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Feature

Demining: Enhancing the Process

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Introduction

There is a good deal of frustration surrounding the demining component of mine action; much stems from the sneaking suspicion that technology to improve the process already exists. Almost everybody recognises that humanitarian demining is slow and dangerous, and most see a need to enhance it. But despite years of research, little has changed in the field: what's going wrong?

Optimising the process of demining requires much more than the development and incorporation of high technology. It involves a logical and coherent approach to well-defined aims. It also requires that many practical problems that plague field operations be identified and overcome. The objectives cannot be achieved in isolation; they involve understanding and building on a process that has evolved as a result of hard-learned lessons over many years. Without a detailed understanding of those lessons, the process of refinement will at best be inefficient and, at worst, totally misdirected.

Until recently, the operational and scientific communities have been poles apart, with hopelessly inadequate communication between them. Both are partially to blame: demining management for being so engrossed in minutiae that they failed to articulate their problems to the developers and some researchers for having the arrogance to believe that they could contribute to a process of which they had minimal knowledge

A further obstacle, rarely mentioned, is that some individuals and organisations do not want to collaborate. For example, some of the hi-tech research has no immediate prospect of benefiting mine clearance but attracts consistent, substantial funding and offers potentially lucrative "spinoffs." Equally, some of the demining agencies, having been disillusioned by a stream of ill-conceived ideas, now hardly consider the possibility that new technologies could help them.

Focusing on the Aim: What Are We Trying to Achieve?

Although it may seem obvious, we need to define what we are actually trying to achieve as a result of "mine action." Perhaps the two foremost issues are the reduction of casualties among the local population–the most direct form of human tragedy–and the reclamation of land for the use of that population. For all its good intentions, these are things that a landmine ban will never achieve. Banning landmines today will not make it any safer to walk across a field in Cambodia tomorrow, and no more of that ground will be usable. So, despite the important role that the ban has in limiting proliferation, practical mine clearance is a basic requirement.

It is also important to consider what "enhancing" the process actually means. Unless new techniques are faster, safer, or fill a capability gap, they are not truly enhancing the process. Even if they can fulfill one or more of these criteria, they must be must be readily available (which basically means affordable) when required.

Primary Factors

It should go without saying that equipment and procedures must work when and where they are needed, yet all too often this requirement is neither recognised nor assessed during development. All too often new equipment is designed without reference to the realities of live minefields and demonstrated in flat, open environments against unrepresentative targets.

To develop realistic techniques and procedures that will truly enhance the process of mine clearance, two primary factors must be considered: mines and the environment.

- **Mines:** The threat presented by the extensive variety of mines themselves and the ways in which they are used.
- **Environment:** The limitations imposed by the real minefield environment, where the ground often rules out whole categories of techniques and equipment.

Blast mines like these Yugoslav PMA-2s are easy to conceal and hard to detect, but the rip wire is more likely to get you killed.

The Over-Publicised Blast Mine

Even within the mine action community there is a stereotype landmine image: the small "non-metallic" anti-personnel (AP) blast mine. Many pressure-operated blast mines are plastic-cased and have a minimal metal content that does, indeed, make them difficult to detect. However, few (if any) are truly "non-metallic" or "undetectable": the most thorough clearance method known, metal detectors and probes, is clear evidence of this.

The blast mine even has a couple of points in its favour. Firstly, the fuze requires direct and often fairly substantial pressure (normally several kilograms). Secondly, the plastic casing creates a very limited fragmentation hazard and is unlikely to be lethal: there are numerous examples of deminers escaping accidental detonations with minor injuries. As with all rules, there are exceptions: mines like the Russian PMN, whose large explosive charge and Bakelite casing creates significant fragmentation. But, to the well-protected operator adhering strictly to standard operating procedures, blast AP mines are not the greatest worry. If the reliable detection of minimum-metal blast mines were the only major problem faced by deminers, clearance rates would be several orders of magnitude greater than they are.

The Lesser-Understood Fragmentation Mine

To the uninitiated, the high metallic content of the fragmentation mine makes it sound almost deminer-friendly: if it's easy to detect, what's the problem? Well, there are several problems. To begin with, stake mines, bounding mines, and Claymore-type directional mines are often initiated by tripwires. Unlike the blast mine, direct contact is not required: this is an area weapon with an area fuzing system. And while most blast mines require several kilograms of direct pressure, tripwire actuation may take as little as 1 kg. Gone, too, is the comforting notion of adequate protection. Not only will a mistake with a "frag" mine result in serious injury or death, but somebody else's mistake may get you killed, as well. The detection of tripwires is every bit as important as the detection

Fragmentation mines like these Italian V-69s often tripwire initiation and substantial range. The dark objects in the background are camels, all killed by the detonation of a single mine.

of minimum-metal mines, yet attracts a tiny fraction of the research effort.

