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Title: Delivering Technology to the Minefield

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This presentation describes some developments undertaken at the Canadian Centre for Mine Action Technologies (CCMAT), as well as the approach taken to introduce these into service in the minefield. Our experience has shown that new technology is readily accepted by the demining community when it represents an incremental improvement over existing equipment, rather than a radical departure into "high tech". This was also the message delivered to the developers by the user community at the DTIF workshop held in Vancouver in June, 2001.

Developing and fielding equipment to meet the needs of the user involves four basic steps:

- Identify the needs of the user
- Research and development as required
- Test and evaluation in a controlled environment
- User trials and technology demonstrations in mine affected countries

The CCMAT maintains close contact with the demining community through meetings, such as the DTIF workshop in Vancouver, and through working visits to demining operations in mine affected countries. In the last three years, CCMAT staff have made working visits to Afghanistan, Bosnia, Cambodia, Colombia, Croatia, Kosovo, Mozambique and Thailand. These visits, mostly to conduct user trials and technology demonstrations, have yielded a wealth of information on how demining operations are performed in each locale.

Since most of the products described in this presentation were developed by Canadian companies, the R&D contribution from CCMAT was mostly in the form of guidance to the companies involved. The Centre's main contribution was to design, build and validate test methodologies and use these to evaluate the equipment at various stages in its development. Information obtained through test and evaluation was provided to the company who used it to refine and improve their designs. An equally important role for test and evaluation is to screen out items of equipment that don't perform well enough to warrant user trials in the minefield.

The final stage in the process leading to deployment of equipment to the minefield is a user trial that also serves to demonstrate the technology to the user. As explained in the previous paragraph, the role of controlled test and evaluation is to refine the design and screen out equipment that can't do the job in field laboratory conditions at the CCMAT. The true test comes in user trials conducted with deminers in a real minefield. However,

it is important that the CCMAT staff who participate in these trials and demonstrations are those who were involved in the development process from the beginning. The CCMAT believes that this continuity is an essential feature of the development process and one of the reasons why CCMAT has been successful in delivering technology that meets the needs of the user.

This process was illustrated with a description of five products developed by Canadian industry in collaboration with CCMAT. These are:

- The Promac brush cutter and deminer (BDM48)
- Mechanical reproduction mines (MRM)
- The binary explosive FIXOR™
- Protection for the deminer
- The Niagara Foot™

1. The Promac brush cutter and deminer (BDM48)

The main strategy at CCMAT is to modify equipment used in agriculture and forestry for application to demining. The advantage of this approach is that these machines are already engineered for their primary function, such as brush cutting, and have a demonstrated history of reliability and sustainability. The BDM48, manufactured by Promac Manufacturing Limited of Duncan, British Columbia, is used for cutting heavy brush in Canadian forests and consists of a revolving drum attached to a power excavator. As modified for demining, the BDM48 has an armored cab which protects the operator against blast and fragment attack. The power excavator allows the BDM48 to be operated from mine free ground adjacent to the minefield, another safety feature.

To evaluate mechanical assistance equipment, the CCMAT constructed a serious of test lanes on level and sloping ground with a variety of soil conditions. These test lanes were seeded with hundreds of the mechanical reproduction mines (MRM) described below. The BDM48 performed sufficiently well to warrant subsequent blast trials at the CCMAT and user trials at the Thailand Mine Action Centre (TMAC). In the Thailand trials, the BDM48 demonstrated exceptional ability as a device for clearing vegetation and tripwires to make the ground available for manual clearance; it also reduced the threat by neutralizing more than 99% of the mines in one pass. The BDM48 was effective in heavy bamboo and extremely wet conditions, normally a problem for brush cutters with less power. This technology demonstration clearly impressed the TMAC who requested that the machine remain in Thailand. With funding from Canada's Department of Foreign Affairs and International Trade (DFAIT), the BDM48 is now an integral part of demining operations in Thailand. In subsequent demining operations in Thailand, the BDM48 suffered the explosion of an RPG-2 grenade, a heavy and damaging munition. The operator was unhurt and the machine was repaired in the field with locally available tools and supplies with the loss of only a single day of operations.

