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Lateral-approach Methodology and HSTAMIDS

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MAG Cambodia has used the Handheld Standoff Mine Detection System (HSTAMIDS) with lateral-approach methodology for three years within an operational field evaluation funded by the U.S. Department of Defense's Night Vision and Electronic Sensors Directorate. MAG's current research tested the productivity of two ways of using LAM combined with HSTAMIDS against the productivity of the traditional one-man one-lane drill methodology; this article presents the findings.

by Clifford Allen and Shathel Fahs [MAG Cambodia]

An operator using a long-reach tool.
All photos courtesy of the authors.

Lateral-approach methodology is the method by which a minefield is cleared along its linear boundaries rather than by breaching clearance lanes every 25m at 90 degrees to the linear boundary into a minefield. This is done by selecting the longest and most conveniently accessed boundary and advancing into the minefield laterally or in extended-line approach. LAM is broken down into phases that can differ in number depending upon the terrain encountered.

LAM is not a new concept; The HALO Trust developed it about half a decade ago when the organization first began deploying the Handheld Standoff Mine Detection System (HSTAMIDS), a metal detector with ground-penetrating radar capabilities, in the field. MAG (Mines Advisory Group) adopted the methodology in November 2007 and has since altered it many times to improve productivity and ease the burden on deminers.

Procedure

Prior to Phase 1, the lane is marked using a red rope with white markers painted or taped onto the rope every meter. The operational field evaluation then begins the following phases for clearance:

1. Quick search
2. Vegetation-cutting/rock removal
3. Raking and blowing
4. Marking
5. Detection
6. Manual excavation
7. Rapid-excavation drill

Quick search. In Cambodia, the tripwire threat is considered non-existent; consequently, the first phase entails conducting what is known

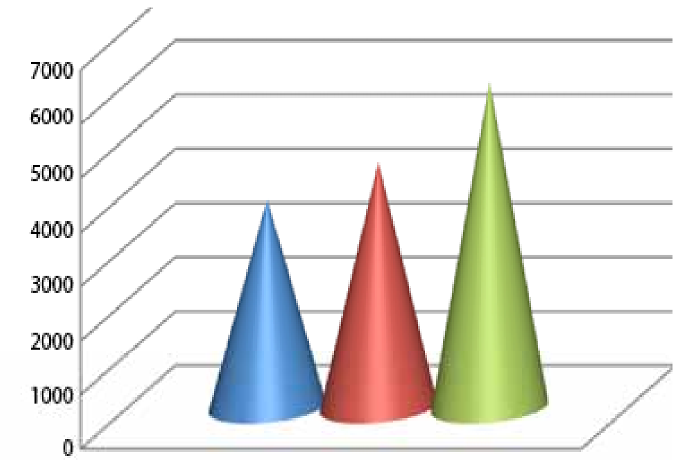

Figure 1. Progress in square meters during the transitional period from OMOL to LAM.
Blue: July 2010/OMOL
Red: August 2010/OMOL-LAM
Green: September 2010/LAM
All graphics courtesy of the authors.

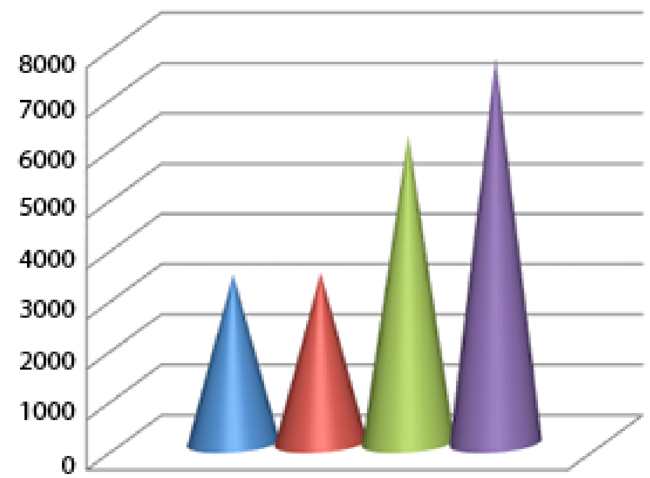

Figure 2. Progress in square meters before, during and after the introduction of HSTAMIDS into LAM.
Blue: July 2010/Without HSTAMIDS
Red: August 2010/With HSTAMIDS-No RED
Green: September 2010/HSTAMIDS with RED
Purple: November 2010/Progression of HSTAMIDS