Such is the strength of the blast mine stereotype that people often overlook the fact that fragmentation mines are normally above ground to maximise their effect. Others tend to believe that being visible, once again, makes them safer. In many situations, the reality is that the lethal range of these mines far exceeds the distance at which they can be seen. In other words, it can see you before you see it. Mines and tripwires placed well above the ground create a 3-dimensional threat, complicating both location and demolition.

The "effective range"' of fragmentation mines is also debatable: a Claymore, lethal at 50 m is clearly not safe at 51 m. The presence of fragmentation mines demands that deminers remain well spread out and are well protected on all sides. But large safety distances make command and control considerably more difficult, while wearing full protection decreases awareness and peripheral vision, increases fatigue, and can make the operator dangerously clumsy.

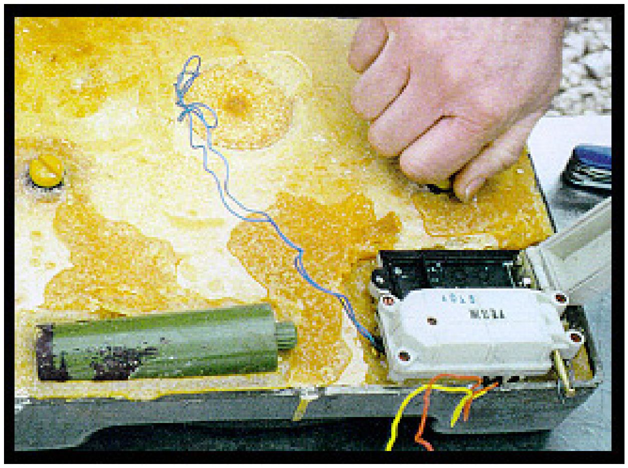
This Jordonian deminer is working in a temperature of 140 degrees F. Though hot and uncomfortable, his armour offers inadequate protection.

Incidentally, much of the protective equipment worn by deminers was not designed for that purpose. Most military issue helmets and body armour are too hot and restrictive for prolonged wear in warm climates and often provide no protection to areas such as the groin and neck.

Rules of Mine Laying

It is the indiscriminate use of mines that is most devastating to communities, and, among the "irresponsible" users, there are no rules. Improvisation makes every aspect of the mine threat unpredictable. The use of wooden stakes to initiate deep buried mines to avoid detection; the linking of claymores to create killing zones; the use of AP mines to initiate large artillery shells or bombs are all examples of improvisation that a deminer could face in addition to routine clearance.

To complicate the picture further, virtually any mine can be booby trapped in a variety of different ways. In former Yugoslavia, World War



A Yugoslav TMA-2 with the top removed reveals a "Special Electronic Fuze" melted into the explosive fill. This effectively converts a blast AT mine into a sophisticated booby trap.

II British and American mechanical booby trap switches are still in use, complemented by a range of ingenious, well-designed modern devices. The presence of booby traps further limits the number of techniques available to the deminer. Where the mines are suspected, they must be uncovered with extreme care and pulled out of the ground remotely or destroyed in place.

Electronic booby traps, which are also used in the former Yugoslavia, can operate on principles such as light, thermal or acoustic sensitivity, vibration, tilt, inertia, time delay, or breakwire. In Bosnia, booby traps like these have been found hidden inside anti-tank (AT) mines, melted into the explosive. In Cambodia, the Chinese Type 72B contains an electronic tilt fuze but is externally identical to the conventional pressure-fuzed Type 72. With such a formidable array of potential traps, it is almost impossible to devise universal manual mine clearance drills.

The Environment: Killing Fields, Not Playing Fields

The stereotype image of a flat, grassy minefield is just as misleading and harmful as that of the "non-metallic" blast mine. Yet the "football pitch" image is constantly reinforced by the trials, demonstrations, and publicity shots that invariably take place in near-perfect conditions. Even ignoring the special circumstances of Kuwait's oil lakes, the Middle East's drifting sand dunes, Afghanistan's mountains, or the Falklands peat bogs, minefields are rarely simple.

To begin with, there is vegetation. Minefields are not harvested or grazed, and many lie in the sort of hot, wet environment that promotes the rapid growth of foliage. Most of the world's minefields have been in place for years and many have become totally overgrown. Not only does this create a physical

Training deminers in Bosnia. This misleading image of flat grassy minefields is also perpetuated by unrealistic trials and demonstrations.

access problem, but the inability to spot fragmentation mines and tripwires makes overgrown minefields particularly dangerous. In some areas of Cambodia, over 70% of operational time is spent on the clearance of undergrowth–at the expense of mine clearance.

The minefields of the real world are often uneven on both macro and micro scales. Rocks of all sizes create problems for the deminer, and even small stones can make probing almost impossible. On the beaches in Kuwait–where it actually was reasonably flat–wet stony sand caused major problems for manual clearance teams. Terrain with steep slopes and large outcrops of rock, common in Afghanistan and the Falklands, simply makes the use of most vehicle-borne systems impractical. The forces of nature will invariably ensure that mines migrate to the lowest area, given time.

