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Understanding the Use of Prodders in Mine Detection

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Can prodding reliably detect mines? Though it may seem obvious to many in humanitarian mine action (HMA) that prodding alone cannot safely and reliably detect mines, recent accidents show that some expatriate newcomers to HMA do not know the risks involved in prodding or that prodding to a depth of 30 cm (12 in) is impossible.[1]

Finding mines with a prodder involves pushing a tool into the ground and relying on tactile feedback to identify an obstruction that may be a mine. Many military groups are trained to use their bayonets as a detection and excavation tool. When the British Army trained me in 1995, I was told to lie shoulder-to-shoulder with my university colleagues and prod every square inch of the ground with a short bayonet.

Figure 1. Low-friction prodders and a PMN anti-personnel blast mine.
All graphics courtesy of the author.

Apart from the very slow technique, I quickly realized that I could not push the bayonet more than a few centimeters into the ground without excessive force. Using considerable force meant that I could not feel when something blocked my progress until **after** I had pressed very hard onto it.

Dangerous Method

Lying shoulder-to-shoulder prodding the ground is not done in humanitarian demining for safety reasons. The deminer's safety is paramount, but the security of those who use the land later is equally important.

If deminers were lying side-by-side prodding with bayonets and one of them detonated a large anti-personnel (AP) pressure mine (such as a PMN), at least three people would likely receive injuries to their faces and eyes. In addition, the person who detonated the mine would probably lose fingers on the hand holding the bayonet, because the hand would be too close to the detonation for safety.

Despite prodding every inch of the ground with bayonets, deminers cannot search the soil deeply enough to reliably locate the mines. Since 2001, the International Mine Action Standards (IMAS) have cited a default depth search of 13 cm (about 5 in).[2] Some countries vary the default depth depending on the ground conditions and the mines or explosive remnants of war under detection. After much discussion, a depth of 13 cm was chosen, because it was the maximum depth at which the best metal detectors could reliably locate minimum metal mines at that time. No one considered the depth that could be reliably reached with a prodder.

The IMAS-recommended clearance to 13 cm was significantly less than the depth of clearance that had been claimed throughout the '90s. At that time the U.N. and other demining organizations claimed to clear ground to a 30-cm depth (about 12 in) using simple detectors and short AK bayonets.

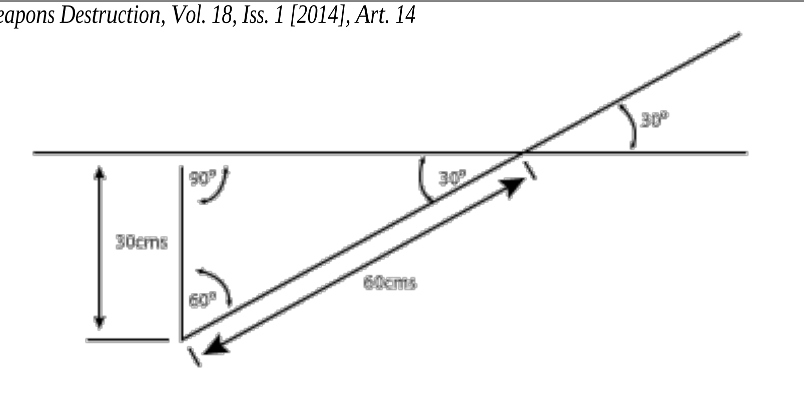

Figure 2. A sketch illustrating the impossibility of prodding to 30 cm at a 30-degree angle with a short bayonet.

Practical Tests and Trials

In 1998, a deminer in Angola demonstrated that no one could prod to 30 cm at the required 30-degree angle. He did so by drawing a basic sketch (Figure 2).

Using trigonometry, the deminer showed that prodding at 30 degrees to a depth of 30 cm required pushing a long prodder 60 cm (2 ft) into the ground. The Angolan deminers used prodders with blades about 20 cm (8 in) long. Accompanying the deminers into the field, I tried pushing their prodder 10 cm (4 in) into the ground to achieve a depth of 5 cm (2 in) and could not do so without pushing with both hands. When prodding—part of their standard operating procedures (SOP)—the deminers said they could only search to a maximum depth of 8 cm (about 3 in) due to the tool's size and the required prodding angle.

