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This issue of the DTIC Review addresses the ideas, strategic trends, nature of warfare, emerging technologies, air and space, military theory and other factors necessary to conform with the conditions and demands of the 21st century.

The authors challenge convictions of the current environment and present a range of conjectural theories on conditions, capabilities and technologies of the next three decades.

The selected documents and bibliography are a representation of the information available on emerging technologies and technology forecasting from DTIC's collection.

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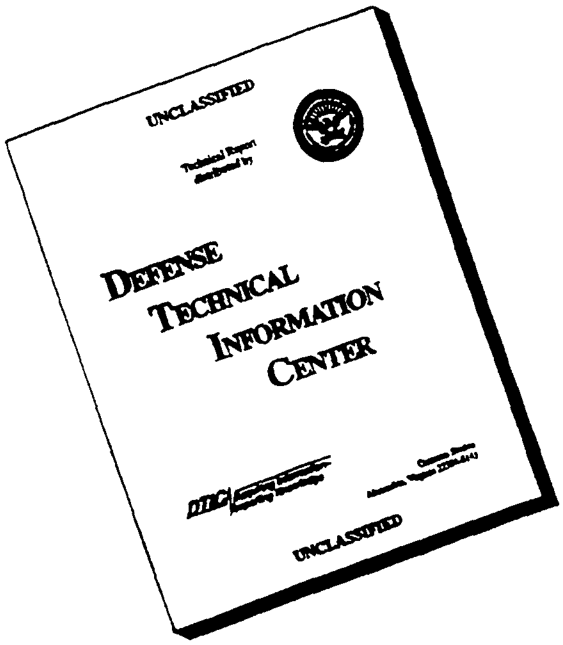

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FOREWORD

The DTIC Review brings its readers the full text of selected technical reports as well as a bibliography of other references of interest under one cover. This format provides our readership with a sampling of documents from our collection on a particular topic of current interest. It is hoped that you find this effort of value and appreciate your comments.

Kurt N. Molholm
Administrator

INTRODUCTION

What can we expect in the 21st century, the new millennium, the future, the year 2000 and beyond? In the new world order, is information power? If our society is in the midst of a revolution in military affairs, how are we preparing for the conditions expected 10 to 25 years in the future? In order to understand the present Information Age, is it wise to look to the past and examine our experience from the Industrial Age?

Numerous rousing questions confront researchers, philosophers, scientists and engineers involved in transitioning technology to current and future systems.

This issue of *The DTIC Review* addresses the ideas, strategic trends, nature of warfare, emerging technologies, air and space, military theory and other factors necessary to conform with the conditions and demands of the 21st century.

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The Future of American Landpower: Strategic Challenges for the 21st Century Army

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March 1996

**Strategic Studies Institute,
U.S. Army War College Carlisle Barracks, PA**

Strategic Studies Institute SSI

THE FUTURE OF AMERICAN LANDPOWER:
Strategic Challenges for the 21st Century Army

Steven Metz
William T. Johnsen
Douglas V. Johnson II
James O. Kievit
Douglas C. Lovelace, Jr.

U.S. Army War College AANP

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An Army War College Special Program

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Questions or comments about the AANP should be directed to Dr. Earl H. Tilford, Jr., Director, Army After Next Project, Army War College, Box 542, Carlisle Barracks, PA 17013. Phone: (717) 245-4086 or DSN 242-4086; FAX (717) 245-3820 or DSN 242-3820, E-mail: tilforde@carlisle-emh2.army.mil.

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The authors explore the premises which will shape thinking about the "Army After Next." In an era characterized by a volatile international security environment, accelerating technological advances (particularly in acquiring, processing, and disseminating information), the emergence of what some are calling a "revolution in military affairs," and forecasts of increasingly constrained fiscal resources, it seems ill-advised to plan only for the "next Army." The authors challenge convictions that provide much of the basis for the "current Army," as well as some of the assumptions that undergird planning for the "next Army." They discuss outlines of future security conditions and the Army's role in that environment. The ensuing exchange of ideas, they hope, will help create a force that can continue to be called upon to serve the interests of the Nation in an as yet uncertain future.

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THE FUTURE OF AMERICAN LANDPOWER: STRATEGIC CHALLENGES FOR THE 21st CENTURY ARMY

Steven Metz

William T. Johnsen

Douglas V. Johnson II

James O. Kievit

Douglas C. Lovelace, Jr.

March 12, 1996

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FOREWORD

Armies historically have been criticized for preparing for the last war. Since the early 1980s, however, the U.S. Army has broken this pattern and created a force capable of winning the next war. But, in an era characterized by a volatile international security environment, accelerating technological advances (particularly in acquiring, processing, and disseminating information), the emergence of what some are calling a "revolution in military affairs," and forecasts of increasingly constrained fiscal resources, it seems ill-advised to plan only for the "next Army."

The purpose of this monograph, therefore, is to begin the debate on the "Army After Next." Initiating such a discussion requires positing the outlines of future security conditions and the Army's role in that environment. This also means challenging convictions that provide much of the basis for the "current Army," as well as some of the assumptions that undergird planning for the "next Army."

The authors recognize that not all will agree with their assumptions, analysis, or conclusions. Their efforts, however, are not intended to antagonize. Rather, they seek to explore the premises which will shape thinking about the "Army After Next." The ensuing exchange of ideas, they hope, will help create a force that can continue to be called upon to serve the interests of the Nation in an as yet uncertain future.

