LANDMINE WARFARE AND THE MARINE CORPS' WARFIGHTING CONCEPT FOR THE 21ST CENTURY

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EXECUTIVE SUMMARY

Title. Landmine warfare and the Marine Corps' warfighting concept for the 21st century

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Thesis. The Marine Corps should integrate a new high-tech generation of landmine alternatives into its future warfighting concepts while ensuring adherence with the basic tenets of the Ottawa treaty.

Discussion. The rapid evolution of landmine warfare over the last decade is the primary reason why the Department of Defense is searching for alternatives to the current inventory of landmines. One dimension of this evolutionary change is the speed at which the modern battlefield has transformed. The second dimension of the evolution in landmine warfare is the metamorphosis of its fundamental tenets. In an effort to address these changes in landmine warfare, the Department of Defense is seeking to develop politically acceptable munitions that will replace the landmine on the modern battlefield while enhancing its basic advantages.

The evolution in landmine warfare was caused and sustained by three events. First, the demise of the Soviet Union and decline in the possibility of the classic massed armor and mechanized battle changed the form of the threat that U.S. landmine doctrine traditionally sought to counter. Second, the rapid rate of technological advancement made a wide range of landmine alternatives available. Third, the global effort to ban anti-personnel landmines provided the political will to develop landmine alternatives and reassess U.S. landmine doctrine. The combination of all three above factors made the rapid evolutionary changes in landmine warfare possible.

Marine Corps' future warfighting concept assumes that the nature of war will continue to change and will be dominated by war in the littorals. Current and future trends of landmine warfare evolution and munitions development are examined within this context. Such an examination should validate current trends and provide other characteristics that will increase the utility of landmine alternatives to the future Marine Corps. This is best done by examining the four areas of Operational Maneuver from the Sea that landmines will have the greatest impact: ship to objective maneuver, anti-armor operations, military operations in urban terrain and military operations other than war.

Conclusion. The Department of Defense is seeking to retain the relevancy of landmines on the modern battlefield while simultaneously addressing political pressure to transform landmine warfare. The application of emerging technologies to the problem of creating alternatives to traditional anti-personnel landmines has resulted in munitions systems with promising application in future military operations. Specifically, the development of man-in-the-loop systems and increased application of non-lethal technology to landmines should continue. An examination of the utility of landmine alternatives based on current developmental trends against the Marine Corps future warfighting concepts reveals additional criteria that alternative landmine development should include. Although, recent trends in landmine alternative development are promising, these new weapons systems must meet additional criteria derived from the Marine Corps future warfighting concepts or risk losing relevancy for the Marine Corps.

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Introduction

The rapid evolution of landmine warfare over the last decade is the primary reason why the Department of Defense is searching for alternatives to the current inventory of landmines. One dimension of this evolutionary change is the speed at which the modern battlefield has transformed. The second dimension of the evolution in landmine warfare is the metamorphosis of its fundamental tenets. In an effort to address these changes in landmine warfare, the Department of Defense is seeking to develop politically acceptable munitions that will replace the landmine on the modern battlefield while enhancing its basic advantages. The Marine Corps should integrate a new high-tech generation of landmine alternatives while ensuring that their use is compatible with the basic tenets of the Ottawa treaty. Although, recent trends in landmine alternative development are promising, these new weapons systems must meet additional criteria derived from the Marine Corps future warfighting concepts or risk losing relevancy for the Marine Corps.

Background

The evolution in landmine warfare was caused and sustained by three events. First, the demise of the Soviet Union and decline in the possibility of the classic massed armor and mechanized force battle changed the form of the threat that U.S. landmine doctrine traditionally sought to counter. Second, the rapid rate of technological advancement made a wide range of landmine alternatives available. Third, the global effort to ban anti-personnel landmines provided the political will to develop landmine alternatives and reassess U.S. landmine doctrine.[1] The combination of all three above factors made the rapid evolutionary changes in landmine warfare possible.