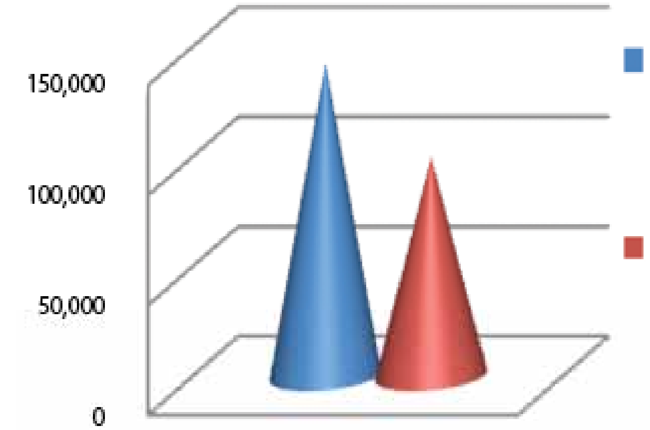

Figure 3. Square meters achieved over a six-month period.
Blue: 9x HSTAMIDS
Red: 18x Metal detectors

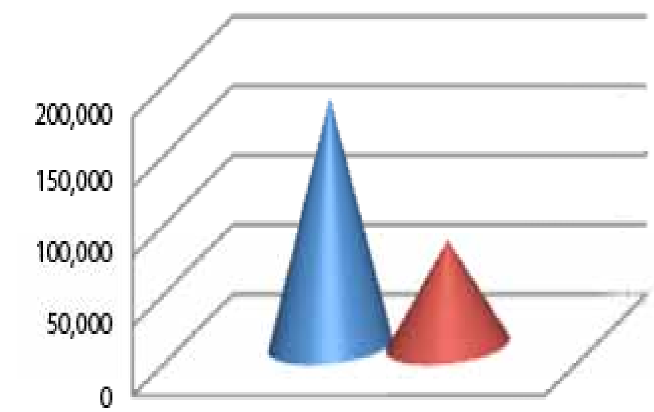

Figure 4. Metal contamination encountered over a six-month period.
Blue: 9x HSTAMIDS
Red: 18x Metal detectors

as quick search using a conventional metal detector that involves thrusting the detector up to 1.2m in and out of the uncut vegetation, moving laterally along the front edge of the area to be cleared, and looking and listening for large signals that may not be at first visible. Any such signals encountered are marked as an obstacle, signifying that these areas are not to be mechanically cut. If it is safe to do so, recognizable surface clutter is removed.

Vegetation-cutting/rock removal. The second phase is cutting the vegetation down to ground level using mechanical means. A long-reach tool with a strimming (mechanical vegetation-cutting) attachment is used in three patterns for various vegetation types. Strimming and rock removal of previously marked quick-search areas are avoided; these areas must be cut manually with secateurs or similar hand-cutting tools. This phase sometimes requires extra work because deminers must remove rocks from the lane first. Rocks are often prevalent on hillsides where mines were deployed to protect key installations.

Raking and blowing. The cutting phase is followed by the removal phase, which can involve hand clearance of large vegetation. This phase is backed up by raking and brushing, and culminates in the use of another long-reach tool with a blower attachment, leaving the lane to be cleared free of vegetation, loose soil and even some surface metal. Magnets can also be deployed at this stage if the area contains large amounts of surface-metal clutter.

