

# Research & Development

Over 120 countries from around the world have signed the Ottawa Treaty, committing themselves to work towards a “mine-free world” by 2009. However, it has been said that without significant improvements to mine action techniques and efficiency, this goal may be unattainable. For this reason, many research institutions are currently working on projects that promise to increase the efficiency, speed and safety of demining. Today, due to increased coordination between researchers and field operators, these institutions have a better understanding of field requirements and challenges.

Researchers have focused both on developing new technologies and on making improvements to the old. The following is a brief list of research areas that have either yielded advances in demining technology or show significant potential for the future.

**Improvements on the Metal Detector** || The metal detector has been one of the most widely used methods of landmine detection, and many of the early ideas for a better landmine detector consisted of improvements to the metal detector. Existing metal detectors are unable to discriminate well between different types of metal in the ground. Furthermore, a problem with existing metal detectors is that

they detect anything metal, which can slow down the work of deminers faced with soil that has been contaminated with metal debris and litter.

**Advanced Metal Detectors** ◆ The idea behind the advanced metal detector is to provide an impulse and watch how the response decays over time.

Ground that contains different types of metals will respond differently. However, the response curve depends on the orientation of the object and the exact metal type, making it difficult to interpret results reliably.

**Induction Coil Imaging Sensor** ◆ It is thought that if the deminers could see the object being detected, the problem could be alleviated. Imaging sensors create an image of the object being detected instead of producing an audio signal. The sensor can be moved around and the data displayed in multiple colors, each representing a different response amplitude. Tests show encouraging results. In its current version, it is able to detect metal parts of less than 1 cm<sup>3</sup> to a depth of 50 cm. The system cannot be used on the newer plastic mines, however, and the prototype is quite heavy.

**Electromagnetic Waves** || Ground Penetrating Radar (GPR) ◆ GPR is a system that uses pulsed radio waves to penetrate the ground and measure the distance and direction of sub-

Electronic probes help to save deminers' lives by alerting them before they dig too deep.





A deminer turns his metal detector to the highest sensitivity in order to detect low metal content mines. New metal detectors will eventually be able to detect different types of metal.

darkness. The sensors detect a difference in temperature between an object and its surroundings. Since mines buried in the ground heat up and cool down at different rates than the surrounding ground, infrared seems to be a good choice for mine detection. Infrared can be used as a mine

detector in two different ways. In one way, the infrared camera is mounted on an aircraft and flown over a field. This method is useful in laying out the boundaries of a minefield. Since the infrared method depends on a difference in temperature, the mines are invisible when the ground and mine are in equilibrium. Therefore, infrared is best used when the ground is warming up or cooling down, such as shortly before sunrise and after sunset. As a whole, infrared can be expected to produce a detection rate of 90%.

stance targets through radio waves that are reflected back to the system. The reflections from the soil are then measured, producing an image representing a vertical slice of the ground. GPR is already in use in many applications, including finding faults in bridges and helping archaeologists locate ruins. As applied to mine detection, however, it has been found to give poor results in wet ground.

**Microwaves** ♦ From the signals that bounce back when microwaves are sent into a minefield, a computer constructs images of the terrain's features, such as stones, twigs, shrapnel and concealed mines. Ambiguous results produced by plastic mines, however, indicate that this method needs more testing. Microwaves have also been used to heat the ground. This is supposed to either cause the mine to deform and prevent the mechanisms from functioning or heat the mine until it explodes. Unfortunately, a large amount of power is required for this method, and steel cased mines and buried mines would be unaffected.

**Infrared** ♦ An infrared scanner was originally developed by the military to be able to see their enemies, even when camouflaged or in

**Biological Indicators || Rats** ♦ Unlike dogs, rats are inexpensive to breed, feed, house and computer train. Researchers are working to train Mr. Bean, a giant African pouched rat, to detect landmines in Tanzania. These types of rats are easy to train and have a dog-like sense of smell. The Belgian government provides funding for the research, hoping to find a less expensive, but still effective, mine detector than those used currently. Rats are too small and light to set off mines, making them ideal as mine detectors. Currently, their most difficult obstacle as nocturnal animals is overcoming heatstroke.

Giant African pouched rats are now being trained to detect mines much like dogs.



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**Ferrets** ♦ Another animal that could possibly be used as a landmine detector is a ferret. Ferrets are light and therefore would not be able to set off the landmine (a problem with using dogs), and because of their small size, more could be sent into a mined country. Additionally, ferrets have a good sense of smell, are able to be trained and, because of their domesticity, are incapable of creating feral populations<sup>[12]</sup>. Ferrets have not yet been tested as landmine detectors, but a project is underway at Messiah College in Grantham, Pennsylvania.

