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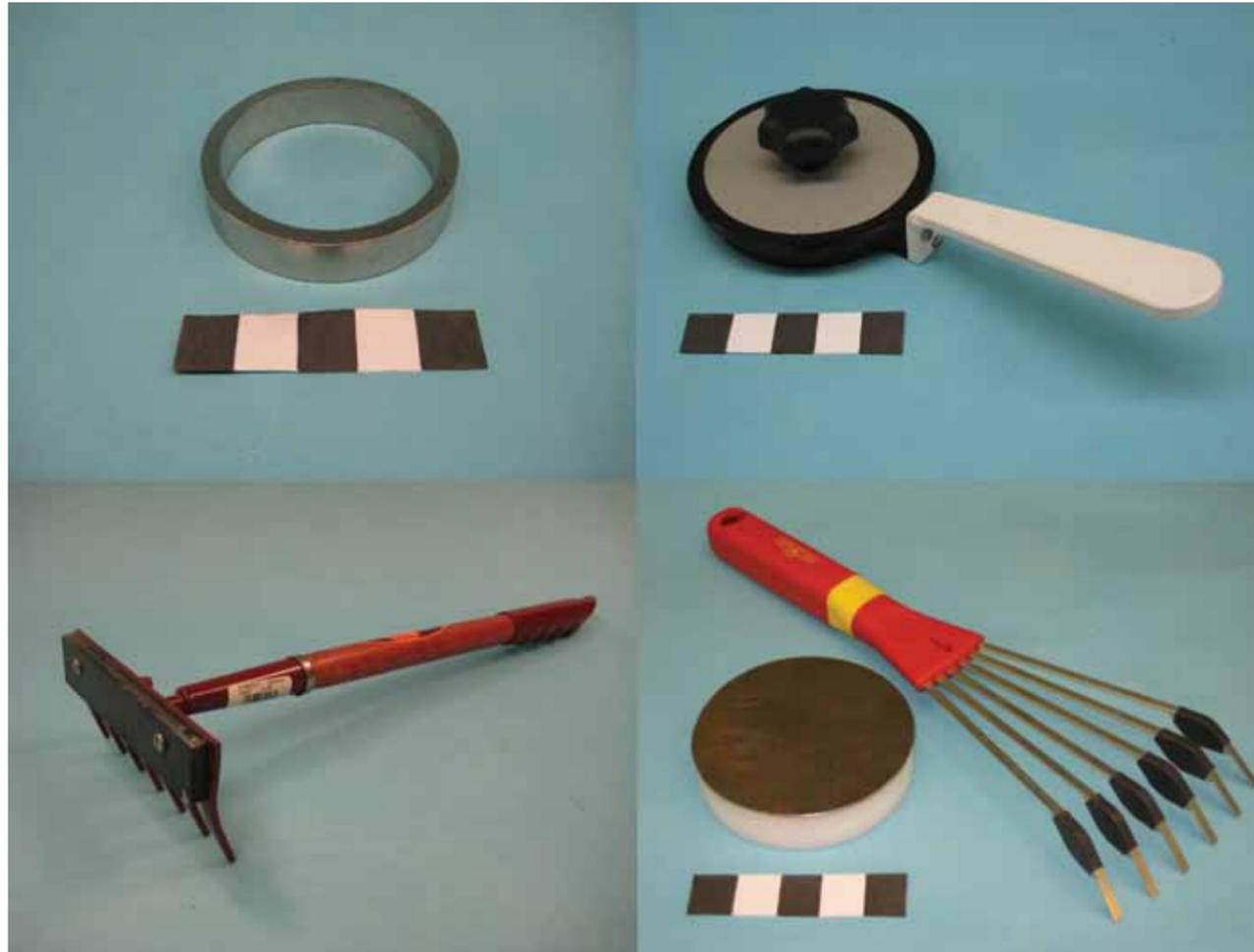
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Clutter Reduction in Manual-Demining Operations with the Help of a Handheld Magnet Tool

The authors discuss a study investigating the potential of permanent magnets for the reduction of metal clutter in manual demining operations.

by Arnold Schoolderman and Yolanda Rieter-Barrell [TNO Defence, Security and Safety]



Images 1–4 show examples of the magnet-tools that were trialed in Cambodia and Angola. Please note that the checkered ruler has a length of 10 cm. Image 1 (top left): Bare ring magnet with a diameter of 10 cm. Image 2 (top right): Magnet-tool with cover and handle, including a ring magnet. Image 3 (bottom left): Large rigid rake with magnet attached above the teeth (handle is 40 cm long). Image 4 (bottom right): Flexible rake with small magnets (black) attached to the teeth and ring magnet in cover.

All images courtesy of the authors.

A handheld metal detector is the most common detection tool in humanitarian demining, not only in manual-demining operations but also as a follow-up to mechanical demining. Most demining organizations adopt the metal detector as the prime detection tool since it is easy to learn and operate, is affordable, and fits well in the standard oper-

ating procedures. However, organizations and deminers are also aware that false alarms occur frequently when metal detectors are employed. It is, generally speaking, not possible to distinguish between an alarm due to a piece of harmless shrapnel or due to a dangerous mine. False-alarm rates in manual-demining operations have been reported as high as 250 false

alarms for every one alarm resulting from an actual mine.¹ It is obvious that a technique to reduce the false-alarm rate would enhance the manual-demining process greatly.