A basic assumption must be made to access the impact of future landmine munitions on the Marine Corps' future warfighting concepts. Marine Corps' future warfighting concepts assume that the nature of war will continue to change and will be dominated by war in the littorals. Assuming this is correct, it is within this framework that trends of landmine development are examined. Such an examination should validate current trends and provide other characteristics that will increase the utility of landmine alternatives to the future Marine Corps.

Political

The Ottawa treaty advocating a total ban of anti-personnel landmines (APLs) embodies the political sentiments of a large portion of the domestic and international community.[2] The basic arguments against APLs within the treaty are that they are "excessively injurious and have indiscriminate effects."[3] Additional nested arguments include the continued effects of uncleared landmines after conflict termination, the detectability of fragments, and the indiscriminate use of APLs. Although the U.S. was not a signatory of the Ottawa treaty, it pledged to continue progress towards meeting all its provisions. The previous administration stated that it would sign the Ottawa treaty if successful in finding suitable alternatives for its APL and mixed anti-tank systems.[4]

The Ottawa treaty does not dispute the utility of anti-personnel landmines. The treaty authors and participants acknowledged the findings of The International Committee of the Red Cross (ICRC) in its *Report of Experts Meeting, Military Utility of Landmines*, which states that APLs are the most "effective means of achieving the objectives for which they are used, that alternative systems would require greater resources, and armed forces would likely suffer greater

losses during a conflict."[5] A study conducted by the Institute for Defense Analysis in the United States confirms the findings of the ICRC by stating that it would take a 30 percent increase in the number of 155mm artillery or a 200 percent increase in the number of multiple launch rocket systems to match the effect of mixed landmine systems.[6] Regardless of their continued utility, even the responsible use of anti-personnel landmines by modern militaries was opposed under the Ottawa treaty based on ethical arguments and attempts stigmatize the weapon.

Unable to match the battlefield utility of landmines with conventional weapons and unwilling to challenge the intransigence of the worldwide movement to ban anti-personnel landmines, the United States began a renewed search for a politically acceptable landmine. The political imperative of the anti-personnel landmine issue has energized the landmine warfare in two distinct ways. Rather than undergoing a traditional Military Technological Revolution (MTR), landmine warfare is undergoing a political technical evolution. In a MTR, "emerging technologies are applied to military systems, whose uses are optimized via custom-tailored operational concepts and force structures, resulting in vast increase in military effectiveness."[7] In a political technical revolution, operational concepts are superseded by political requirements and the ultimate result may or may not increase military effectiveness. Therefore it is essential to examine current trends in landmine alternative development against the Marine Corps future warfighting concepts. Failure to do so may result in the development of meaningless defense systems that fulfill a political role but fail to find applicability on the future battlefield.

The second way in which the political imperative has driven the development of landmines is in the fiscal arena. The United States has invested approximately $900 million into APL alternative investigations since 1997.[8] Some argue, like Major General Jarvis D. Lynch Jr. USMC (Ret), that this is a misplaced allocation of resources and a "the waste of more taxpayer

money."[9] However these expenditures have accelerated landmine development far beyond previous boundaries and have maintained an elevated forward momentum. It is reasonable to assume that given the current level of media attention and continuing discussion over landmine issue as well as the fact that U.S. "dumb" landmines still guard the DMZ in Korea, that the political will to create a landmine alternative will remain strong for the foreseeable future.

War in the Littorals

According to the *Marine Corps Warfighting Concepts for the 21st Century*, without a peer competitor, the United States will face a myriad of threats emanating primarily from the littorals where three-quarters of the world's population lives, 80 percent of the world's capitals are located, "and nearly all of the marketplaces for international trade" reside.[10] Threats in the littoral region will range from "non-state actors wield[ing] considerable destructive power" to an enemy "who is likely to combine the destructive capability of a conventional force with the elusiveness of a guerilla."[11] The primary enemy threat will not consist of concentrated armor and mechanized forces but rather smaller more dispersed individuals, vehicles and units that will use the littoral and urban terrain to their advantage.[12] In the environment of the littorals where 75 percent of the world's population will be crowded into mega-cities, large lethal only minefields will have little utility and be a significant political liability.