I have since tried pushing a prodder into the ground in many ground conditions around the world, finding that even in loose sand, ground friction always prevents any tactile feedback at a depth of more than 10 cm (4 in). This was of little relevance during the 1990s, because the detector used most frequently in humanitarian demining had no ground-compensating capacity and could not reliably detect many plastic-cased AP mines. Without a detector signal, no one needed to investigate a deeply buried signal with a prodder.

Figure 3. Report on "Comparative trials of manual mine clearance techniques" in Mozambique in 2004.

Professor James Trevelyan of the University of Western Australia reported some results of relevant tests in his paper "Statistical Analysis and Experiments in Manual Demining." In 2000, he conducted 72 probing tests in soft sand and concluded that "even under ideal conditions, probing was not a reliable method for finding buried targets at depths of greater than about 8–10 cm" (3–4 in).[3]

In 2004, I conducted a series of trials for the Geneva International Centre for Humanitarian Demining (GICHD) designed to compare the relative safety and speed of different manual demining systems. Conducted in Mozambique, the trial was designed and implemented in collaboration with Tim Lardner and Håvård Bach from GICHD; Neville Goulton and Dai Lewis from the U.K.'s defense-technology company, QinetiQ; and Dr. Mate Gaal and Professor Christina Mueller from the German Federal Institute for Materials Research and Testing known as BAM.[4] The trials identified prodding as the most dangerous method tested due to its potential threat to deminer safety and inaccuracy in finding mines.

Former soldier and longtime U.N. humanitarian mine action actor Peter Isaacs was not surprised by these results. As a soldier, he suffered multiple severe injuries when he stepped on a mine **after** prodding the area thoroughly with his bayonet.

Figure 4. A deminer prods the soil at different angles.

During the manual demining prodder trials we used a marked base stick and an angle guide, as well as a low-friction prodder. A student at the Massachusetts Institute of Technology originally designed this prodder, which was later developed and put into production in a program supported by the U.S. Army Communications and Electronics Research, Development, and Engineering Center's Night Vision and Electronic Sensors Directorate (CERDEC NVESD).[5,6] Designed to record when they had been prodded, dummy mines were concealed and watered-in a month before the trials.[7] All mines below 10 cm (4 in) were missed, while shallower mines were found damaged in a way that probably would have caused detonation.

Using the Prodder

All demining groups have their own SOPs, and the ways they investigate a metal detector reading vary. The method may also vary depending on the type of mines expected.[8]

Figure 5. Widely used around the world, the deminer's blast-resistant toolkit was developed with NVESD support in 2000.

Most deminers today are issued prodders, which are dangerous when used as the sole means of finding and excavating mines. When carefully used with a trowel or scraper as part of the process of excavating a metal detector signal, prodding can give tactile feedback and help loosen the ground before mine removal.

Generally, an investigation should be started by prodding the ground a safe distance from the signal marker.[9] In most types of soil, the prodder will not penetrate more than a few centimeters. The deminer must not apply excessive pressure. Sometimes the ground has a crust with softer soil underneath. Frequently, the ground becomes harder as the investigation gets deeper, and the use of other tools is required.

The ground should be prodded or broken up over an excavation width equal to the width of the anticipated threats at the site. The ground loosened with the prodder should then be removed with a trowel or scraper.

Prodding and removing loose ground should be repeated as many times as necessary to create a sloping hole advancing toward the signal marker. The hole's depth should be the required clearance depth before the signal marker is reached. The prodder is used to prod the vertical face of the excavation from the bottom upward, thus contacting any mine from the side.