Marking. The red rope may have moved and be out of alignment due to the previous phases of strimming, raking and blowing, so it may have to be adjusted prior to marking. After these adjustments, a blue rope is placed 0.6m into the uncleared area running parallel to the red rope. This creates 1m x 0.6m cells along the length of the lane. The area cleared within each lateral lane is 0.5m, with the other 0.1m designated as overlap. The overlap area is covered twice as the lane progresses forward. Spacers are used every 8m to ensure the ropes are kept straight and parallel.

Lanes are normally defined as being 25m in length but can be any length. These 25m lanes form a grid that is logged by numbers and letters, allowing accurate data collection so that data can be used for quality-control/quality-assurance investigations as well as assisting in mapping, etc. The practice of working at some considerable distance greater than 25m is to be encouraged where the supervisor can observe all activity from a central focal point.

Detection. The next phase is detection or clearance, and it can be executed using either conventional metal detectors or HSTAMIDS. If the former is adopted, the deminer starts a systematic search, sweeping sideways in straight lines, placing red chips on all signals encountered. If HSTAMIDS is used as the primary search tool, the detector operator can immediately differentiate between metal clutter and possible mines, and the operator places blue and red chips (markers) accordingly.

If the area being detected has many signals per cell, then a magnet can be utilized to reduce surface clutter. A senior deminer or a superior, such as a supervisor in Cambodia or a deputy team leader in Angola, should supervise this activity to negate any missed signals. The procedure is to lift a chip and sweep the magnet over the area where the chip was placed, attracting metal fragments to the magnet. A detector is then passed over the area again, and if the signal has disappeared, the chip is removed. However, if the signal remains, the chip is again placed on the spot for further action. When the cell sweep is completed, the operator moves the sensor/search head forward and continues with the next sweep. The operator progresses to the blue-colored rope, thus creating overlap. Overlap should also be maintained at the front and ends of all cells.

If a conventional metal detector is used for detection and marking of the entire lane with red chips, the HSTAMIDS detector then verifies all red chips placed by conducting isolation and moving in a zigzag motion over each chip. Since HSTAMIDS costs upwards of US$16,000–20,000 and conventional metal detectors cost roughly $3,000, the use of a conventional metal detector is often used in place of HSTAMIDS. On the other hand, HSTAMIDS' GPR sensors allow the operator to change up to 95% of the red chips to blue, which identifies the remaining 5% as being the only red chips necessary to manually excavate. If the HSTAMIDS is deployed as the primary clearance tool, then the blue and red chips are placed concurrently, depending on the signals HSTAMIDS gives.

Manual excavation. The next phase involves manual clearance with the help of a conventional metal detector. The deminer observes the lane for chips and moves to where the first red chip is placed. If this is, for example, in cell 4, then the excavation deminer will manually excavate that signal using conventional standard-operating-procedure excavation drills, which is done by centralizing the chip using the metal detector. No sweeping toward the signal is required. If the chip is in the correct position, as indicated by the detector, the operator will proceed to excavate the signal location, moving along the lane until all locations are excavated. Mines are not completely excavated; they are only partially excavated to allow a donor charge to be placed alongside unless they are to be neutralized or disarmed. QC/QA is then conducted on the excavations, and any mines are destroyed *in situ*.

Rapid-excavation drill. The final phase is to proceed to rapid excavation of all blue chips using mechanical means, which is carried out by an operator using a long-reach tool with a digging attachment. This procedure is known as a rapid-excavation drill. The long-reach tool operator will excavate each blue chip by digging a trench to the rear or side of the blue chip as per manual drill, and will force their way forward with the long-reach tool until the operator is just behind or alongside the chip. At this point, the operator must stop the digging bit from revolving and brush the chip into the excavation behind or alongside the chip's position before continuing excavating 5cm beyond the place where the chip was originally lying.