The Marine Corps bases its vision of future warfare on historical precedent as well as observations of the demographic shift of the world's population. Recent historical examples of fighting in built up areas such as the battles in Stalingrad, Hue City, Beruit, Grenada, Somolia, Grozny, and Jenin demonstrate that fighting in urban areas cannot always be avoided and in fact takes place with some regularity. In the future, critical enemy systems and leadership will be

located within urban areas partly to offset U.S. air superiority but also to increase and maintain control of enemy populations. Tactical operations in urban terrain will surgically seek to create specific effects while limiting collateral damage. Decisive battle in urban terrain under such a concept is not necessary. As the strategic significance of urban areas grows, the necessity for the Marine Corps to develop weapons systems to include landmines that function in accordance with its future warfighting concepts increases.[13]

Emergence of New Technology

Michael O'Hanlon, author of Technological Change and the Future of Warfare, states that the three primary areas of technological advancement in the military are in the areas of sensors, computers and communications.[14] In an attempt to comply with the Ottawa treaty, the Department of Defense has sought to include improvements in all three of these areas in landmine alternative development. The two central arguments from the Ottawa treaty that the application of new technology must overcome are the issue of landmine persistence on the battlefield and the indiscriminate killing caused by victim initiated anti-personnel landmines. A solution to the persistence of landmines on the battlefield is available in the form of self-destructing landmines. According to Allied Techsystems, the manufacturer of scatterable mines for the United States, the self-destruct mechanism provides a 99.99996 percent reliability rate, which is lower than the standard dud rate for artillery or bombs.[15] Even though such technology successfully addresses the issue of persistence, during the act of self-destruction these munitions may still have unintended lethal effects. Therefore the migration of this self-destruct capability to a non-lethal self-neutralization is necessary. Otherwise, the issue of mine persistence can be

addressed by the application of self-destruct/self neutralization technology throughout the entire inventory of landmine munitions in the future.

SYSTEM*	BASIS OF FIELDING	APPROXIMATE QUANT OF MINES
VOLCANO (Employed via Helicopter or via ground vehicles)	2 SYS/ENGR COMPANY 3 SYS/SELECTED ASSLT HELO CO (ONE CO PER DIV/CORPS/ACR)	135,800 CANISTERS 1 AP, 5 AT EACH
MOPMS (Modular Packed Mine System)	CLASS V ITEM	2,300 SYSTEMS OF AP, 17 AT EACH
ADAM (Area Denial Artillery Munitions)	BASIC LOAD, ALL 155mm BNS	167,400 ROUNDS OF AP PER ROUND
FLIPPER	HELD IN WAR RESERVE	76,000 MINES
PURSUIT DETERRENT MUNITION (PDM)	CLASS V ITEM	16,154 MINES
*Note: The GATOR aircraft-delivered system via Navy and Air Force platfor supports Army operations. There are approximately 14,100 systems that dispense a mix of AP and AT mines. The Air Force has approx 10,800 system of 22 AP and 72 AT per system. The Navy has approximately 3,300 systems o 15 AP and 45 AT per system.		

Table 1-1 Army Mine Delivery Systems w/ Self-Destructing Anti-Personnel Landmines from "An Evaluation of US Policy on Anti-Personnel Landmines."[16]