Accident Records

According to data available in the Database of Demining Accidents (DDAS), most accidents occur when deminers investigate a metal detector signal or excavate over a wide area.[1] The deminer knows that something may be there but exposes it without due caution, and the mine detonates. If a deminer only uses a prodder, this is more likely to happen than if a deminer uses a range of tools.

Figure 9 shows activities conducted during accidents over the past 10 years (2003–2013) based on data available in

DDAS.[1]

Original accident reports are saved in the DDAS, so that when researching "Prodding & Excavation" accidents, the researcher can learn what tools were used during the accident. During a recent review, I found that patently inappropriate tools are still used to detect or uncover mines in the same way they were 15 years ago. Examples include the use of pickaxes, mattocks and spades. Using short AK-47 bayonets and lengths of reinforcing bar to prod for mines also remains common. Finger and hand loss is a frequent consequence.

Figure 6. A deminer loosening ground with a prodder in Iraq.

Figure 10 shows technological advances such as the implementation of the Rake Excavation and Detection System (REDS) developed by Luke Atkinson for Norwegian People's Aid (NPA) in Sri Lanka in 2004.[10] Several other groups adopted REDS, including Sarvatra and Danish Demining Group (DDG) in Sri Lanka, DDG in Somaliland, and Santa Barbara Foundation in Libya. The REDS' attraction lies in the fact that almost all REDS accidents resulted in little or no injury.

Figure 7. A deminer using a trowel after the prodder in Cambodia.

REDS was originally designed for mine detection and excavation. Jan Erik Stoa adapted it to cover excavating metal detector indications for NPA in Jordan in 2007. REDS was then used while clearing the border minefield between Syria and Jordan until 2012. The minefield was a mix of anti-tank and AP mines (most AP mines were U.S.-made M14s). The mines had been in place for decades, and the ground was often very hard. All metal detector signals were investigated using REDS; two designs of long-handled rakes were used to safely expose the mines. The long-handled rakes kept the deminers back from any accidental blast.

While removing approximately 105,000 mines from the Syria-Jordan border minefield between 2007 and 2011, as well as mines on the Syrian border with Israel, NPA reported a total of 43 accidents using the rakes to excavate metal detector readings.[11] No injuries occurred in 23 of these accidents. In 19 accidents the injuries were trivial and did not prevent a rapid return to work. The only severe injury occurred when a deminer was not wearing eye protection. Rakes have also been used to detect and expose mines in Libya in 2013 and in Burma (Myanmar) in 2014.

Leaving aside advances such as REDS, accidents recorded in the last five years (2008–2013) broadly display the same pattern as in the preceding five years (2003–2008), indicating that the same mistakes continue to be made. Prodding to detect mines is not limited to village deminers. In a 2011 accident, a senior deminer detonated a PMN while using a prodder at, what he claimed, was a depth of 30 cm.[1] This is clear evidence that lessons learned are not effectively passed on to

Figure 8. The exposed side of a mine.

those in the field.