Brushing the chip aside to continue excavation 5cm beyond will ensure that all items will either be uncovered or flung to the side, and will enable the long-reach tool operator to determine the source of the signal. Once all the rapid excavations are completed in a given lane, the lane is deemed clear, and the next lane can be prepared. The rapid-excavation drill procedure achieves final quality assurance.

Modifications to LAM

Since the inception of LAM, a number of innovative ideas were adopted, and most of these have come from the deminers on the ground. For instance, since MAG first utilized LAM and the introduction of rapid-excavation drill in November 2008, marking has seen substantial changes. This methodology was simplified and re-engineered to optimize productivity.

Two improvements in the process were made. First, the red rope with white markers has eliminated the need for conventional minefield pickets at every meter, thereby removing these obstacles for the deminers. Second, the way in which these ropes are deployed, by means of polyvinyl chloride pipe reels and stakes, is also an improvement. MAG is continually rethinking marking to increase efficiency.

Even without HSTAMIDS, evidence suggests LAM is easier to control, has improved safety benefits, and is more cost efficient on marking materials than the one-man, one-lane drill methodology. LAM could better benefit road/verge clearance than the current method of clearing with the one-man, one-lane drill methodology. These productivity advantages can be seen in Figures 1 and 2 (previous page).

On the other hand, using HSTAMIDS in LAM is additionally advantageous in a number of ways:

- As shown in Figures 3 and 4 (above), substantial increases in productivity occur.
- The number of time-consuming and labor-intensive manual excavations are minimized.
- Using a blower is seen to have morale-boosting effects on deminers as it clears everything from the lane in a less labor-intensive way. Removing some surface metal and stones means the detector operators have an easier time sweeping the detector close to the ground for better detection.
- Using magnets before and after chipping, depending upon contamination levels, is a time-saver. If a lot of surface clutter is encountered, then the magnet can be swept over the cell before the detector is deployed. Correspondingly, after chipping, the magnet can be deployed on selected targets, particularly around red chips that can then be discounted if the magnet detects and lifts the offending signal from the surface.

In a conventional minefield, the standard operating procedure for MAG Cambodia states that the safety distance between any working deminers should be not less than 25m. However, this distance is largely because all deminers work independently, and 25m is the default distance that most demining organizations worldwide adopt in anti-personnel minefields. Due to the nature of the methodology covered above, not all activities are deemed equally hazardous or potentially so. Therefore, the authors devised a system pertaining to the nature of the activity shown in Table 1 (next page) giving various distances that should not be exceeded.

Use of and Adaptations to Long-Reach Tools

MAG used Honda long-reach tools for strimming before it began using LAM. However, since MAG began using LAM with HSTAMIDS, a range of tools designed for gardening produced by Stihl, a German manufacturer, were procured. These tools were modified in many ways to adapt them for the demining industry. For example, the shafts MAG uses are half shafts held together in the center by a coupling, which has also been modified. This facilitates quick tool change—a shaft change

Activity	Hazardous	Non-hazardous	Safe Distance
Marking		x	5m
Quick search		x	10m
Sawing	x		25m
Strimming	x		25m
Raking	x		25m
Blowing		x	10m
Lane preparation		x	10m
HSTAMIDS		x	10m
Data Collection		x	5m
Manual excavation	x		25m
Rapid excavation	x		25m
QA		x	2m

Table 1. LAM safety distances.

takes one minute, whereas a complete tool change can take up to 15 minutes and can cause more wear and tear on the tool head connection. MAG also radically modified the shafts to make them more robust. By changing the outer casing from aluminum to steel and by exchanging various components manufactured in plastic to steel alternatives, the working life of these components has been greatly lengthened.

Gear heads supplied by Stihl are flimsy for the type of application MAG requires and have been replaced by a much cheaper and more robust Honda version that has stronger bevel gears and an outer casing.

Along with the introduction of a variety of attachments, the strimming procedure was refined. By sweeping the strimmer from right to left, for example, in a half circular motion, the cut vegetation is dragged toward the red rope and thus reduces vegetation left in the uncleared area, alleviating part of the raking and blowing. Using different cutting blades and circular saw attachments has optimized the activity further.