Although demonstrated technology can overcome the question of persistence, the issue of the indiscriminate killing of non-combatants by victim-initiated mines, will not be solved solely by the application of technology. The Department of Defense has sought to develop landmine systems that can discriminate between combatants and non-combatants yet retain their lethality when appropriate. Lethal anti-personnel landmine alternatives will include the capability to provide real-time surveillance, deliver precision firepower while minimizing collateral damage and include a command and control system that includes a man-in-the-loop.[17] This technology is currently available and incorporated into the U.S. Army's countermobility remote-control system (CIRCE). CIRCE is a one man-in-the-loop system, teleoperated via "fiber-optic monitors that relay information back to the controller. It allows the operator to decide whether to initiate individual mines based on a video image."[18] Although currently an anti-tank system, it could be modified for the antipersonnel role. CIRCE is based on the concept of maintaining a human operator within the munitions initiation cycle. Similar in concept to a command-detonated mine; such as the claymore which is permitted under the Ottawa treaty, maintaining a man-in-the-loop

increases the political acceptability of landmine alternatives. Additional alternatives examined by the Department of Defense include area denial weapons such as sensors linked to unmanned aerial vehicles equipped with scatterable munitions reserving the decision to fire by an operator. In general the trend of U.S. landmine alternatives consists of weapons systems that include a minimum of three components: a sensor, a command and control system with a man-in-the-loop, and the munitions.

Advancing sensor, computer and communications technology will be increasingly incorporated into landmine alternatives. Improving sensor technology such as systems that utilize infrared (IR), ultraviolet (UV) light and other types of electromagnetic radiation as well as laser sensors that actively search for any reflections may also be combined with man-in-the-loop landmine alternatives.[19] Span of control for the man-in-the loop will be addressed by the incorporation of computers to compress, filter, and configure raw sensor information into processed information. Only key results will be relayed to the human controller, allowing him to make timely decisions about munitions initiation.[20] Finally, development in communications technology will allow for greater operator standoff as well as a clearer shared operational picture of man-in-the-loop mine systems. Application of satellites, laser communication, digital radio and fiber optics will allow constant monitoring of future minefields beyond simply line of sight and through different mediums from concrete to soil while miniature identification friend-or-foe (IFF) devices allow friendly forces to safely pass through friendly minefields.[21]

Other technologies are aimed at alleviating the need for anti-personnel landmines in protecting anti-tank mines and thus comply with the Ottawa treaty that does not ban anti-tank mines. Such systems include a “self healing” anti-tank system that the US Defense Advance Research Projects Agency is expending $13 million to develop.[22] Such alternatives do not

address the change in threat in which enemy personnel with access to unprecedented firepower will be the primary concern. It also does not address the continuing political movement for a ban on all mines (anti-tank and anti-personnel). Lethal alternatives that do not incorporate man-in-the-loop systems do not address the basic argument against indiscriminate killing. Civilian casualties caused by man-in-the-loop systems can be attributable to an operator who makes a conscious decision to initiate the landmine. At its very root, the decision to develop man-in-the-loop systems is part of a larger ethical argument about allowing machines and computers to make life and death decisions.

Non-lethal munitions make up the second major sub-division of the anti-personnel landmine alternative discussion. Tunable munitions, which incorporate non-lethal technology but may be "placed in a lethal mode when there is a man in the loop" are also included in this section.[23] Examples of non-lethal anti-personnel landmines that have recently been demonstrated include soft-projectile kinetic munitions (non-lethal Claymore mine), various nets that either interfere with mobility or deliver an incapacitating shock, taser mines, sticky foam mines, and the Texas boot mine that latches onto the enemy's foot and immobilizes him.[24] Although non-lethal APLs will fulfill many of the basic requirements that lethal APLs currently fulfill, they will not act as the psychological deterrent that lethal APLs do today.[25]

Operational Maneuver from the Sea (OMFTS)

As the cornerstone underlying the Marine Corps warfighting concepts for the 21st century, OMFTS is based on several assumptions and predictions. It portends an "unprecedented emphasis on littoral areas, requiring more intimate cooperation between forces afloat and forces ashore and introduces the concept of naval expeditionary force."[26] OMFTS contains a concept

for future naval mine countermeasures in littoral power projection yet falls short of including landmine countermeasures or offensive mine warfare in a seamless area of operations that transcends from deep water through to the objective. The next logical step in the development of the OMFTS is to add a sub-concept of landmine warfare and identify what capabilities future landmine alternatives should have to support the Marine Corps vision. This is best done by examining the four areas of OMFTS that landmines will have the greatest impact: ship to objective maneuver, anti-armor operations, military operations in urban terrain and military operations other than war.