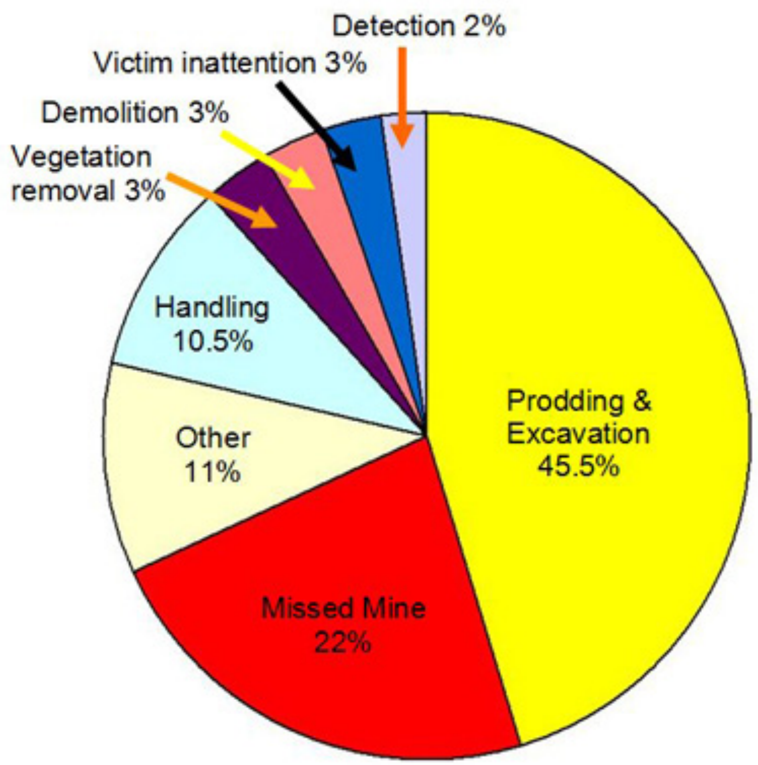

Figure 9. Activity when an accident occurs. A missed-mine accident occurs when the explosive device was in an area declared clear. A victim-inattention accident usually involves a deminer moving outside the cleared area accidentally (by stumbling or simply not thinking).

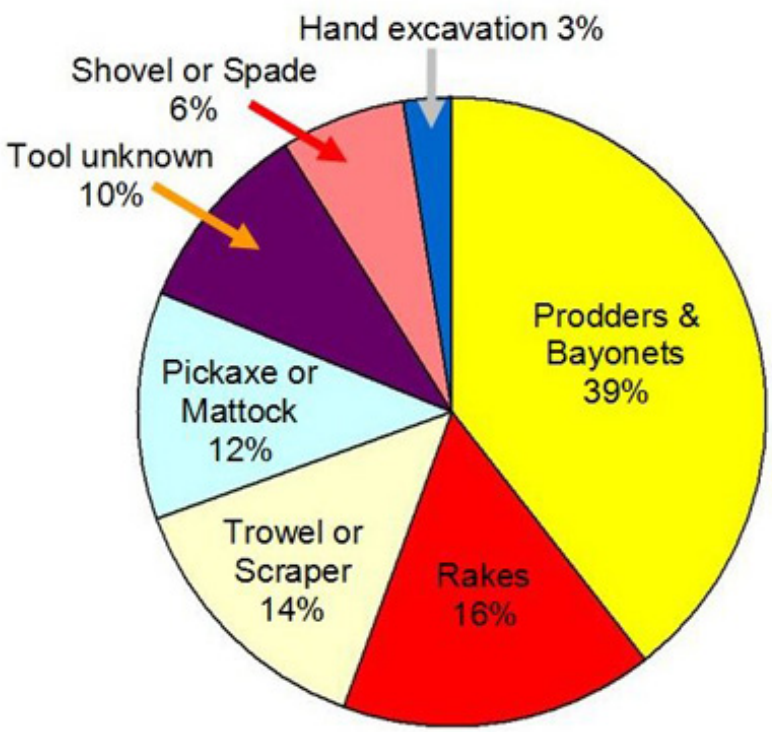

Figure 10. Many non-English speakers write accident reports, and the words used to describe tools vary. Photographs and other evidence were used to identify the tool type wherever possible. When this was not possible, the tool type is listed as **unknown**. Shovels or spades include folding sapping shovels and garden implements. Pickaxes and mattocks include short- and long-handled versions. Most bayonets in use are short Russian bayonets to fit the

The Logical Choice

Prodding should not be used as a mine-detection method. Further, a prodder should only be used in combination with other tools to excavate a metal detector signal.

Since at least the early 1990s, experienced soldiers and those with hands-on experience have known that prodding for detection is ineffective and dangerous. Yet when a soldier is trapped under fire in a minefield, he may be obliged to lie down and prod his way out. The risk the soldier faces by staying put or standing up to walk out of the minefield may turn prodding risks into the lesser of two evils. Because humanitarian demining is never conducted under fire, that scenario does not apply.

