Executive summary

Introduction

The last 15 years have seen the evolution of machines used in demining. At the beginning of the 1990s, the few machines on the market tended to be large and heavy, often based on converted armoured military vehicles. There is now a much greater array of machines of varying size and armour protection to suit the different physical environments and threat levels found in mine-affected regions of the world. Certain trends have emerged, such as the development of multi-tool systems for multiple tasks, the design and manufacture of machines in mine-affected countries using indigenous materials and skills, and the adaptation of commercial earth-moving vehicles for mine clearance purposes.

A glance at the 35 machines detailed in the GICHD's *Mechanical Demining Equipment Catalogue 2004* reveals that there is no shortage of machines to choose from. But this impression belies the fact that machines in demining remain underused and the market for them is relatively small. Of those listed, very few have been sold; most specialist demining machines cost more than US$250,000, and a cost-effective return on such an outlay is not always perceived. However, *A Study of Mechanical Application in Demining* demonstrates the vast potential of machines to make demining more efficient and faster, either independently or when combined with other clearance methodologies.

Mechanical clearance

Machines are yet to be fully accepted among deminers as a tool of equal reliability to the two mainstays of clearance methodology: manual deminers and mine detection dog (MDD) teams. This results from of a lack of knowledge as to the capabilities of mechanical demining systems and misunderstanding as to their potential application. In the early days of humanitarian demining, machines acquired a reputation for adding less value than expected. They were

also blamed for a range of negative effects, such as throwing mines into safe areas, failing to detonate mines or burying them deeper, and causing mines to become more volatile for subsequent manual deminers. Although some of these allegations have been well-founded, a decade and a half of technological development has rendered many of these effects negligible or redundant. However, this statement is difficult to prove: there is not yet an internationally agreed and recognised testing and accreditation regime for demining machines, and empirical data to support the application of machines, however good in quality, is weak in quantity. Two developments would greatly enhance the understanding of mechanical application in demining: an increase in the testing of machines using an appropriate number of test targets — at least 800 for each machine tested — and closer attention to recording mechanical clearance data in live operations in order to build up empirical information.

Recent research has shown that, given suitable conditions, machines can be used as the primary clearance system. This is based on a careful examination of clearance data of machines used for ground preparation. This data showed that after the passage of machines manual deminers and MDD teams found no live items of ordnance in areas known to have previously contained them. Deminers who use mechanical systems have a good idea as to the most appropriate environments in which their machines might achieve clearance to humanitarian standards, but national demining authorities are still reluctant to accept that machines form the primary clearance method. The lack of precedents creates a lack of confidence.

An exception to the general reticence to apply machines as the primary clearance method is mechanical excavation with converted commercial earth-movers. These machines remove potentially contaminated soil down to a depth suggested by survey information. It is undisputed that areas treated in this way are free of ordnance down to the depth excavated. This technique represents the only current example of machines being employed as the primary clearance tool, but the practice is not widespread.

Risk assessment

According to the International Mine Action Standards (IMAS 09.10 — Clearance Requirements), land "*shall be accepted as 'cleared' when the demining organisation has ensured the removal and/or destruction of all mine and unexploded ordnance hazards from the specified area to the specified depth*". Once an area has been selected for clearance, it must be treated in this way regardless of the clearance method selected. However, the process for deciding on which area should be cleared and which clearance method should be used requires a rational framework. This can be achieved by using a risk assessment methodology to determine the probability of a post-clearance mine/UXO incident and the impact this might have on subsequent users of land. Machines can make a major contribution to this process by gathering information as part of technical survey. Where information about a suspect area is weak, a machine passed over the area will reveal not only the presence of ordnance but also the specific threat; this is invaluable information for any clearance plan.

Area reduction

Area reduction is a component of the technical survey process. In all clearance tasks, the great majority of efforts are conducted on ground that subsequently proves not to contain mines or UXO. Clearance data gathered by the GICHD from 15 countries suggests that of suspect areas cleared, less than three per cent actually contained mines or other ordnance (individual items of ordnance were allocated a ground coverage of one square metre). This suggests that effective area reduction is the phase of demining where the greatest increases in efficiency can be made. Thanks to their speed of operation, machines are best placed to achieve such increases. Manual survey cannot possibly cover the same area in as little time and should be used only where extremes of topography rule out the use of machines. Dogs are good at area reduction, but are far more affected by such vagaries as weather, soil conditions and vegetation. The importance of improving the speed and reliability of area reduction operations is recognised by deminers and is reflected in the research findings of the GICHD publication, *Mine Action Equipment: Study of Global Operational Needs*.

Ground preparation

Currently, most mechanical mine clearance operations are in support of manual deminers and/or MDD teams as ground preparation systems. All case studies conducted by the GICHD show a significant increase in productivity where machines are applied to assist manual or MDD methods. Tests and research have shown that increased productivity is achieved by the removal of vegetation and tripwires, the turning-over of soil and the reduction of scrap metal contamination using magnets. Machines can perform all of these functions, and much faster than any other known method. The optimal machine would be one that can perform all of these functions in one or two passes of a suspect area. Such a machine does not exist at present, but it is hoped that future research will reveal to manufacturers what is most needed.

Protection of vehicles

Many machines employed in demining are commercially available earth-movers, civilian engineering plant, or agricultural vehicles. To operate in suspected hazardous areas, operators must be protected against the expected explosive threat. Usually, the armouring of such machines is left to the respective demining body. The calculation of appropriate thicknesses, placement, welding, angles, materials and spacing of armoured plate is often military specification, information which is not available publicly. This study explains the background to the principles of armouring vehicles intended to work in suspect areas and how to assess the probable effectiveness of armour based on the threat. The information on the protection of vehicles and plant equipment against mines and UXO is designed to provide demining organisations with a check-list of practical principles, and is a starting point for those seeking information on the subject.

Cost-effectiveness

Case studies of the use of machines in demining revealed a positive effect on productivity for demining operations. However, cost-effectiveness is not automatically guaranteed in all cases and, where it is achieved, it might be improved. The Cost-Effectiveness Model (CEMOD) developed for this study provides managers with a software tool to input all costs related to the running of a machine in a mine clearance programme. A cost in US dollars per square metre can be calculated. The software can also compare machine cost-effectiveness with manual and MDD operations within the same programme. With this information, managers should be better able to use available resources to maximise cost-efficiency, allowing savings to be made that could be plied back into operations.

Summary

In sum, the GICHD believes that machines are underused in demining, in large part due to a lack of understanding by the mine clearance community of their most suitable roles and applications, and particularly of recent improvements in design. The GICHD seeks to improve comprehension of mechanical application in demining, because machines are critical to efforts to speed up the painfully slow process of clearing the world's mined areas.