Ship to Objective Maneuver

One of the key sub-concepts of OMFTS, Ship to Objective Maneuver (STOM) envisions the naval expeditionary force having the ability to project forces and firepower to the objective with minimal command and control, and sustainment forces ashore. Landmine alternatives based on the current trends of development will augment the expeditionary force commander's ability to shape and control the land portion of the battlefield from the sea. By adapting artillery delivered mixed systems to new ship-board fire support systems such as the next generation of naval guns (the 5"/62 gun on DD-21) and vertical launch systems, the expeditionary force commander will be able to deliver landmines to approximately 50 miles and further inland from over the horizon. Expansion of current man-in-the-loop landmine alternative systems by applying emerging communications and computer technology will allow control of the minefields from ship board command centers. Technology enabling the operator of such systems with a greater span of control is a critical component in making sea-borne control of minefields possible. However the promise of continued advancement in increasing connectivity and awareness over distances is good given that common picture command and control and

intelligence system such as the US Army's All Source Analysis System (ASAS) currently exist and are already being linked to lethal delivery systems.[27] Close control and monitoring of landmine munitions inherent in these new systems will lessen the possibility of civilian casualties and make landmine alternatives acceptable under the current provisions of the Ottawa treaty.

Use of sea-based landmine alternative systems will impart certain advantages to the expeditionary force commander. Area denial or the denial of key avenues of approach will no longer require the suppression of enemy air defenses or the application of limited air assets to execute such missions from the sea. Expeditionary forces ashore can be protected from possible enemy counter-attacks by sea-projected minefields without detracting from their primary mission on the objective. With landmines providing the force with these new capabilities, air assets can concentrate on facilitating the actual ship to objective maneuver of the assault forces. The use of sea-projected landmines in conjunction with STOM is consistent with the Marine Corps' vision of future warfare, which states, "Seabased weapons, operating from over the horizon or inshore as the situation permits, will shape the battlefield and provide protection to the landing force during ship to objective maneuver."[28] Additionally, landmine alternatives offer a certain level of persistence as previously determined by the commander; thus providing for further economy of force over a longer period of time. Also, the employment of landmine alternatives in such a manner allows for the total sea-basing of the logistics and command and control supporting it. As landmines are developed that cover greater areas and lower minefield densities, the logistics burden will further decrease. Landmine alternatives delivered in such a way will truly give the naval expeditionary force the ability to influence enemy ground maneuver while leveraging the ocean as maneuver space.

Concept of Anti-armor Operations

The Marine Corps' future warfighting concept of anti-armor operations specifically calls for the use of remotely delivered minefields from sea-based and other platforms. Fortunately, many of the other stated requirements for countermobility are addressed by the current trends of alternative landmine systems development or fielded systems. However, the concept of anti-armor operations contains two new criteria for future landmine alternatives not previously mentioned. These are the requirement that such munitions be recoverable and that a non-lethal counter-material version be developed.[29]

Military Operations in Urban Terrain

A recent article entitled "Are We Operationally Prepared to Win a Street Fight?" published in the July 2001 edition of the Gazette, answers the question of why cities are growing in military importance. Balanced against the increasing importance of urban terrain is the demonstrated cost as "traditional approaches tend to produce higher casualties and consume large quantities of manpower and logistics."[30] Current Marine Corps' force structure as well as public demands for minimal casualties require that the Marine Corps leverage a future urban operations concept that applies "unorthodox methods of mobility and combat power to achieve objectives."[31] Also, the military and political requirements to limit civilian casualties must be addressed when developing landmine alternatives.

