The Role of Technology in Peace Operations 14

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INTRODUCTION

The variety of possible military operations can be viewed as a continuum. One end of the continuum may be described as peace, characterized by diplomacy, humanitarian assistance, disaster relief, and generally nonviolent forms of military activity. The other end is war. In the middle region between these two antipodes are several categories of limited military operations that are less than war but that require military activity to support or enforce peace.

All points on the continuum are influenced by the quality and availability of information. As a general rule, the “peace” end of the continuum tends to be information-rich, with much shared knowledge regarding the parties’ interests, assets, and capabilities. The “war” end of the range tends to be information-poor, requiring extraordinary measures to collect intelligence. It may be inferred that abundant, shared information tends to increase understanding and reduce the level of violence at which disagreements are resolved.

Toward the center of this continuum are military operations falling between war and peace. In peacekeeping, a truce or treaty may be in effect, and the former combatants may agree to permit activities (perhaps conducted by a third party) to reduce suspicions and build confidence. In peace enforcement, one or more of the combatants do not agree to cease hostilities, and a third party endeavors to prevent the warring parties from continuing their violence. Peacekeeping and peace enforcement may differ significantly in the weapons and military systems employed and in the lethality of their operations. Of the two, peace enforcement presents the most difficulties, both from a policy and a military perspective.

POLICY FRAMEWORK

Overcoming the policy difficulties is as important to a successful outcome as surmounting the military challenges. It is essential that the intervening party or coalition agree on objectives that are realistic with respect to the risks and costs they are willing to accept. All participants should understand and endorse the defined objectives of the operation.

Once those objectives have been established, it will also be necessary to negotiate rules of engagement that will free the military command from micro-management by political representatives. In conformity with those rules of engagement, a unitary command structure should prosecute the objectives in the most expeditious manner possible. Unnecessary levels of bureaucracy in the command structure should be eliminated, following principles similar to the quality management techniques used by industry.

The exercise of establishing objectives, if done properly, may reveal significant problems in both policy and military feasibility. A policy of neutrality may become untenable if significant military loses are incurred. Countermeasures against peace enforcers may be so facile and so potent that effectual peace enforcement becomes unfeasible. Military services treat peace enforcement missions as a form of combat, and combat invariably produces unforeseen problems and losses.

Nevertheless, peace enforcement may, in some cases, be the least undesirable option for an obdurate military/political disagreement that will not yield to diplomacy. For those cases, it is increasingly clear that information technology can be an important tool providing a crucial advantage to the peace enforcers. An information advantage translates into a military advantage in conflicts that tend toward the "war" half of the spectrum and can be decisive if skillfully exploited.

SENSOR SYSTEMS FOR PEACEKEEPING AND PEACE ENFORCEMENT

Data collected through sensor and surveillance systems can help increase the confidence of the parties to an agreement or it can provide operational intelligence for preventing violence. Sensor systems for peacekeeping should enhance confidence that parties to an agreement, such as a truce, are not violating the terms of the agreement. Such confidence reduces speculation and unfounded suspicions and helps stabilize the peace. Tensions are reduced when potential adversaries have adequate information about each other's movements and intentions. Open Skies, satellite reconnaissance, seismic monitoring stations, and cooperative inspection are examples of information-gathering systems that build confidence.

A cooperative monitoring center should continuously collect data relevant to the terms of the truce. Data can be collected by various sensor systems in space, on aircraft, or on the ground. The data should be summarized and displayed in near-real-time to all parties. Open knowledge of potential adversaries' movements, capabilities, and intentions is a key element of successful crisis prevention.

Sensor systems for peace enforcement must be integrated with battle management systems appropriate for the situation. Space and airborne imaging systems, including the new day/night, all-weather synthetic aperture radar systems under development, are valuable for monitoring surface activity. During military operations, detecting and identifying mobile or relocatable assets could be assisted by small, smart, unattended ground sensors and longer-range sensors using technology already available. Long-range, high-resolution imaging radar with automatic target recognition capability could detect mobile targets as well as stationary targets in bad weather, in daylight or at night. Unmanned aerial vehicles and tele-robotic ground vehicles could roam the battlefield and monitor the situation without exposing peacekeepers to hostile action.