The Strategic Studies Institute strongly encourages readers to participate in a continuing discussion on the future of American landpower and the challenges it holds for the U.S. Army.

Richard H. Witherspoon

RICHARD H. WITHERSPOON
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The authors earlier collaborated on an SSI study entitled *The Principles of War in the 21st Century: Strategic Considerations*.

SUMMARY

The global security system of the early 21st century will be configured into three tiers, each defined by economic form and degree of governability. The first tier will include the technologically advanced states of Western Europe, North America, and the Pacific Rim. Intense economic competition may occasionally lead to political conflict and even spark full-blown information warfare, but there will be no traditional warfare within the first tier. Second tier regions will retain most features of Cold War era nation-states. Periods of rapid internal political transition will occur cyclically and often will be violent. Second tier states may occasionally resort to conventional, inter-state war, and will retain large land armies equipped with some sophisticated weapons systems. Many of them will develop weapons of mass destruction. The third tier will experience ungovernability, occasional anarchy, endemic violence, severe ecological degradation, the politicization of primal loyalties, and political fragmentation. Third tier states may engage in short, spasmodic wars with each other.

Interdependence will be the defining characteristic of the future global security system. Because of interdependence, the global security system will continue to experience cycles with periods dominated by violence followed by widespread resolution of conflicts. The goal of the United States, the only power involved everywhere, will be to take maximum advantage of periods of peaceful conflict resolution and shorten periods of violence. American landpower can play a key role in these efforts.

While the internal dimension of American security will probably change less over coming decades than the external one, several trends are important. Political leaders and the public are likely to remain intolerant of protracted or costly military ventures except when crucial national interests are

clearly threatened. Pressure for near total disengagement from the third tier will be particularly strong.

If the future security environment takes the form just described, five strategic challenges will be most important for the Army:

Reconcile long-term and short-term imperatives. Strategists must maximize the chances of long-term success while minimizing short-term risk. If the future global security system is relatively benign, the Army can minimize the resources it devotes to long-term modernization and force development. But if conflict dominates the future global security system, the United States must accept greater short-term risk and focus on force development and modernization. Current American strategy may be slightly skewed in favor of the short term.

Maximize efficien.. American military forces will remain small in comparison to the number and scope of tasks they will be given. This creates an overriding need for efficiency. One way to augment efficiency is through coalitions. Technology probably holds greater promise of bringing dramatic improvements in efficiency, but it requires extensive investment. Reliance on technology also can generate unintended adverse effects. New technology can make current (and expensive) technology obsolescent. Or, challengers might seek low-tech, asymmetric responses to counterbalance the American advantage.

Maximize the political utility of landpower. A military force has political utility when political leaders and the public deem the expected costs acceptable. It is impossible to predict precisely what the American public and its leaders will define as acceptable costs in coming decades, but Army leaders must be aware that this fluid equation can change rapidly, and the type of force they create, train, and equip must, in part, be determined by the need to maximize political utility.

Undertake a controlled institutional revolution. The historical boundaries of landpower may be stretched as the basic concept of national security expands to include, e.g., protection against violent threats to national information and information systems, the environment, and public health. The Army must decide whether to expand and accept the new roles of landpower or specialize in one or two functions and allow some other institution to assume the new roles. Phrased differently, the Army will have to decide whether warfighting is *the* function for which it exists or simply one function (albeit an important one) among several.

While the *need* for a controlled institutional revolution in the U.S. Army is becoming clear, its precise direction is not so obvious. If the functions of landpower continue to diverge in terms of the skills, concepts, and organizations they require, it will become increasingly difficult to craft a military organization that can perform all of its required tasks. If tasks other than warfighting become more strategically important, the relationship between the Army's warfighting component and its peace operations/conflict resolution/grey area threat component may need radical change.

Preserve public support for effective landpower. To retain the public support necessary for continued investment in landpower and for recruiting from a shrinking pool of candidates, senior Army leaders must persistently and convincingly explain the roles that landpower plays in deterring violence, defending against aggression that does occur, reassuring allies and friends, and helping resolve conflicts.

As senior Army leaders explain the enduring significance of landpower to political leaders, the media, and the public, they must counter several popular myths concerning American strategy and the role of landpower plays in it.

- The United States can disengage from the conflict prone parts of the world, thereby obviating the need for direct involvement.

- The world will see no more conventional wars.

- Allies or international organizations can compensate for a decline in U.S. ground forces.

- Landpower can be allowed to atrophy during the current period of fragmented threat, and be reconstituted if necessary.

The current Army leadership recognizes the need for fundamental change. But this is only the first (and easiest) step. The next one is to reach consensus on exactly what the most pressing strategic challenges are. This essay suggests five. The development of coherent programs to deal with these challenges is the greatest legacy that the 20th century Army can leave the nation.

THE FUTURE OF AMERICAN LANDPOWER: STRATEGIC CHALLENGES FOR THE 21st CENTURY ARMY

Introduction.