Based on the current trends of emerging technology, future landmine warfare can address the basic problem of manpower consumption, supporting Marine Corps mobility in urban terrain. Rather than having to garrison each building, sewer and roadblock once taken, tunable landmines with integrated sensor and man-in-the-loop technology can perform the terrain denial function while providing the commander with real-time data and minimizing civilian casualties. Because

of their small size, landmines can easily be deployed throughout the urban dimensions to include the surface, sub-surface and super surface areas. Additionally, future landmine alternatives must be able to cover greater areas with observation and fire per individual munition in order to further reduce the logistics load of employing such systems. Marine Corps forces can concentrate on the enemy while minimal landmines with minimal forces (remote landmine operators) assume the role of guarding areas already taken.

Secondly, the Marine Corps Future Warfighting Concept for MOUT calls for flexibility in munitions so that they can be used in both offensive and defensive roles. Countermobility evolutions in MOUT will be conducted throughout all urban avenues of approach that includes streets, subways, and buildings.[32] Thus any countermobility system employed in urban terrain must have the ability to be employed throughout the surface, subsurface and super surface areas of the MOUT battlefield. Neither air power nor the application of artillery can address all three dimensions of a city. However, hand emplaced compact landmine alternative systems can be employed throughout the entire urban battlespace.

Offensively, the Marine Corps future MOUT concept requires that Marine units bypass enemy concentrations, by using "countermobility means to contain the enemy within his positions."[33] Countermobility means such as landmine alternatives, will also be used to seal off potential approach routes from enemy counterattacks. Landmine alternative systems can be employed in either offensive or defensive roles with the only difference being the effect the commander desires and the area in which he employs the system.

Although not the only solution capable of providing the countermobility function for the Future MOUT Warfighting Concept, landmines will offer the most logistically supportable, versatile and flexible means of area denial. Landmines are small, hand portable and can

potentially provide a wide area of coverage per munitions. They can also be emplaced throughout the MOUT environment and can apply either lethal or non-lethal fires against the enemy. Finally, the addition of miniaturized identify friend or foe (IFF) systems to the battlefield and the inclusion of self-neutralization ability to landmine alternatives will reduce the possibility of friendly and civilian casualties. The combination of the criteria discussed above will give the commander a weapon system of unprecedented utility in urban terrain.

Future Landmines and Military Operations Other than War (MOOTW)

The application of non-lethal technology to landmines makes them particularly suited for use in MOOTW. Two concepts on which employment of landmine alternative in MOOTW environment should rest include area denial and physical separation capabilities. Area denial will have vast utility in situations such as humanitarian assistance where there is a threat for relief workers and relief staging areas being overwhelmed by the people they are trying to help. Low kinetic impact landmines such as the non-lethal Claymore Mine (MCCM) have replaced the standard lethal vintage Vietnam claymore metal balls with small rubber balls and are primarily designed for crowd dispersal and vehicle protection.[34] The application of such a weapon in scenarios like Somalia where food trucks are being attacked by starving people or convoys are held up by unarmed civilians is apparent.

Besides, crowd control and vehicle protection, future landmines will also provide a commander with a key means of separating factions in peacekeeping and peacemaking operations. One proven method temporarily limiting or stopping violence between groups is to physically separate them. Rather than placing large numbers of Marines between warring factions, non-lethal, progressive punishment or tunable mines could be used to ensure physical separation. Such a capability will be particularly useful in instances of ethnic conflict where the

hostile populations are often geographically segregated into their own enclaves to begin with. The use of tunable landmines that can deliver both non-lethal and lethal fires gives the commander the option of increasing penalties should the situation deteriorate. Because physical separation will be maintained by landmine alternatives, fewer peacekeeping personnel will be exposed to the risk of sniper fire, hostile landmines, and ambushes. Man-in-the-loop systems incorporating video and fiber optic systems can take the place of some outposts and if linked to a video recorder, can act as evidence of crimes for future prosecution. Landmine alternatives incorporating technologies such as non-lethal fires, man-in-the-loop sensor systems, and tunable effects, will give future commanders the flexibility in a munitions systems that allows them to meet the full spectrum of MOOTW.