This assertion is confirmed in a study² by the Geneva International Centre for Humanitarian Demining on the different phases of a manual-demining operation. The study concludes that

improvements in the “close-in” detection phase yield “very significant benefits” on the efficiency of the total operation. The study’s results show that decreasing the number of metal-detector false alarms by 50% will yield efficiency improvements of 21–47% in demining operations in 10 of the 12 scenarios defined in this study.

In the last five years, a few different types of dual-sensor detectors, in which a metal detector is combined with ground-penetrating radar, have been developed in Europe, Japan and the United States. These developments are aimed at the reduction of metal-detector false alarms by using the GPR alarm. The GPR will ideally only give an alarm if an object with a certain volume is present that has different electromagnetic properties³ than the soil in which this object is buried. Hence, a small piece of shrapnel or a nail will only result in a metal-detection alarm, while a mine will also set off the GPR alarm. Although the benefit of dual-sensor detectors in reducing the false-alarm rate has been shown in trials,⁴ it is questionable if dual-sensor detectors will be applied for humanitarian demining in large numbers in the future because these devices have a number of disadvantages. These disadvantages include the high price of the devices, complicated operation resulting in long operator training, the need for modifying the SOPs (since the use of a dual-sensor detector will generally not fit in the current SOPs for manual demining) and the need for implementation of a suitable quality-assurance method.

Permanent Magnets

Another method to remove metal clutter is magnet use; if a magnet is moved manually over the surface, ferromagnetic metal parts on and just under the ground’s surface will stick to the magnet. If the magnets are attached to a small handheld rake, the topsoil can be manipulated in order to loosen metal fragments from the soil. The magnets can then pick up these fragments. Though this idea is not new and several individuals and demining organizations have tried it over the past 10 years, substantiated information on the benefits is lacking. Magnets made from niobium, a so-called rare-earth metal, are nowadays affordable. These magnets are much stronger than those tried in the past.

In order to investigate the efficiency increase obtainable by using handheld permanent magnets in the “close-in” detection phase, a project was started by the Netherlands Organization for Applied Scientific Research (TNO). The Netherlands Ministry of Defence financed this project as part of the



Images 5 (top) and 6 (bottom): Use of two types of magnet-tools during the trials in Cambodia (Image 5) and Angola (Image 6).

Netherlands’ contribution to the International Test and Evaluation Program for Humanitarian Demining, which ended in July 2010.

Trials

Based on criteria applicable to humanitarian demining, such as cost, weight, robustness, exerted force, etc., suitable magnet tools were selected and designed. Images 1–4 show examples of the magnet tools trialed in Cambodia

and Angola. The data necessary to quantify the clutter reduction by applying the magnet tools was gathered during live demining operations in Cambodia and Angola with the Cambodian Mine Action Centre and Norwegian People’s Aid, respectively, as partners. To this end, a procedure was set up to train the local deminers in the magnet-tool use. During the trials the deminers were divided into several groups. All deminers in one group worked with one



Images 7 (left) and 8 (right): A deminer working with the final version of the magnet tool at the Camabole task in Malanje, Angola in October 2010. In Image 7 the deminer is using the magnet tool during the detection phase and in Image 8 the deminer is using the magnet tool during excavation.

type of magnet tool. Additionally, one extra group did not use any magnet tools and served as the reference (control) group for the trial. Images 5 and 6 (see previous page) show impressions of the use of the magnet tools during the trials. Data-gathering procedures were set up that fit into the SOPs the demining organizations used. After proper instruction, the deminers executed the data-gathering according to these procedures, recording the cleared area day by day, all encountered metallic clutter and how each metallic clutter piece was found (visually, with the magnet tool, or during excavation). The TNO project team analyzed the data after corrections for the absence of deminers due to other duties, vacation days, illness, etc.

Trial Results and Pilot Implementation

The trials of several types of magnet tools were conducted in Cambodia in 2006 and in Angola in 2007. Although many aspects—such as the mine threat, SOPs of the two demining organizations, etc.—were different, the results of these trials were quite similar. For this reason, only the results of the trial conducted in Malanje province, Angola are presented.⁵ Figure 1 shows the average area cleared per deminer per day (in square meters) for the deminers working with the magnet tool under trial (this tool is shown in Image 2 and Image 6) and for the deminers of the reference group, working without a magnet tool. Surprisingly, the deminers without the magnet tool were the most productive: On average they cleared 11% more land per day. This revelation can only be explained when considering that the deminers with the magnet tool encountered 26% more metal parts per square meter (Figure 2). At the end of all trials in Cambodia and Angola, all participating deminers were asked their experiences with the magnet tools. Without any exception they responded that the magnet-tool use sped up their work. Hence, the authors concluded the deminers' lower productivity with the magnet tool is a result of working in an area with more metallic clutter. Because

