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Mechanical Application in Demining: Modernising Clearance Methods

Even as mechanical mine clearance systems are increasingly employed throughout the world, the full potential of these machines remains to be seen. Further study of the issue has prompted the Geneva International Center for Humanitarian Demining (GICHD) to release the "Study of Mechanical Application in Mine Action," due in December 2003.

by Alexander Griffiths and Leonard Kaminski, *GICHD*

Introduction

The majority of humanitarian mine clearance is carried out by manual deminers and specially trained mine dog detection (MDD) teams. Machines make a contribution to the work of these two systems, creating safer conditions and greatly speeding up the overall clearance process.

In various forms, machines have been employed for mine clearance since World War I. For many years, demining machines were the preserve of the military. Until the advent of the humanitarian demining movement in the late 1980s, the development of specialist vehicles for mine clearance had been relatively limited. As humanitarian demining gathered pace, it was assumed that machines would inject a much-needed increase in clearance rates with a higher safety level. Thus far, this has occurred to a lesser extent than was expected.

Mechanical mine clearance systems are employed on an ever-widening scale and the choices of machines on the international market continue to expand. However, a belief that machines have not been applied to clear mines to their fullest potential still exists. There is little continuity of opinion among the demining community as to why this might be. The problem could be a result of accumulated experience, suggesting that current technical limitations on mechanical abilities to clear mines effectively prevent the success expected; or it could be that mechanical demining has become beset by conservative thinking in deployment solutions, preventing machines from realizing their productivity potential.

Ground Processing

One potential use for machines that has not been fully explored is the use of machines to process ground. Mechanical ground processing implies that a machine is deployed into a minefield in order to provide the main clearance method of a task, rather than merely preparing the ground for subsequent clearance systems such as manual deminers or MDDs. If particular machines can prove themselves capable of clearing a stated mine type in stated topographic and soil conditions, it may be possible to curtail back-up assets to a minimum, used only to remove the residual threat expected to be left by the machine. A reduction of back-up clearance systems behind machines would save time and money.

The employment of machines for ground processing is a possible goal for mechanical application in mine clearance, though currently not widely practiced. It is slowly being recognized within the demining community that some machines have the potential to become primary clearance assets followed by scaled-down, secondary clearance methods. Rather than using machines to support manual and MDD teams, in certain conditions with specific systems, manual and MDD teams could be used to support the machine. Using adapted commercial earthmovers such as front-end loaders, primary ground processing is already successfully practiced using the mechanical excavation method. This entails the removal of contaminated soil to a depth beyond where ordnance is expected to be found, and laying the soil out for inspection and cleansing in another area.

Numerous examples exist of machines employed in the ground-preparation role, achieving "full clearance" unintentionally. In some cases, subsequent clearance assets (manual and MDD teams) are recording that all AP blast mines are detonated or sufficiently broken-up so that the hazard is removed.

Machines are under-employed and few attempts have been made to use them as primary ground processors (except mechanical excavation). The demining community is conservative regarding machine employment. For primary ground processing with flails or tillers, a culture of "not doing it" has prevailed. Concerning flail and tiller systems, limited scientific research, but extensive empirical experience, has exposed potential technical reasons for why mines are missed or not destroyed. Better understanding of these negative effects may lead to their suppression, thus better controlling the outcome of machine work. Empirical data shows that for some systems, technical problems identified are not seriously detrimental to machine performance.

There is no solid evidence to suggest that machines are less effective or more prone to missing mines than are dogs or manual deminers. Skepticism surrounding mechanical efficacy is commonly held. Research to understand which environmental conditions are optimal for clearance by machine (terrain, soil and vegetation type, mine type) is required. Once best conditions are identified, machines could be employed with greater confidence of success.