Strategists around the world are slowly transcending the "post-Cold War" mind-set. Immediately after the collapse of the Soviet Union, confusion reigned as national security professionals agreed on little other than that the world was entering a period of fundamental change. Today, there is a loose consensus among strategists and futurists concerning some of the key trends shaping the future security system. Army thinkers must now explore the implications these trends have for their organization. This essay is designed to fuel such a process. The goal is to draw a plausible sketch of the future security system, suggest the strategic challenges this will pose for the Army, and lay a conceptual foundation for exploring the 21st century Army.[1]

The Strategic Environment: External Dimensions.

Any assessment of the Army's future must grow from assumptions or conclusions about the emerging strategic environment. While these judgements are necessarily tentative, they do provide guidelines for long-term strategic thinking. The global security system that replaced the Cold War one is still coalescing. Eventually it may evolve in unforeseen directions and force American strategists to alter radically the concepts and techniques they use to understand national security. For now, though, it is possible draw working conclusions on what are likely to be the most salient characteristics of the future global security system and, from these, derive implications for the U.S. Army.

For instance, the structure of the future global security system will probably replicate the late Cold War system in that sub-state, state, and supra-state actors will all remain strategically significant. The relationship of the three elements, however, will change. Proliferation of weapons of mass destruction and other forms of technology will augment the power of sub-state actors. Through terrorism, sub-state actors may be able to stymie or deter militarily superior opponents such as nations. Electronic communications will allow networks of sub-state actors–some of them violent–to form more easily and coordinate their actions more effectively.

At the other end of the spectrum, supra-state actors will probably become more effective in both the political and economic realms as governments accept the transnational nature of many of the problems they face and cede some power to other organizations. As Brian Nichiporuk and Carl H. Builder note, "Since so many of the institutions of the nation-state are hierarchical and so many of the transnational organizations are networked, the net flow of power today tends to be out of the nation-state and into nonstate actors . . . Many of the world's environmental and social problems have passed beyond the scope of the nation-state."[2] But in the mid-term, nation-states will remain best able to mobilize, apply, and sustain armed force. Managing the tension arising from the fact that traditional nation-states remain militarily important while less able to deal with the broad gamut of political, economic, and social problems faced by their populations will play a major role in shaping the future global system. In developed areas, the result may be the gradual obsolescence of traditional states as power moves to supranational organizations. In less developed areas, the internal cohesion of states will erode with political power and responsibility for security devolving to local satraps, warlords, and militias.

Many analysts believe the future global security system will be configured into three tiers, each defined by economic form and degree of governability.[3] The first tier will include the technologically advanced states of Western Europe, North America, and the Pacific Rim. It will be characterized by extensive political, economic, and cultural integration of elites; reliance on information-based sources of wealth; effective government; and relative stability. Elites (defined by possession of information skills and access to wealth-generating forms of information) will increasingly share values and perspectives across national borders, and thus experience a form of cultural convergence. The first tier will not, however, be perfectly peaceful or cooperative. Intense economic competition may occasionally lead to political conflict and even spark full-blown information warfare between technologically advanced states, but there will be no traditional warfare within the first tier. First tier states may, however, use proxy violence against each other.

Internally, many first tier states will undergo cultural differentiation as communities form that differ in values and perspectives from the centers of economic and political power. Of course, nearly every state throughout history has experienced regional variegation and diverse sub-communities. What will be different in the future system will be the prevalence of sub-communities based on shared values–modern-day Mayflower Pilgrims and Utah Mormons–and "generational" ones based on age. Other sub-communities will be based on more traditional factors such as economic ties, language, religion, or ethnicity. In states composed of such politically coherent sub-communities, national leaders will have a more difficult time manipulating public opinion and building the consensus needed for radical programs or risky ventures, including the overseas deployment of military force. This condition will make it even more imperative to minimize the risk involved with the use of military force abroad.

Second tier regions will retain most features of Cold War era nation-states. Economically, they will rely on industry and suffer from uneven internal development, with relatively prosperous, large metropoli surrounded by backward areas. Ecological decay will be a serious problem and sometimes breed political conflict within and between second tier states. Internally, the second tier will be characterized by cycles of political instability and stability as relapses into authoritarianism or sham democracy follow waves of democratization and political reform. The periods of rapid political transition will often be violent.

In contrast to the first tier, second tier states may occasionally resort to conventional, inter-state war. They will retain large land armies equipped with some sophisticated weapons systems. In fact, traditional sustained war in the future security system will almost always involve a second tier state in conflict with another second tier state or with a first tier state. Many of them will develop weapons of mass destruction. When second tier enemies both have weapons of mass destruction and effective delivery systems, their relationship may reflect the Cold War in miniature with direct conflict unacceptably risky but proxy violence common. Conflict will also occur when second tier states intervene in bordering third tier regions or use proxy violence against each other.

The third tier of the global system will consist of nations with economies largely dependent on subsistence production, foreign aid, and the export of primary products. Small pockets of industry will be surrounded by regions of dire poverty. Most of the third tier will experience ungovernability, occasional anarchy, endemic violence, severe ecological degradation, the politicization of primal loyalties, and political fragmentation.[4] Third tier states may engage in short, spasmodic wars with each other, but will not have the resources for prolonged conventional combat. Within third tier states, predatory governments will be as common as those sincerely promoting the public welfare. Public health disasters, many spread by refugee flows, will be common. Democratic experiments will be short-lived. Military power will devolve to the private security forces of the rich and poorly-led, lightly-armed but dangerous militias associated with political parties, regions, ethnic groups, races, or religions.