Introducing a 90-degree plasticized polyvinyl chloride bend to the blower's end also helped develop the blowing technique. This change allows the debris to be more easily blown into the cleared area, minimizing the operator's effort. The blowing is done in roughly the same manner as strimming, bearing in mind MAG is not looking for a metal-free minefield. Drive shafts were modified, and the locating pin was replaced by placing a bearing on the shaft to stop oscillation.

Sometimes overhanging trees and bamboo must be removed before clearance. Teams are supplied with chainsaw attachments to deal with the heavier branches and bamboo shoots. These saw attachments on the end of a half shaft are easier to transport and operate than a completely independent chainsaw.

Various digging devices were trialed and mostly discarded, although the cutting blades designed by engineers at NVESD have had some success in soil that is not densely compacted and is largely free of rocks and roots.

The rapid-excavation drill uses the pineapple drill head, which is the mainstay of mechanical-excavation activity.

Two Methods of Clearance Utilizing HSTAMIDS

The agreement between MAG and NVESD is that HSTAMIDS should be the primary clearance tool; therefore, the lateral-approach methodology was largely developed with this in mind. More recently, the purchase of additional HSTAMIDS units, funded by the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA), is allowing MAG to experiment with other approaches outside of the NVESD operational field evaluation.

The OFE methodology has evolved as three-by-three-person sub-teams, each with an HSTAMIDS detector and all the ancillary equipment needed to conduct operations. Each sub-team is allocated an area of the minefield and concentrates its efforts in this area only. Each member of the sub-team is multi-skilled in as many of the activities as possible needed to conduct operations, thus allowing for flexibility and continuity. These three individuals can operate the various phases independently and without strict supervision. Each team member knows what the next step is and equips themselves with the necessary equipment from a focal point (rest area) close to their working lane, which has been found to work very well provided that the sub-team is continually allocated between five and seven lanes minimum to allow for observance of safety distances while conducting constant activity.

Teams outside the OFE are equipped with one HSTAMIDS detector and two operators and they support a number of metal detector operators. The team is roughly divided into two parts. On average, five or six conventional metal-detector operators are deployed, conducting quick search and marking all signals in lanes with red chips. This practice ensures that the HSTAMIDS has sufficient work to sustain it for an entire day. Later, these operators also manually excavate red chips that remain after HSTAMIDS has verified them.

The basic design of the pineapple and the alignment of drill heads maximizes the potential for digging.

Each mine triangle represents a partially manually excavated mine.

The other team members (up to six in a standard MAG mine-action team configuration) perform the other activities, which revolve around the long-reach tools. These are strimming, cutting, sawing, blowing and rapid-excavation drill. All of the operators are also involved in marking when the HSTAMIDS is being used as the verification detector.

This methodology needs further study to ascertain whether this procedure should be altered to remain flexible in order to account for varying contamination levels. Metal contamination is the main factor governing the number of metal detectors deployed at any given time because this affects whether more than one HSTAMIDS detector is necessary.

Productivity

MAG continually strives to increase efficiency and effectiveness, and the introduction of HSTAMIDS has greatly enhanced its ability to do so, as illustrated in Figures 3 and 4 (page 67). LAM's success significantly improved with the introduction of HSTAMIDS to the toolbox.

Conclusion

The methods MAG Cambodia uses when deploying HSTAMIDS with the lateral-approach methodology exhibit certain advantages when compared with the traditional one-man, one-lane approach, particularly with regard to productivity. The analysis of HSTAMIDS and LAM is still an ongoing process within the program with further technological advances and improvements in productivity expected.

The various outlined approaches are open for improvement and adjustment, with expectations that as HSTAMIDS is introduced into other programs, the improvements in these methodologies will ensure that HSTAMIDS and LAM continue to give significant benefits over standard metal detectors and more conventional clearance methodology.

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