Conclusion

The Department of Defense is seeking to retain the relevancy of landmines on the modern battlefield while simultaneously bowing to political pressure to transform landmine warfare. The application of emerging technologies to the problem of creating alternatives to traditional anti-personnel landmines has resulted in munitions systems with promising application in future military operations. Specifically, the development of man-in-the-loop systems and increased application of non-lethal technology to landmines should continue.

An examination of the utility of landmine alternatives based on current developmental trends against the Marine Corps future warfighting concepts reveals additional criteria that alternative landmine development should include. The Marine Corps should seek to influence landmine alternative development to include the criteria listed in table 1-1 below. The inclusion of these criteria will ensure that landmine warfare will continue to play an integral role in the

Marine Corps future warfighting missions -- especially ship to objective maneuver, anti-armor/vehicle scenarios, military operations in urban terrain and military operations other than war.

	MAN-IN-THE LOOP	SELF DESTRUCT	SELF NEUTRAL	RECOVERABLE	IFF	COMPACT/ INCREASE COVERAGE	NON-LETHAL	TUNABLE/ PROGRESSIVE	VISUAL COVERAGE	DUAL PURPOSE SENSOR
CURRENT TREND	X	X					X	X	X	X
STOM	X	X			X	X			X	X
ANTI-ARMOR	X		X	X	X	X	X		X	X
MOUT	X		X	X	X	X	X	X	X	X
MOOTW	X		X	X	X	X	X	X	X	X

Table 1-2 Required Characteristics for Landmine Alternatives required to support the *Marine Corps Warfighting Concepts for the 21st Century*

NOTES

[1] Kemp Loren Chester, "Influence and Outcome: The Making of a US Policy on Anti-Personnel Landmines," (South Carolina: University of Columbia, 1999), iii. DTIC ADA364209

[2] Paul W. Fredenburg, "The Banning of the Anti-Personnel Landmine," *Canadian Defence Quarterly* (Winter 1997): 9. The United States ultimately withdrew from the Ottawa conference because of two reasons that prevented it from complying with the APL ban treaty. The first was the refusal of the conference to grant the United States an exemption for the defense of South Korea. The second was the refusal of the conference to modify the definition of anti-handling devices to allow the U.S. continued use of its self destruct/ self detonating APL systems in conjunction with its anti-tank systems.

[3] Fredenburg, 5.

[4] Deborah Rosenblum, "Implementation of U.S. Anti-Personnel Landmine Policy," reprint of 1 July 1998 remarks in *The DISAM Journal* (Summer 1998): 97. Director, Office of Humanitarian Assistance and Anti-Landmine Policy for the Department of Defense, Deborah Rosenblum summarized the Department of Defense's unilateral progress towards the voluntary elimination of APLs: "On January 17, 1997, the United States permanently banned the export and transfer of antipersonnel landmines. Additionally, in September 1997, the President directed the Department of Defense to develop alternatives to APL so that by the year 2003, we can end the use of APL outside Korea. As for Korea, the is to have alternatives to APL ready by 2006. Finally, the Administration has made clear that the "U.S. will sign the Ottawa Convention by 2006, if we succeed in identifying an fielding suitable alternatives to our APL and mixed anti-tank systems by
then."

[5] International Committee of the Red Cross, *Report of Experts Meeting, Military Utility of Landmines*, (Geneva: International Committee of the Red Cross, 11 January 1994).

[6] Stephen D. Biddle, Julia L. Klare, Jaeson Rosenfeld, "The Military Utility of Landmines: Implications for Arms Control," (Alexandria, VA: Institute for Defense Analyses, June 1994), 52-55. DTIC ADA283061.

[7] Paul F. Herman, "The Military-Technical Revolution," *Defense Analysis* 10, no.1 (1994): 91.