Initially, divisions within the global system will not be rigid. Multiple links will exist between the tiers and occasionally a state will shift from one to the other by altering its economic and political systems. Like contemporary Iraq or the former Soviet Union, some states may be second tier in economic form but retain enough military power to challenge first tier states at least temporarily. Over time, though, the distinction between the tiers is likely to solidify. U.S. security strategy in such a system will seek to assist the controlled integration of the first tier, encourage second tier states to take on first tier characteristics and prevent conventional war between them, ease human suffering and the spread of violence and public health problems from the third tier, and discourage the use of proxy violence by all the actors in the system.

In the system as a whole, a number of formal mechanisms will provide order and encourage conflict resolution. Regional organizations and alliance systems will be important nearly everywhere but, in the mid-term, only the United States and the United Nations will be involved everywhere. However, the United Nations will continue to be hampered by an aggregate shortage of economic and military resources. Unless formal methods of sustaining order and resolving conflict mature, interest-driven, ad hoc coalitions will continue to form and dissolve. Usually, only first tier states will have the broad range of resources and the political stability to orchestrate successfully effective coalitions. Therefore, harmony of foreign policy among first tier states will become increasingly important.

Interdependence–not information or regional instability–will be the defining and dominant characteristic of the future global security system. This feature will strongly influence security policy and military strategy. Driven by rapid communications and the cross-border movement of people and goods, interdependence will affect all three tiers of the global system (albeit in different ways). Within the first tier, interdependence will be strong, almost pervasive. The interdependence that connects states within the second and third tiers or that links the various tiers will be weaker, but still significant.

The most prevalent form of interdependence will remain economic. This factor will intensify in the future as international trade becomes more important to almost every state. National economies will be superseded by regional economic blocs and, eventually, by a seamless (but not necessarily egalitarian or equitable) global economy. Prosperity will be almost impossible outside the global economy. Although integration into the global economy will not assure prosperity, states which reject integration will invariably remain impoverished. Political interdependence will also increase as successful policies, procedures, and organizations are rapidly emulated. The outcome of democratization in one country will shape its prospects elsewhere. World public opinion will play a larger role in the domestic politics of all states by influencing elites attuned to the global culture.

Because of interdependence, the global security system will continue to experience cycles with periods dominated by violence followed by widespread resolution of conflicts. Every violent conflict around the world will affect some other state. Many violent conflicts will affect other regions. Some violent conflicts will touch all regions and have global repercussions. Propelled by electronic communications, the successful use of aggression or proxy violence in one part of the world may spawn emulators in other parts, thus establishing a pattern of violence. Similarly, the deterrence of violence or the resolution of conflict will also establish a temporary pattern. The goal of the United States will be to take maximum advantage of periods of peaceful conflict resolution and shorten periods of violence. American landpower, if it remains effective and efficient, can play a key role in these efforts.

Cultural interdependence will also intensify. In most states, tension and outright conflict between the (American dominated) world culture and local culture will be a major problem. In the first tier of the global system, elites will generally embrace the world culture but tolerate local cultural differentiation and diversity. In the second tier, elites favoring acceptance of the world culture will compete with those opposing it. Acceptance of the global culture will ebb and flow in the second tier according to the perceived benefits. In the third tier, many elites will reject the world culture and force those who accept it to emigrate. Moreover, the movement of people between states will be even easier than today as the technology of transportation improves and economic interdependence leads to the erosion of legal constraints on cross-border movement. As one result, nearly every state will have important emigre or foreign resident enclaves economically, culturally, politically, and electronically linked to similar communities elsewhere, thus forming pseudo-states that overlap traditional national boundaries.

Interdependence in the future global security system will be tempered and sometimes thwarted by multiple sources of competition, instability, conflict, and violence. While competition among first tier states will rarely, if ever, lead to war between them, it may have severe repercussions throughout the second and third tiers. Information warfare or trade wars between first tier states could result in economic dislocations that exacerbate conflict in the second and third tiers. The conflicts that arise will then affect stability in the first tier, completing the circle of interdependence.

Most instability will originate in the third and second tiers of the future system. Its effects, though, will be global. Some instability will actually be beneficial, since reform and democratization in authoritarian systems is inherently destabilizing. Violence, not instability, will be the primary security problem. Conflict will arise in two major ways. In the first case, traditional competition between states will spark conflicts: rulers will continue to covet their neighbors' resources, irredentism will persist, and clashing ideologies will still be resolved through force of arms. In the second case, internal divisions will result in conflict based on: (1) primal identity (ethnic, tribal, religious, racial); (2) class tension (with class defined by the possession or lack of wealth-generating information skills); (3) generational disputes over the share of national wealth devoted to caring for the old rather than providing opportunities for the young (health care versus education and job creation); and (4) cultural differences pitting integrationists who favor inclusion in the world culture and economic system against radical particularists who oppose it. Often a single conflict will intermix elements of more than one of these sources.

