shortcomings may be, as it did with the Mini MineWolf. The team in Thailand put together an armored, mobile operator's platform, a new version of which is under construction at the HD R&D workshops in the U.S. This platform will deploy to support the Mini MineWolf before 2015.

Some issues experienced with the original camera and monitoring system on the Mini MineWolf needed addressing, and the HD R&D Program resolved these issues through the addition of a replacement system built in-house by the HD R&D technicians. The original camera system fitted to the machine by the manufacturer was a complex four-camera system. It was bulky and used analog cameras and electronics. HD R&D staff at Fort Belvoir, Virginia (U.S.) built a different camera system, using small wide-angled digital high-definition cameras. These were then coupled with a simple 900 Mhz WIFI transmission and receiving network. The use of the small wide-angle cameras enabled the team to cost-effectively switch from the four-camera system (three forward facing and one reverse facing) to a two-camera system (one forward/one reverse), while maintaining the same field of view. The new system lessened the weight of the technology, improving the quality of photo monitoring while maintaining its scope. This also allows for additional camera monitoring from the control point (via the same WIFI link), and it can allow hard drive recording.

| Clearance Statistics – 04/2013 to 04/2014 | |
|---|---|
| Total Area Tilled | 122,890 sq m |
| AP Mines Encountered | 397 |
| AT Mines Encountered | 3 |
| UXO Encountered | 53 |
| Hours Operated | 327 |

Table 1. OFE clearance figures.
*Table courtesy of HD R&D.*

### Looking Ahead

The OFE, including data collection on the Mini MineWolf's performance in Thailand, will continue through 2015, as will the support for TMAC's clearance operations, to the benefit of both parties.[2]

*See endnotes page 66*

**Phil Straw** has worked in mine action since 1997 and began working with the U.S. DoD HD R&D Program in early 2004. Straw has extensive experience in field operations and mine action management, and is a qualified mechanical engineer.

Phil Straw
U.S. Humanitarian Demining R&D Program
US Army RDECOM CERDEC NVESD (RDER-NVC-HD)
10221 Burbeck Rd. - Bldg 392
Fort Belvoir, VA 22060-5806 / USA
Website: http://humanitarian-demining.org/2010Design/Contact.asp