**Fruit Flies and Bees** ♦ Deminers have also tried genetically engineered fruit flies and bees. The altered insects mistake the explosive vapors for pheromones, and once they are let out on the field, cluster around a mine.

**Microbial Detection** ♦ Some organisms feed on certain elements of explosive chemicals, using sensors to identify concentrations of these

U.S. soldiers attach a flail to a tank during Desert Storm.



organisms could help determine landmine location.

**Mechanical Means || Flail** ♦ Rotary flail devices are typically composed of cylindrical drum structures housing a collection of chains on a horizontal bar that spins beating the ground ahead of tanks to detonate anti-tank mines.

**Robots** ♦ Robots in landmine detection range from kamikaze, the kind that roll around a field and blow up all the mines, to more sophisticated ones that may someday take the place of human deminers. The latter type of robots have probes, which, like the mechanical method of mine detection, are spring-loaded and will retract if they hit an object harder than ground. The use of these robots is safe for the deminer, and often quicker. A robot with several probes can simulate several deminers walking side by side. However, if the robot is blown up, it is expensive to repair or replace.

**Electronic Nose** ♦ In an attempt to solve the problems associated with dogs, efforts have been made to duplicate their noses. An exact replica has not been developed yet, but several notable examples do exist. The closest method to actual animal olfaction is an array of sensors to which different airborne molecules attach in different places on the sensor. Detection is based on unique patterns of responses generated by the sensor array in the presence of an odor.

**Acoustic Technology ||** Acoustical scientists are developing new methods of detecting landmines, two of which were presented at a

meeting of the Acoustical Society of America that took place in early June of this year. The first method, developed by a research team from Georgia Tech, releases small seismic waves into the ground and measures the subsequent vibrations. The waves are not large enough to set off the mines, but they have been able to allow researchers to distinguish mines from other objects, such as rocks and sticks, in lab tests.

Another acoustical detection method has been developed by a team from the University of Mississippi. This technique uses broadcast sound to produce measurable vibrations that can pinpoint concealed landmines with a laser sensor. In a difficult Army field test last year, the system was able to locate a record 95 percent of the buried mines. The team is now honing the system to make it capable of recognizing different types of landmines.



Honey bees are used to seek out mines because they mistake the explosive vapors for pheromones and cluster around mines.

## Are Smart Mines Smart Enough?

by Huntington Associates

The devastating effects of landmines stem from their inability to discriminate between soldiers and civilians and from the fact that they remain active long after hostilities cease. An important distinction in the debate over landmines is therefore the difference between “smart” mines, which can be programmed to self-destruct or switch off three hours to 15 days after they are placed, and “dumb” mines, which can remain active for years after placement.

The United States and some other nations producing “smart” mines argue that because these mines are self-destructing and self-deactivating, they present little danger to civilians and need not be included in a mine ban. However, others question whether these mines are safe enough. Despite impressive performance rates in testing, actual battlefield conditions may cause “smart” mines to remain active long after they should have self-neutralized. The Russian Butterfly Mine, designed to be “smart” and used extensively in Afghanistan, failed to work. During the Gulf War, the United States experienced malfunctions with a few of its “smart” Gator Mines, possibly due to incorrect deployment. Another concern is that people cannot tell whether some “smart” mines are still active or not. As a result, they may prevent civilians from using a mined area and may have to be cleared as if they were active mines, even though they are not.

These problems are currently being solved by improved technology. Mines have already been developed that expel their batteries like a jack-in-the-box when they deactivate. One Italian-made mine ejects its battery pack and detonator to show quite unambiguously that it is safe. Others break in two, making it clear that they are harmless. Technological advances are also improving the reliability of self-destruction and deactivation mechanisms in battle conditions. Current negotiations in the CCW are moving to increase the reliability of “smart” mines from 90% to 95%. Finally, research in sensor technology promises to result in even smarter innovative systems that may take the place of current “smart” mines during the next decade.

A final question concerning the use of smart mines is that of expense. Some “smart” mines cost approximately \$300 apiece. “Dumb” mines can cost as little as \$3 and can be improvised for far less. Some have argued that a ban, which applies only to “dumb” mines, would deprive poor countries of the military benefits of mines while allowing wealthy countries to continue using them. Therefore, while “smart” mines clearly present less of a humanitarian threat, some consider that these financial considerations necessitate a ban on all types of mines.

One alternative suggestion for leveling the playing field is that industrial countries agree to share their technology and perhaps subsidize the supply of “smart” mines or self-neutralizing components to developing countries. The United States is playing a lead role here, openly sharing its “smart” capabilities with the Russians and other interested nations. Once technology is shared and private manufactures are involved, the cost of “smart” mines will come down. One hope is to eventually bring them into the price range of “dumb” mines so that non-state actors might use them as alternatives.