Not all conflicts will be violent; most will remain political (particularly in the first and second tiers). But political conflicts may turn violent when populations become frustrated by their governments' inability or unwillingness to meet their perceived needs by nonviolent means. In many cases, governments corrupted by criminals will fail to provide basic public safety, thus encouraging the formation of private armies or militaries. Conflicts will also arise when governments are unable to control conflict between armed sub-national groups, whether political, criminal or a combination of the two, or when regimes become externally aggressive to distract attention from internal shortcomings. As in the past, when weak regimes based political mobilization on traditional grievances such as territorial disputes, they will often find it difficult to control the passions they unleash. Parties to a conflict will sometimes use violence to increase their leverage over their opponents or deliberately provoke outside intervention. Often violence within a state will provoke outside intervention.

Even given the multiple forms of conflict that will characterize the future security system, it is not condemned to constant violence. The potential exists for an effective global concert of democracies that can at least control inter-state violence and create the conditions for the amelioration of intra-state violence. Consolidation of such a concert, though, will be extremely difficult. To succeed, the world's democracies must act now while there are no superpowers hostile to free market economics and democracy. The window of opportunity is narrow. If consolidated, a global concert could promote security by excluding aggressors and states with closed political systems.

The Strategic Environment: Internal Dimensions.

National security strategy always reflects internal tensions, compromises, and conflicts as much as the external environment. While the internal dimension of American security will probably change less over coming decades than the external one, several trends are important. For instance, political leaders, the media, and the public are likely to remain fairly intolerant of protracted or costly military ventures except when crucial national interests are clearly threatened. American military operations must thus continue to be conducted as quickly as possible and result in as few casualties as feasible. Indeed, even in the face of increasing interdependence among first tier states, isolationist tendencies will persist in the United States. Pressure for near total disengagement from the third tier will be particularly strong and, in many parts of the United States, a majority will resist rapid integration into the world culture and economy. Support for the U.S. military, then, may be stronger on the coasts than in the nation's interior. And, as the "baby boomer" generation ages and places greater strains on the American health care system, all non-health oriented government spending, including that for national defense, will face increasing opposition.[5]

Demographics will complicate the U.S. military's attempts to obtain an adequate supply of high-quality recruits.[6] Only a small portion of the public will have first-hand experience with the military. This trend will be exacerbated by the escalating physical concentration of the military as bases close. Stationing most or all of the U.S. military on the east and west coasts makes sense from the perspective of power projection, but it will alter civil-military relations since the vast majority of American communities will not have an active-component military presence. Such conditions will also make public outreach an increasingly important function for the military services.

Challenge I:
Reconcile Long-Term and Short-Term Imperatives.

If the future security environment takes the form just described, five strategic challenges will be most important for the Army. The first is reconciliation of long-term and short-term imperatives. In the broadest sense, strategy always entails balancing the present and the future. Strategists must maximize the chances of success in the future while simultaneously minimizing short-term risk or danger. For the U.S. Army, the tension between the long-term and the short-term has never been more intense as force development and modernization are postponed to preserve current operational readiness. If leaders transfer human and financial resources to force development and modernization, it raises the chances that the Army might face dangerous challenges in the short-term. To postpone modernization, though, could increase future danger. And further complicating things, the relationship between short-term and long-term risk shifts continuously. How much short-term risk, then, should the nation accept in order to augment its long-term security? Unfortunately, this question can only be answered using assumptions and speculation. The driving factor is the extent of the security threats the United States will face in the 21st century. If the future global security system is relatively benign or cooperative and no other hostile superpower emerges, the Army can minimize the resources it devotes to long-term modernization and force development. But if conflict dominates the future global security system, second tier powers pose challenges where U.S. national interests are limited, or a hostile peer (or more than one) emerges, the United States must accept greater short-term risk and focus on force development and modernization. Either approach is a gamble.

One can argue that focusing resources on current operational readiness and force quality will help prevent the emergence of hostile peers. Potential enemies, according to this logic, will recognize the futility of trying to match the military power of the United States and "abandon the field."

Two factors undercut this argument. First, it is expensive to dissuade the emergence of hostile peers by retaining existing superiority. Such a concept requires the American public to support fairly high levels of military spending in what appears to be a nonthreatening security environment. Just as it is difficult to convince those who are young and in good health that they should devote a large amount of their limited financial resources to life insurance, sustaining public support for a level of military spending adequate to dissuade hostile peers may be impossible. In addition, history does not bode well for such an approach. Very rarely did competitors abandon the strategic field even in unipolar security systems. They might have avoided direct military confrontation with the dominant power, but worked diligently to augment their capability, rectify the power balance, and exploit weaknesses in an opposing power or superpower.

While it is never easy to reconcile short-term and long-term security imperatives, current American strategy may be slightly skewed in favor of the short term. The level of current risk to vital U.S. interests is limited, but the resources devoted to long-term modernization are inadequate. Such a focus on the short term at the expense of the long term is an enduring element of the American national culture. We are a nation of spenders rather than savers. In the realm of national security, then, one of the prime challenges for Army leaders is to adjust the focus as far toward the future as is possible without generating an unacceptable level of short-term risk.

Challenge II:
Maximize Efficiency.