Risk Assessment

One way to reduce the inhibiting practices induced by skepticism is by applying a methodical risk assessment system for deciding how a suspect area should be dealt with. Risk assessment is a tool used to make qualified decisions about how to optimize the use of scarce resources. Risk assessment provides the basis for determining the risk involved in certain processes and justification for the actions that have been undertaken. It can be used to assess factors of machine deployment and the roles machines fulfill. A proper risk assessment could be used to stimulate thinking into the greater use of machines based on the concept of reliability of a particular system and the probability of UXO presence in clearance tasks. Risk assessment is a combination of analysis and evaluation that may lead to a risk reduction and a reduced clearance requirement.

Currently, identified minefields are cleared with the intention of achieving 100-percent clearance. Potentially, depending on future debate, measurement and management of risk could be viewed as being determined by local tolerance and acceptance of risk. Disciplined and methodical approaches to risk assessment will strongly influence operating procedures and desired clearance outcomes in a demining task. Impact and probability of an accident should be considered. A focus on impact alone, however, may lead to clearance standards that are unduly restrictive or prohibitive (i.e., tasks take too long). The extremes of clearance requirements for a particular community could range from full clearance to only area reduction. The application of risk management theory to demining and especially wider employment of mechanical systems could result in increased safety (due to a greater number of tasks being completed), productivity and cost-effectiveness.

Machines could be well employed to provide information about a minefield prior to clearance. Rather than assuming that all suspect land requires full clearance, information gained from machines could be used to estimate the risk of mines being present. From this data, follow-up clearance can be formulated to the requirements of each situation. Follow-up can be based on information available concerning risks remaining after a machine has been deployed. This process is seldom put into practice today.

Limited research has been conducted as to the reliability of mechanical systems to clear mines. However, empirical evidence has shown that in many cases machine capabilities are high. A standardized, higher quality of clearance data for machines will aid the build-up of empirical information in order to gain a more accurate picture of mechanical system efficacy. Records regarding mechanical systems' effects on mines by type, at what depth and in what condition (if not detonated) they were found by follow-up clearance methods. A definition as to what constitutes a "broken-up" mine—no longer a hazard—needs to be established. There may be circumstances where broken-up ordnance can be left in situ as long as fuse mechanisms have been neutralized. Exposed explosive material left behind can naturally deteriorate through weathering.

Tolerable risk criteria can be established prior to clearance activities. This occurred in Kosovo where high-risk areas were identified and targeted. Suspect areas that did not represent a direct risk to communities were deemed tolerable and left for the national clearance agency to deal with at a future date.

Ground Preparation

Demining machines have already established respected credentials as ground preparation tools for manual and MDD demining methods. Three main scenarios for ground preparation exist. The removal of vegetation and tripwire threats generally involves two types of machines: non-intrusive machines, which operate from previously cleared lanes using commercial bush-cutters attached to hydraulic arms that extend to cut vegetation in uncleared areas, and intrusive machines, which include small, remote-controlled machines specially designed for vegetation cutting from within uncleared areas. This level of ground preparation brings limited benefits to manual and MDD team demining. Intrusive machines can support more deminers than non-intrusive machines, but both are highly dependent on their association with follow-up clearance and the distance between demining lanes.

Moving up the scale is the removal of vegetation and tripwire threat, plus a ground-penetrating tool to break up soil. This method often involves flail- and tiller-type tools attached to armored prime-movers that operate by remote control or are operator-driven from within uncleared areas (intrusive). This offers a marked improvement in the benefits brought to manual and MDD teams. According to tests carried out by the GICHD, the speed of manual excavation of metal signals is significantly increased. Turning over soil may allow dogs to work the ground for longer periods in theatres where winter hinders their deployment. Machines that carryout these types of ground preparation are always intrusive.