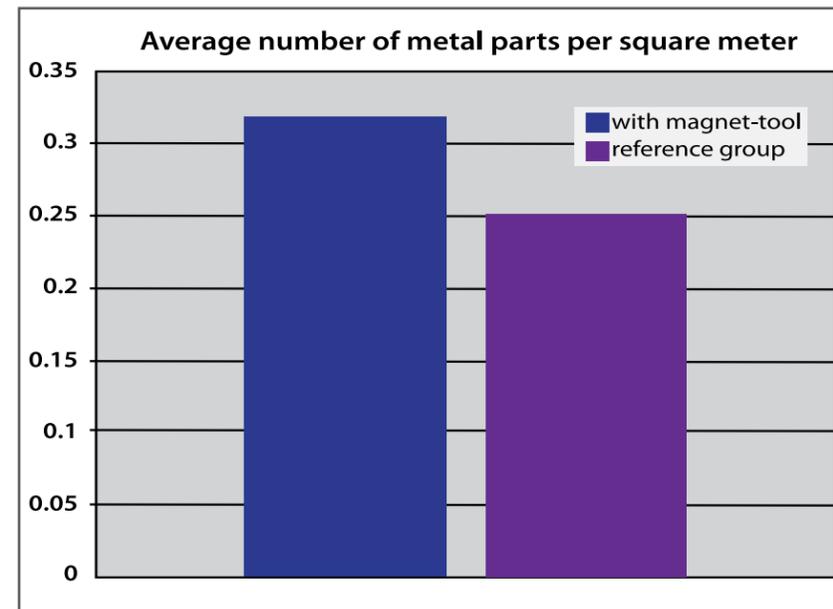
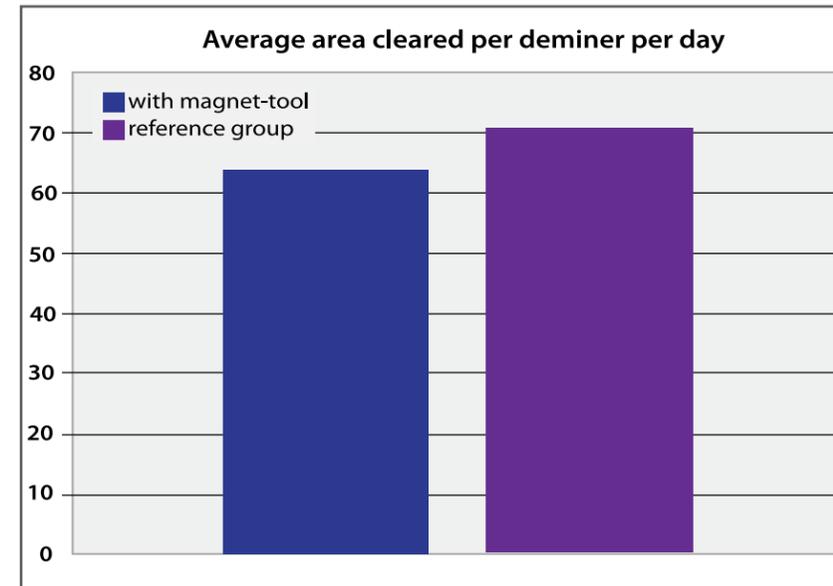
the trials were conducted in live demining operations, controlling this aspect of the trials was impossible. The deminers used the magnet tool not only during the detection phase of the demining procedure, but also during excavation to find metal fragments in the removed soil.

The deminers who worked with magnet tools during the trials not only responded positively to the question of increased productivity by the magnet tools, but also recommended adding one of the trialed magnet tools (the ring magnet with the plastic casing and handle, shown in Image 2) to their demining toolbox. As a result of this recommendation, NPA Angola requested TNO to support a pilot implementation of this tool for all NPA deminers in Angola. For this pilot implementation, the tool was redesigned to allow production at the lowest price possible. One hundred samples were transported to Angola where the tools were handed over to the NPA deminers in October 2010 and were used in the clearance of a former military position at Camabole near the town of Malanje (Images 7 and 8).

Conclusion

Strong handheld magnet tools with niobium magnets can be used in manual-demining operations to remove metal clutter and thereby reduce the number of metal-detector false alarms. The magnet tools are cheap and easy to handle in comparison to a dual-sensor detector. Various magnet-tool trials in live demining operations did not show a quantitative increase in the cleared area per day. This is most likely due to the fact that the deminers working with the magnet tools encountered more magnetic clutter than the reference group. However, the deminers experience the tools as a useful addition to their toolkit as they are convinced the magnet tools speed up the demining process. Therefore, the magnet tools are useful in supporting a deminer's strenuous job and are now included in the toolkit of the NPA deminers in Angola. ♦

see endnotes page 83



Figures 1 (top) and 2 (bottom): Average area cleared per deminer per day (Figure 1) and the average number of metal parts found per square meter (Figure 2). Here the results of the trial in Malanje province, Angola, with NPA deminers are given. The blue represents the deminers using the magnet-tool and the purple represents the deminers in the reference group who did not use the magnet-tool.

Figures courtesy of author/CISR

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