In the future security system, American military forces will remain small in comparison to the number and scope of tasks they will be given. This creates an overriding need for efficiency. Of course, this is not new. Ever since the United States decided in the late 1940s to assume global responsibilities without becoming a nation in arms, efficiency has been important. One way to augment efficiency is through cooperation and burden-sharing with other military forces. Coalitions, especially with other first tier militaries, hold somewhat greater promise of bringing dramatic improvements in efficiency. This is especially true if the United States pursues what might be called "qualitative" coalitions based on a synergistic division of labor among the participants rather than "quantitative" coalitions where all the forces involved have similar capabilities. Of course, qualitative coalitions create mutual dependencies among their participants, so only nations that trust each other deeply would allow them to develop. And, in the case of a global power, it would be difficult to structure several regional coalitions each with a division of labor similar enough to achieve such efficiencies.

Technology probably holds the greatest promise of bringing dramatic improvements in military efficiency. In fact, a number of analysts are predicting that a combination of new technology, concepts, and organizations is generating a "revolution in military affairs" dominated by precise stand-off strike platforms, near-perfect communications and intelligence, information dominance, computer-enhanced training, and nonlethality.[7] Eventually robotics, "brilliant" nanosensors, and psychotechnology will bring further change. The result may be a dramatic improvement in efficiency. Unfortunately, the revolution in military affairs carries its own set of problems. Probably the most pressing obstacle is the expense. To bring emerging technology to fruition will require extensive investment and, as noted earlier, it is difficult to convince the American public and their political leaders that money invested in military modernization today will bring great future returns in terms of augmented security. People invest for retirement because they expect it to come; the closer the event, the more they invest. So long as the American public is not convinced that the nation will face threats and dangers in the 21st century, there will be resistance to investment in military modernization. This means that military leaders must develop ways to pursue the revolution in military affairs as cheaply as possible, whether through creative relationships with business and industry or through new forms of cooperation with other states. Finding methods of frugal modernization is one of the great challenges that current and future Army leaders will face.

Furthermore, reliance on technology can generate unintended adverse effects. New technology can relegate current (and expensive) technology to obsolescence. Even more ominously, challengers facing a technology-reliant U.S. military might seek low-tech, asymmetric responses to counterbalance the American advantage. These may be "dirty," perhaps relying on nuclear, biological, or chemical terrorism, and aimed at "soft" targets such as population centers. And reliance on technology can lead to a "band-width" problem where the U.S. military is configured exclusively for one type of enemy. Thus, future Army leaders must encourage the development of technology that addresses, and thereby deters, asymmetrical, dirty responses.

Challenge III:
Maximize the Political Utility of Landpower.

A military force has political utility when the expected costs of using it–whether political, economic, or human–are deemed acceptable by political leaders and the public. What makes the job of military strategists so difficult is the tension or even outright contradiction between the various costs associated with the use of armed force. For instance, one way to limit the human cost of military operations, whether in terms of friendly or civilian casualties, is to spend massive amounts of money to develop a high-technology force. Human costs are limited, but economic costs escalate. Conversely, one way to limit the economic costs of a military force is to give it the minimum of training and provide it with low-technology, relatively cheap equipment. But, as the Russians are discovering in Chechnya, such a force will take extensive casualties wherever it is used. Eventually, its political utility will decline because policymakers will recognize the opposition generated by casualties.

The challenge for future Army leaders is to monitor and understand the changing relationship among the various dimensions of political utility. During and immediately after the Cold War, the United States was willing to spend much money to minimize military casualties. And, in the years following the collapse of the Soviet Union, the nature of the global security system, particularly the absence of a hostile peer to mobilize world opinion against the use of American military power, made the political costs of armed force relatively low once the American public was convinced of its necessity. But these factors may change in the 21st century. It is impossible to predict precisely what the American public and its leaders will define as acceptable costs in coming decades, but Army leaders must be aware that this is a fluid equation that can change rapidly, and the type of force they create, train, and equip must, in part, be determined by the need to maximize political utility.

Challenge IV:
Undertake a Controlled Institutional Revolution.

The overwhelming characteristic of life at the end of the 20th century is rapid and profound change. This certainly holds for all aspects of military affairs. Today, American landpower is undergoing fundamental change. To deal with this, the Army must undertake a controlled revolution.

Historically, American landpower was used to defend against external enemies and to maintain order in regions or under conditions where the police could not. During the Cold War, Soviet and Soviet-ally military power provided the clear and preeminent threat to U.S. interests. From a landpower perspective, a ground invasion of Western Europe or South Korea by mechanized communist forces posed the greatest danger. This forced the U.S. Army to focus it efforts on mobile warfighting by armor-heavy divisions. From the Kennedy administration on, policymakers began to use the Army for nontraditional missions such as humanitarian relief, nation assistance, foreign internal defense, counter-narcotrafficking, and peacekeeping. Strategic exigencies forced landpower to become two-dimensional, with one focused on warfighting and the other on low-intensity conflict or military operations other than war. While warfighting remained the dominant focus by far, the Army became a more flexible institution in terms of doctrine, training, and mindset.

In the future, the boundaries of landpower may be stretched even further as the basic concept of national security expands. By the second decade of the 21st century, national security is likely to include not only traditional meanings such as protection of national territory, way of life, and citizens, but also protection against violent threats to national information and information systems ("cyberdefense"), the environment ("ecodefense"), and public health. Landpower will thus become three-dimensional as ground forces are configured for traditional warfighting, military activities other than war such as peace operations and defense against "grey area" threats such as organized crime, and new functions such as cyber- and ecodefense.