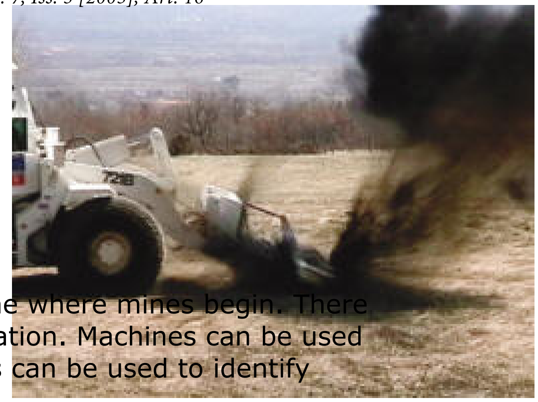
The final degree of ground preparation is the removal of vegetation and tripwire threats, breaking up of the ground, and removal of metal contamination. This will often involve machines that break up ground but with the addition of a magnet to collect metal fragments from over-turned soil. The addition of a magnet has the potential to greatly increase the speed of manual demining in areas where metal fragments hinder progress, as well as the benefits of vegetation and tripwire removal. The optimum machine is one that can defeat all common obstacles that hinder manual deminers in one pass. The ability to achieve this would generate the greatest value for follow-on clearance techniques. These obstacles can be grouped in a hierarchy (i.e., removal of metal contamination has the greatest impact on efficiency).

A mechanically prepared area in Thailand. Vegetation is cut and collected, hard soil loosened and the majority of metal contamination removed with the use of a powerful magnet. *c/o L. Kaminski*

Mechanical demining systems manufacturers should be encouraged to understand where the highest benefits are found.

Area Reduction

Area reduction could become the highest impact role for machines in mine clearance. Within large and indistinct suspect areas, it is greatly beneficial to quickly and efficiently elucidate where mines are not located as part of the survey process, and to delineate actual parameters of a minefield. This not only frees up large areas of land previously considered unusable, but also facilitates rapid deployment of other clearance assets straight into true mined areas. The greatest drag on time in mine clearance is spent clearing land where mines are subsequently not discovered. Canceling out non-mined land by machines provides a significant contribution to demining operations. Allocating this task to manual or MDD methods is vastly time consuming and, therefore, expensive.



A Pearson Area Reduction Roller operates in Abkhazia. *c/o Alexander Griffiths*

In patterned minefields, machines can be used to identify a line where mines begin. There is a high reliance on verbal and/or documented survey information. Machines can be used to confirm information. In non-patterned minefields, machines can be used to identify areas containing mines.

Locating the perimeters of actual mined areas could potentially cancel out non-mined areas where manual and MDD teams spend the majority of time clearing. Worldwide, the majority of time spent in mine clearance is wasted searching for mines. If machines are incorporated to reduce area as part of the technical survey process, significant time may be saved.

Future Guidelines: IMAS for Mechanical Application

The GICHD has neared completion of a study on the use of machines in mine clearance. The “Study of Mechanical Application in Mine Action” is due for publication in December 2003. From this will emerge drafts of mechanical Integrated Mine Action Support (IMAS). These will provide guidelines for practitioners employing machines in mine clearance, covering the main roles for mechanical systems: ground processing, area reduction and ground preparation. Design specifications for operator safety are also considered.

Other aspects currently being drafted include performance-testing standards (to include occupant/machine survivability testing and test target standards). These guidelines are being developed by the European Committee for Standardisation process (CEN workshop), which was driven by the Swedish Demining and Explosive Ordnance Disposal Centre (SWEDEC). It is planned that these standards will form part of IMAS in the near future.

Future Work

As a result of the study, the study team plans to conduct further research into areas that could significantly broaden the future employment of machines. This will include a definition, after mechanical action, of what differentiates a non-hazardous, broken-up mine, from that which still poses a threat and must be dealt with. This could also address the contention that certain mechanical systems in certain environments actually increase the danger posed to manual deminers by rendering ordnance in a more volatile state.

Machines have been underemployed. Worldwide, current clearance rates using the two most common demining methods of manual and MDD teams are too slow. Efforts should be made to achieve greater productivity. Despite some of the scientific and high-tech solutions that are currently undergoing research and development, effective machines exist today that can be exploited in order to increase the pace of freeing-up land and reducing risks to civilians.

More investigation needs to be conducted, and more empirical data needs to be collected before a better understanding of how effective machines are can be accurately stated. What does seem certain is that machines have much to contribute to demining efforts—both operationally and financially.

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