Sensors can support both cooperative and noncooperative measures to detect weapon deployments and movements. But the capability to exercise a quick response to an artillery or missile attack by a combatant will require rapid integration with battle systems. It will be necessary to develop standoff methods for precision strike, offering high lethality and low collateral damage. Some prototype hardware and test experience exist.

While many such sensor and strike capabilities are either in hand or on the technical horizon, a daunting problem that will require a major research effort is the conversion of sensor data into useful knowledge. A sizable sensor system will create an ocean of data. The problem is how to distill that ocean into the droplets of vital information that provide real-time, exquisite awareness of the dynamic situation under surveillance.

This distillation will require the extraction of knowledge from the high-bandwidth, high-volume data stream. Data prioritization will be accomplished using pattern recognition principles (to extract features of interest from the data stream) and model-based data fusion techniques. Features identified in the sensor data stream will be compared with feature data stored on the sensor platform, resulting in a prioritized cueing list for the human observer. Data from multiple sensor systems will be fused at the feature level as opposed to the image level. This prioritization and subsequent data rate reduction will result in more efficient use of communications bandwidth and reduce operator overload. Once transmitted back to the observation point, the merged knowledge extracted at the sensor platform can be combined with situation awareness data and contextual information from multiple sources in a human systems interface. The purpose of the human systems interface is to efficiently present data to the observer in a prioritized manner that maximizes human effectiveness.

While sensor data fusion has been demonstrated in discrete and comparatively small applications, the ability to extract knowledge from a system of systems in real-time has not been demonstrated. The ability to demonstrate this will require advances in automatic target recognition systems, including high-performance embedded processors and advanced algorithmic approaches such as neural networks and model-based vision. This technology must be combined into a system that properly cues and synthesizes the represented features into a form that provides knowledge to the observer instead of merged raw data. This task is technically challenging but builds on strengths and technologies currently under development at Sandia National Laboratories and elsewhere in the technical community.

LESS-THAN-LETHAL WEAPONS

Novel, less-than-lethal weapons are beginning to provide new options for peace enforcement operations. Such weapons include foams and sprays, entanglements, electromagnetics, and other applications. They may be effective in stopping civil offenders without killing them, controlling violent crowds or prisoners, gently stopping fleeing cars, and improving response options in hostage situations. Sub-lethal kinetic projectiles include such items as foam rubber bullets, “doughnuts,” bean bags, and soft plastic pellets. Entanglements such as nets and adhesive snares can be lobbed over individuals or groups. Sticky foam can be shot against individuals at a distance of about ten meters and can be very effective in frustrating an attacker.

Novel, non-lethal weapons might also provide ingenious ways for denying use of military hardware. It may be possible to impound military equipment with chemical locks that are reversible only with a unique chemical key. A hardening foam containing a unique organic molecule could be used to temporarily render equipment inoperative. A special solvent containing a complementary catalytic molecule would be the unique key. Chemical tags and markers could be designed in a similar way.

If a combatant uses military hardware in defiance of a cease-fire, credible warheads and delivery systems for novel, anti-hardware weapons could make peace enforcers’ response options more palatable. Trucks, tanks, artillery, and aircraft could be incapacitated by powerful adhesives. Optics could be permanently disabled with indelible coatings. Frictionless powders could render roads and airstrips unusable. Rubber-eating chemicals could destroy tires, insulation, and hoses. Air-intakes on engines and electronics are vulnerable to invasive particles that can gum-up mechanical systems or short-out electrical wiring. Even common nontoxic substances such as gum resins and sugars can incapacitate equipment if properly applied. If violators could be located quickly using counter-battery radars or fire-burst detectors, and if such novel warheads could be delivered in rapid, precise counterstrikes (for example, with laser-guided rockets), the authority of peace enforcers would be dramatically improved.

Anti-personnel applications of benign, nonlethal weapons would seek to temporarily frustrate combatants' personal combat capacities. A charge of sticky foam shot in a small, soft projectile could render an infantryman incapable of using small arms (or his own arms) until the foam is laboriously removed. Frictionless powders could make soldiers unable to walk, run, stand, or manipulate equipment. Repugnant malodorous paints delivered in sprays (skunk shots) could inhibit military teamwork and effective command. Nontoxic aqueous foams could be used to befuddle combatants' senses and effectiveness. The ordnance and fuzing of such novel projectiles will be a design and development challenge for the near future.