Some of these new functions may not be *Army* roles, but they will be *landpower* roles. The traditional providers of American landpower–the Army and the Marine Corps–may be inadequate, thus forcing national policymakers to consider creation of new institutions to provide new forms of landpower. Within this context, the Army must decide whether to expand and accept the new roles of landpower–to become three-dimensional–or specialize in one or two of the functions and allow some other institution to assume the new roles. Phrased differently, the Army will have to decide whether warfighting is *the* function for which it exists or simply one function (albeit an important one) among several.

To meet the demands of the future, the Army must alter its current focus. A security system dominated by interdependence, multiplicity of threats, and stress on conflict resolution will require a different mix of Army capabilities. Even if warfighting with armor-heavy divisions remains significant, it will probably become no more than the co-equal of other tasks, and may eventually become a secondary mission if enemies like Iraq and North Korea reform or collapse. While the Army's mastery of mobile armored warfare demonstrated in *Desert Storm* may, in the short term, deter aggressors from challenging the United States, it may not in the long term. Strategy, as Edward Luttwak points out, pits two scheming, adapting opponents.[8] What works today probably won't tomorrow as enemies find ways to circumvent U.S. strengths and exploit weaknesses. That is the challenge the U.S. Army faces in coming decades: its unquestioned superiority at mobile armored warfare will decline in strategic significance as aggressors develop techniques that cannot be easily countered by armored and mechanized divisions. *Desert Storm* is not a prototype for all future wars.

No one can predict precisely which of the Army's functions will be most significant in the future security system. Initially, the most likely candidates are peace operations to support conflict resolution and defense against grey area threats. Eventually, totally new functions may require more and more attention. It is clear at this point, though, that the Army's focus must broaden: the emphasis on warfighting required by the Cold War security environment must be adapted to the future security system. As Brian Nichiporuk and Carl H. Builder contend, "If the Army fixes itself too firmly on fighting and winning the nation's conventional wars as a way to husband its scarce resources, it may find that its market–like that of the mainframe computer makers–is narrowing."[9]

While the *need* for a controlled institutional revolution in the U.S. Army is becoming clear, its precise direction is not so obvious. During most of the 20th century, modernization of land forces was defined by mechanization. The more armor-heavy and mechanized an army, the more advanced. In the future, modernization will be multi-dimensional, driven by the phenomena associated with the current revolution in military affairs. Although it is too early to predict the precise impact that advancing technology and changes in the strategic environment will have on ground forces, it is possible to at least conceive of "post-mechanization" forms of landpower.

In some important ways, the evolution of landpower has always mirrored the development of human production. For 500 years, the trend in economics was toward centralization, vertical and horizontal integration, and increasing scale. From autonomous estates, farms, and plantations, the bulk of production moved to large industries, corporations, and cartels. Landpower underwent similar changes as the autonomous warrior carrying his logistics or living off the land gave way to specialized units operating in combined-arms, joint, and coalition structures dependent on a massive support and logistics network.

Today, what Alvin and Heidi Toffler call "de-massification" forms the dominant trend in production. Even while technology is leading to greater managerial concentration in some industries, the same technology is allowing small organizations to compete with large ones in certain niches. This trend also affects military organizations.[10] Future landpower will probably be based on ground units that are small and highly autonomous, yet extremely versatile, flexible, and lethal. Technology may allow such units to provide much of their own logistics, mobility, and intelligence support or to acquire this support electronically, with the providing units located far away, perhaps even at bases in the United States. The 21st century Army may also be a "post division" force built on some sort of smaller, more versatile basic units that can combine and disaggregate with relative ease. Technology may also obviate the need for multiple layers of intervening headquarters. The battalion/brigade/division/corps structure that proved so effective for conventional armored warfare may be less relevant in the future global security system.

Eventually, the requirements of warfighting and other functions of landpower might so diverge that the flexibility of existing Army units becomes inadequate. If the current revolution in military affairs continues, for instance, robotics and the technology of smart (soon brilliant) weapons may advance to the point where much of warfighting by first tier military forces will be based on fighting machines, whether remotely controlled or robotic. In the early phases of conflict and only after one side's machines have significantly weakened or defeated the other side's, may an enemy be attacked at short range. In the mid-term, proliferation of nuclear weapons and smart or brilliant conventional munitions will force land commanders to place even greater stress on the dispersion of units and support bases and other force protection measures. According to Martin C. Libicki, "Systems composed of millions of sensors, emitters, microbots, and miniprojectiles, will, in concert, be able to detect, track, target, and land a weapon on any military objective large enough to carry a human."[11] The norm in combat will be extensive dispersion of forces and concentration of fires. While individual soldiers are likely to remain highly effective as sensors and target spotters, warfighting units will rely almost wholly on long-range weapons for fires.[12] Operations will unfold without clear fronts and with few, if any, close tactical engagements.

Landpower functions other than warfighting, whether peace operations to support conflict resolution or defense against grey area threats, will be radically different. Machines will not, in the immediate future, be capable of complex and subtle interface with humans. Only highly trained officers and soldiers can cultivate the psychological sophistication to succeed fully in peace operations. Only specialized units can develop adequate skills at what Nichiporuk and Builder call "script adaptability" which allows a military force in an operation other than war to rapidly change its methods in order to project the right image to attain designated political objectives.[13] Ground units will not need the sort of long-range weapons systems required for warfighting, but will need effective mechanisms for integrating their efforts with political, economic, and relief organizations. Jointness will be less important than inter-agency and international cooperation. While the warfighting component of the Army will continue to rely on Clausewitzean concepts like centers of gravity, the peace operations components will look more to Sun Tzu's stress on the psychological impact of military force.