However, detection by prodding is still an approved procedure for many demining organizations—usually as a method that can be used in an emergency, e.g., when needing to access an injured person. However, organizations should be aware of the risks. Prodding onto a mine makes it likely deminers will lose fingers or a hand. Unless they are wearing the correct eye protection, deminers may also be blinded. Prodding does not remove the chance of stepping on a mine, because mines below the prodding depth can still detonate when stepped on. Many DDAS accident records report victims stepping on a mine that was more than 10 cm (4 in) beneath the surface.

Official U.N. advice to anyone finding themselves in a minefield includes lying down and prodding their way out if no other options are available, and implies that people can be trained to safely prod for mines.[12,13] However, evidence shows that it is simply not possible to safely prod for mines. A civilian without any eye protection or appropriate demining tools should make a simple risk assessment. On the one hand, the individual can lie down and prod for mines with a knife or stick. They risk detonating a mine with the stick or by lying on it. On the other hand, they can walk slowly back the way they came, looking at the ground carefully as they go. The first option risks serious injury to hands and eyes, or worse. The second option risks losing a lower leg or worse. If suddenly aware they are in a minefield, civilians will probably have seen a mine, which means they have reason to hope that others may be visible. Putting the risks in the balance, the scales come down unequivocally on the side of making a cautious retreat.

Deminers are not ordinary civilians because they may have tools or protection with them when they find themselves unexpectedly inside a minefield. They may also be able to read the area and predict the location of other mines. Even with

AK-47.

those advantages, every field deminer I know (including myself) has chosen to make a cautious exit when they have found themselves inside a minefield. I know of no one who dropped to the ground and prodded their way out. To do so without eye protection or sensible excavation tools would be to increase risk of catastrophic injury.

Figure 11. A T-AB-1 mine is safely uncovered with a rake in post-revolution Libya.

Biographies

Andy Smith has worked in HMA since 1995 as a deminer, surveyor, technical adviser, trainer, program manager and U.N. chief technical adviser. He was the longest serving member of the IMAS board when he left in 2011. His not-for-profit research and development work includes developing safety equipment for use in HMA. Examples include the most commonly used blast visor and blast-resistant hand tools.

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Endnotes

1. Specific details of accidents from prodding are not included to avoid identifying the actors involved. Some recent prodding accidents can be found in the DDAS database. All accident figures are taken from Smith, Andy. "Database of Accident Records." Database of Demining Accidents. Accessed 16 December 2013. http://ddasonline.com.
2. "International Mine Action Standards 2013." IMAS no. 9.2. (June 2013). http://www.mineactionstandards.org/fileadmin/user_upload/MAS/documents/imas-international-standards/english/series-09/IMAS-09-10-Ed2-Am5.pdf.
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5. "MIT Design for Demining." Massachusetts Institute of Technology. Accessed 16 December. http://web.mit.edu/demining/overview/about.html.
6. Formerly the U.S. Army's Communications-Electronics Command, Night Vision & Electronic Sensors Directorate. http://www.nvl.army.mil/index.php.
7. The watering-in process first begins with removing any turf and digging a narrow hole to the chosen depth (typically 10 cm). Afterward, the "mine" is placed and its depth (to the top) measured and photographed. The soil is then replaced with a lot of water. This ensures that no air cavities are in the soil above the mine as the water quickly spreads into the dry surrounding soil. After the water spreads, the turf is then replaced and trodden in, surrounding the "mine."
8. Smith, Andy. *Generic SOPs: Chapter 6: Manual Demining,* 24. Accessed 16 December 2013. http://www.nolandmines.com/Generic_SOPs/V2.1%20Generic%20SOPs%20Chap%206%20Manual%20demining.pdf
9. The safe distance should be varied to suit the anticipated hazards but is generally at least 20 cm.

10. Smith, Andy. *Generic SOPs: Chapter 6: Manual Demining*, 32–35. Accessed 16 December 2013. http://www.nolandmines.com/Generic_SOPs/V2.1%20Generic%20SOPs%20Chap%206%20Manual%20demining.pdf
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TOP OF PAGE

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