[8] Scott Gourley, "Towards the Smart Mine," *Janes Defense Wee*kly 34, no. 3 (19 July 2000): 27.

[9] Major General Jarvis D. Lynch Jr., USMC, (Ret.), "Landmines, Lies and Other Phenomena", *Proceedings* (May 1998): 47.

[10] United States Marine Corps, *United States Marine Corps Warfighting Concepts for the 21st Century* (Quantico, VA: Marine Corps Combat Development Command, 1996), I-4.

[11] *Warfighting Concepts*, I-5 and I-8.

[12] Thomas K. Adams, "The Real Military Revolution," Parameters 30, no. 3 (Autumn 2000): 57. Thomas Adams does not specifically apply his concept of the "swarm theory" to U.S. adversaries. However if one extends his concept of complex adaptively to urban and tribal societies that lack the ability to wage conventional warfare against the United States, a swarm system on a very basic level becomes an attractive and effective means of fighting.

[13] Norman L. Cooling, "Are We Operationally Prepared to Win a Street Fight?" *Gazette*, (July 2001): 15. "Normally, cities [are] bypassed or besieged in order to avoid fighting in their close confines or injuring the non combatant populace. Unfortunately, in the post-Cold War era, avoiding urban areas is becoming increasingly difficult without abandoning strategic objectives. The strategic significance of urban areas is rapidly growing."

[14] Michael O'Hanlon, *Technological Change and the Future of Warfare*, (Washington DC: The Brookings Institution, 2000): 32.

[15] Major Jon N. Jones, USA, "United States Army Operations Under the Ottawa Convention: Mine Warfare without Antipersonnel Landmines," (Fort Leavenworth, Kansas: U.S. Army Command and General Staff College, 1999): 10. DTIC ADA367686.

[16] Lieutenant Colonel Dale Carr, USA, "An Evaluation of the U.S. Policy on Anti-Personnel Landmines," (Carlisle Barracks, PA: U.S. Army War College, 1999): 9. DTIC ADA364457.

[17] Hewish, Mark and Pengelley, Rupert, "In Search of a Successor to the Anti-personnel Landmine," *Jane's International Defense Review* 3 (1998): 33.

[18] Byran Green, Captain, USA, "Alternatives to Antipersonnel Mines," *Engineer*, (December 1996): 11.

[19] O'Hanlon, 34.

[20] O'Hanlon, 53. Such technology already exists and is in a variety of weapons platforms to include ship's sonar and radar systems. The trend towards miniaturization of computers has made this capability available to the soldier and will continue to allow more powerful computers a wider range of applications on the mobile battlefield.

[21] O'Hanlon, 52.

[22] Jane's Press Center, "Walking Landmines Expected to Reduce Need for Anti-Personnel Mines," 14 September 1999, URL:<www.janes.com/press/pc990914-02.shmtl>, accessed 12 November 2001.

[23] Green, 13.

[24] Hewish and Pengelley, 36.

[25] Eugenia M. Kolasinski,Ph.D., "The Psychological Effects of Anti-Personnel Landmines: A Standard to which Alternatives can be Compared," (West Point, NY: United States Military Academy, April 1999): iii. DTIC ADA371531. This monograph provides an in-depth study of the psychological effects of landmines, an important aspect that landmines bring to the battlefield that is often not considered by those who seek to discount the landmine's utility on the battlefield.

[26] *Warfighting Concepts*, I-3.

[27] Jones, 59.

[28] *Warfighting Concepts*, VIII-9.

[29] *Warfighting Concepts*, VIII-11.

[30] Biran W. Neil, "Future Military Operations On Urbanized Terrain," *Gazette*, (July 2001): 24

[31] Neil, 24.

[32] *Warfighting Concepts*, VII-10 - VII-11.

[33] *Warfighting Concepts*, VII-10 t- VII-11.

[34] John B. Alexander, *Future War: Non-Lethal Weapons in Twenty-First-Century Warfare*, (New York: St. Martin's Press, 1999): 226.

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