2. Mechanical reproduction mines (MRM)

The mechanical reproduction mines (MRM) were developed to CCMAT specifications by Amtech Aeronautical Limited, Medicine Hat, Alberta. They replicate the most common types of anti-personnel mine in shape, size, weight, fuse principle and trigger force, but do not contain explosive. Each MRM is uniquely identified and can be remotely interrogated by means of a hand-held reader that logs location and functional state. Successful trials at the CCMAT and in Thailand validated the MRM as a tool for evaluating mechanical assistance equipment and the manufacturer has sold them to the US Army's Night Vision, Electronics and Sensors Directorate, Fort Belvoir, and to the Defence and Evaluation Research Agency (DERA), Chertsey, UK.

3. The binary explosive FIXOR™

The binary explosive FIXOR™ was developed by MREL Specialty Explosive Products Limited, Kingston, Ontario. It consists of two precursors, neither of which is classified as an explosive, which are mixed to form the explosive immediately prior to placement next to the unexploded munition or landmine. FIXOR™ is safer to transport and store than conventional explosive which is an important security consideration in mine affected countries.

A series of trials at the CCMAT confirmed that FIXOR™ is effective against a wide range of landmines and other munitions. Subsequently, a technology demonstration was arranged by the CCMAT for members of the demining community in Kosovo. FIXOR™ is now widely accepted by the demining community and is used by demining organizations such as Ordnance Disposal International (formerly RONCO) and Handicap International.

4. Protection for the deminer

The CCMAT supports the development of protective equipment by Canadian industry by providing test and evaluation services. To this end, the CCMAT has developed, independently or in collaboration with the US and Australia, a sophisticated methodology for studying the effects of mine blast on the human body:

- Protection for the lower limbs is investigated using the Mechanical Surrogate Leg (MSL). Strain gauges measure bending of the leg, indicating the possibility of bones breaking due to flailing. Accelerometers measure the shock transmitted to the leg and the chance that bones will shatter. The MSL, developed at the CCMAT, is designed to withstand blast and to be reusable.

- The Frangible Surrogate Leg (FSL) is a precise reproduction of the human leg using materials that react to blast in a manner similar to human tissue. The FSL was developed at the Defence Science and Technology Organization (DSTO) in Australia and was validated in joint trials (Canada/US/Australia) at the CCMAT. Since it is damaged in the blast, the FSL is not reusable.

Methodology for evaluating protection for the upper body employs a crash dummy of the type used by the automotive industry. Canada and the US developed a special test rig that places the dummy in the kneeling or prone positions routinely adopted by deminers when probing for mines. Flexible mounts allow the dummy to yield to the blast in a realistic manner. The full manikin test methodology has been validated in a series of trials carried out at the CCMAT and at the US Army's Night Vision, Electronics and Sensors Directorate, Fort Belvoir, Virginia.

Using the methodology described above, protective equipment developed by Canadian industry was exhaustively tested at the CCMAT. The Humanitarian Demining Ensemble (HDE), including a foot protection system (the "Spider Boot") and tool kit accessories, is manufactured by Med-Eng Systems Inc., Ottawa, Ontario. The HDE is a lightweight, modular suit that provides flexibility and balanced protection against anti-personnel blast mines. The HDE enables the deminer to work comfortably in all operational climates without need of body cooling equipment. The modular design enables deminers to configure the ensemble quickly and easily to their particular requirements. The optional foot protection system (the Spider Boot) is engineered to distance, deflect and absorb energy transmitted to the foot by blast type anti-personnel mines.

5. The Niagara Foot™

The Niagara Foot™ is an improved prosthetic foot developed and manufactured by Niagara Prosthetics and Orthotics Limited, St Catherines, Ontario with additional funding from CCMAT and the National Research Council. The Niagara Foot™ is a low cost, high performance, injection molded prosthetic foot. The design is intended to overcome the shortcomings of current commercial devices, such as poor performance on rough ground, and susceptibility to fatigue failure, and the cost is greatly reduced by the use of "high tech" materials and manufacturing methods. Fatigue testing was carried out at Queen's University, Kingston, Ontario. A successful clinical trial was carried out at the Thailand Mine Action Centre in November, 2001, as a collaboration between CCMAT and Queen's University.

For more information (with pictures of equipment under test) on the CCMAT and its program, check our web site (www.ccmat.gc.ca).