Finally, it will be desirable to develop solvents, antidotes, and disposal techniques for those substances that would pose a continuing threat to civilians after hostilities are over.

MINE CLEARANCE

Detecting and safely removing abandoned anti-personnel mines is a major problem in peacekeeping and post-conflict situations. In several countries, hundreds of civilians continue to be killed or maimed by mines years after hostilities have ended. Abandoned minefields also have a severe economic impact due to lost farmland, roads, and injured livestock.

In a current program involving the United States Army, Sandia National Laboratories, and the University of Florida, the capability of imaging buried mines using backscattered x-rays even with surface clutter has been demonstrated.[1] This detection method could be adapted to civilian de-mining using off-the-shelf technology. Another current project being developed by EG&G employs ground-penetrating radar and metal detectors.[2] This project has demonstrated sensor performance, sensor data fusion, and real-time processing for countermine and combat support applications. These concepts are modular and could be expandable to larger platforms. Lockheed Martin[3] and Lawrence Livermore National Laboratories[4] are doing research on the use of infrared sensors for mine detection.

Shock waves propagating downward from a fuel-air blast can detonate some mines within the radius of the blast. For obvious reasons, this technique is suitable only for wartime conditions. In civilian de-mining, environmental and property considerations necessitate that mines be removed by hand and detonated in a remote area. Remote detonation also removes the possibility of contaminating an area with debris that would make additional mine detection more difficult. Pulsed or continuous water jets could be used to

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[1] J.G. Campbell and A.M. Jacobs, *Detection of Buried Land Mines by Compton Backscatter Imaging*, Nuclear Science and Engineering, 110, 417424 (1992); C.M. Burchanowski, R.B. Moler, and S.L. Shope, *Scanned Beam X-ray Source Technology for Photon Backscatter Imaging Technique of Mine Detection: Advanced Technology Research*, Proceedings of SPIE International Symposium on Aerospace/ Defense and Control Dual-Use Photonics, Orlando, Florida, April 1995 (to be published); and J.Wehlburg, S. Keshavmurthy, Y. Watanabe, E. Dugan, and A. Jacobs, *Image Restoration Using Compton Backscatter Imaging for the Detection of Buried Landmines, ibid.*

[2] Phil Johnson, EG&G MSI, Albuquerque Operations, Albuquerque, New Mexico (private communication).

[3] P. Ngan, S. A. Garcia, E.L. Cloud, H.A. Duvoisin III, D.T. Long, and J.K. Hackett, *Development of Automatic Target Recognition for Infrared Sensor-based Close-range Land Mine Detector*, SPIE Proceedings, *op.cit.*

[4] N. Del Grande, *Sensor Fusion Methodology for Remote Detection of Buried Land Mines*, in Proceedings of the 3rd National Symposium on Sensor Fusion (Infrared Information Analysis Center. ERIM August 1990). vol. 1. p. 407.

cut a mine into pieces, rendering it safe.[5] Techniques with potential for nondestructively demining large tracts of land in reasonable periods of time exist, but they will require considerable research and development before this problem is solved.

CONCLUSION

New technologies are rapidly emerging that can help manage or enforce peace and inhibit the deterioration of crises into war. The key to employing these technologies effectively is advanced information technology based on sensor systems, networks, and new software and hardware.

A variety of novel, less-than-lethal weapons can be developed and deployed to provide peacekeepers and peace enforcers with the means to precisely deny the use of war fighting equipment to combatants. This can be accomplished with a minimum of casualties to both aggressors and noncombatants.

An implementation challenge will be training troops to use these new systems in a peacekeeping mode. Peacekeeping operations are a cultural challenge to traditional military operations and thinking. Simulated environments for training may be useful in helping military personnel acquire new operational skills and techniques appropriate for peacekeeping.

Information technology supports the entire peace/war continuum: In peacetime it serves as a mechanism to minimize fear and mistrust; during war it provides an significant military advantage. For those new-world-order situations that fall between peace and war, information technology can be the crucial factor that makes engagement possible at acceptable levels of risk.

[5] Christopher Cherry, Sandia National Laboratories (private communication).