An example of this would be a rut or pothole just beyond the reach of a flail hammer or roller or the bottom of a hill–perhaps outside the known minefield boundary.

Water is a powerful influence in a minefield, moving mines and creating obstacles. Erosion in the Jordan Valley minefield has made systematic clearance almost impossible.

Water is, perhaps, the most significant of the natural influences, with the capability to carry mines well away from their intended locations. Erosion can undercut mines in one area and bury them deep under silt deposits in another. It can also create obstacles impassable to any mechanical clearance equipment. In the Jordan Valley, the river has cut 3-m gullies through mixed (AP and AT) minefields; some mines are left dangling over the cliff edge while others are buried under the collapsed ground. Several miles downstream, the Sea of Galilee must be patrolled daily to check for mines washed up on the beaches. Elsewhere, mine clearance

Winter in a Bosnian minefield

is made almost impossible by tidal action on the beaches of the Falklands, standing water in the rice fields of Cambodia, and snow in the minefields of Bosnia. Once again, water does not feature prominently in most equipment test sites and display areas.

Battle Areas

Not surprisingly, mines are often found in and around battlefields, where the ground has been contaminated with the scrap of war. At best, there will be large quantities of metal present: one shell can produce thousands of steel fragments, and each splinter will be large enough to dwarf the signature from a minimum-metal mine. At worst, the area may be cratered, strewn with barbed wire and guidance wires from missiles, and littered with unexploded ordnance (UXO). The failure rate among conventional munitions is generally around 10%, and can be far higher. This means that the quantity of UXO can often exceed the number of mines, as was the case among the "Rockeye" submunition strikes in the Persian Gulf, where large numbers failed to function. Most types of UXO are less hazardous than mines, but this is not always so–particularly with submunitions. Once armed, unexploded dual-purpose bomblets, such as the American M42 or the Yugoslav KB-1, are far more pressure sensitive than any AP mine.

The presence of an unexploded ordnance is a major complication, and can pose a substantial threat. Once armed, the KB-1 submunition is far more sensitive than any mine fuze.

Urban Areas

The word "minefield" strongly conveys a rural setting, yet some of the most awkward and dangerous minefields are in urban areas. In most cases, the presence of buildings, walls, fences, paths, and roads makes the use of mechanical equipment impossible, and detection techniques are hampered by the large quantities of metal present. Inside buildings, where virtually any type of booby trap may have been used, the clearance procedures are often similar to those needed in a counter-terrorist environment, such as Northern Ireland. In Afghanistan, the collapse of mud walls and subsequent re-mining have created layers of mines–sometimes to a depth of several feet.

Minefields are not always rural. Man-made obstacles prevent the use of mechanical clearance techniques, while the extensive presence of metal hampers detection.

Another important consideration is infrastructure–or rather the lack of it. Communications and repair facilities are strictly limited in most heavily mined third-world countries. We also tend to assume that road and rail networks are universally available for the movement of heavy equipment, but, in some areas, routes have become virtually impassable. Even where suitable tracks still exist, few of the bridges can cope with anything more than a domestic 4x4. Mobility, survivability, and 'sustainability' are therefore key considerations for new demining equipment.

Summary

Most of these factors would create significant problems if they were encountered in isolation, but, unfortunately, they are superimposed onto each other. The result is a complex, unpredictable tangle of mines and tripwires among man-made and natural obstacles. In the Falklands, for instance, there are steep, rocky slopes with soft grassy patches, crossed by streams and littered with wire, shrapnel, and UXO.

At this point, perhaps it is appropriate to return to the principles outlined in the introduction, assuming our primary aims are to reduce casualties and return land to the population. To attain these objectives, we seek to enhance the mine clearance component of mine action. Enhancing means making safer, faster, cheaper or a new capability–n other words finding solutions to overcome existing problems.

Obstacles are often compounded. In the Falklands high winds, water, soft ground, rocks, UXO, and shrapnel combine to hinder demining.

On close examination of the real issues, it emerges that much of the technology under development will have, at best, limited application. Sadly, some research has been so misguided that the effort was totally wasted. The detection of minimum-metal mines, seen by so many as the holy grail of demining, is only one of many problems faced by the deminer. Gradually, both the scientific and mine clearance communities are realizing that a selection of equipment and techniques are required, closely tailored to the specific threat in each minefield. Both communities are, at last, beginning to understand the need for communication–even if they still do not fully understand each other's position.

There are major practical problems to be overcome to enhance the process of demining. The number of permutations arising from the array of mines and variety of environments guarantee that there will be no universal solution. Those that say the process has remained unchanged since World War II are wrong. It has been continually modified through the revision of procedures and the incorporation of new technology, but the overall capability has not been greatly improved. The key to significant enhancement is to ensure that new techniques are well-conceived, steered through development, and applied appropriately.