For the U.S. Army, the implications of this dichotomy are stark. If the functions of landpower continue to diverge in terms of the skills, concepts, and organizations they require, it will become increasingly difficult to craft a military organization that can perform all the tasks required of them. Nichiporuk and Builder contend that technology will increasingly allow "an Army of armies" based on differently organized, trained, and equipped units.[14] This may mean that the U.S. Army's warfighting component, built on armored and mechanized divisions, will evolve in an entirely different direction than its peace operations/conflict resolution/grey area threat component based on Special Forces and light divisions. Overarching doctrine and common training and equipment may become impossible. And, in fact, the careers of officers and soldiers might be limited to one component or the other. To some extent, this separation already exists, but reflects the clear priority of the warfighting function. If tasks other than warfighting become more strategically important, the relationship between the Army's warfighting component and its peace operations/conflict resolution/grey area threat component may need radical change, perhaps to the point of separating the two into distinct organizations.

Challenge V:
Preserve Public Support for Effective Landpower.

During most of the Cold War, the need for a strong U.S. Army was self-evident.[15] Senior Army leaders did not have to concern themselves with making this point to political leaders, the media, and the public. In the future security environment, American landpower will continue to play a vital role in promoting national interests, but in more subtle ways. To retain the public support necessary for continued investment in landpower and for recruiting from a shrinking pool of candidates, senior Army leaders must persistently and convincingly explain the roles that landpower plays in deterring violence, defending against aggression that does occur, and helping resolve conflicts through peace operations.

For instance, the Army plays a central part in deterrence. By the last half of the Cold War, most American strategists had jettisoned the notion that nuclear forces alone could deter aggression and recognized the value of conventional deterrence.[16] If anything, the deterrent value of the U.S. Army will increase in the future. As nuclear weapons and sophisticated delivery systems for them become widespread, deterrence will hinge on the United States having a wide range of coercive resources. Landpower will remain one of the most effective. It connotes political resolve and can be adapted to the widest range of conditions. However, as American defense planners recognized during the Cold War, deterrence hinges on threatening what an adversary values most. Most future aggressors will remain landpower- or "expanded landpower" (land plus cyberspace)-based. Additionally, in authoritarian states, land forces will remain the ultimate guarantor of the regime's survival. Deterring them or reassuring friends whose major threat is a landpower-based enemy will require effective and flexible U.S. landpower.

It is generally cheaper and safer to deter an aggressor than defeat him, and to reassure a friend rather than rescue him. But if deterrence fails, American landpower will also play an important part in thwarting aggression. A determined aggressor can be decisively countered only in the primary medium in which he operates, whether aerospace, land, cyberspace, or the seas. Asymmetric actions such as responding to a land invasion with air or naval power alone can be operationally or tactically successful, but have never proven strategically decisive. Furthermore, there are often severe political limitations to asymmetric applications of force, particularly where U.S. interests involved are "significant" but not "vital," where the aggression is "limited" rather than "outrageous," or where the opposing "will" lacks a center of gravity that can be struck either at all or within the bounds of proportionality. Because most future aggressors will operate in the landpower or expanded landpower medium, they must be confronted there.

Finally, landpower is absolutely crucial in resolving violent conflict. Political, psychological, and economic factors can bring a violent conflict to the point where settlement is possible or push an authoritarian state toward democracy. Once peaceful resolution or reform is underway, though, military power is often necessary to safeguard the process. Military force can ease the transformation of an aggressor's political system by protecting advocates of democracy. It can also support conflict resolution by constraining those who seek to upset an ongoing peace process. While all forms of military power can play a role in such actions, only land forces have the flexibility and capacity for the direct, personal interaction that sustained peace operations demand. Peace operations–which are the applications of military power most directly related to conflict resolution–thus require effective landpower.

As senior Army leaders explain the enduring significance of landpower to political leaders, the media, and the public, they must counter several popular myths concerning American strategy and the role landpower plays in it. For instance, some neo-isolationists feel the United States can disengage from the conflict prone parts of the world, thereby obviating the need for direct involvement. But the multidimensional interdependence of the future global system will make this impossible. Over the long term, disengagement will endanger U.S. national interests. This does not imply a "global policeman" role. The United States can choose the form and extent of its engagement in individual conflicts. Most often, the American role will be to lead or support an alliance or coalition effort. The greater the range of options available to policymakers, though, the greater the chances of an outcome favorable to U.S. interests.

Other opponents of continued investment in American landpower contend that the world will see no more conventional wars. But while the nature of armed conflict is changing, the incentives to use military power remain and, in some ways, have been amplified. If one nation succeeds at aggression, others will emulate it. Eventually, an effective global concert may, in fact, abolish traditional war. In the mid-term, construction of such a concert will rely on American military power. And, even in regions without conventional war, American landpower will retain its salience for other functions such as humanitarian relief under hostile conditions.

Other opponents of investment in American landpower argue that allies or international organizations can compensate for a decline in U.S. ground forces. But allies and international organizations do not appear capable of or intent on orchestrating adequate forces for deterrence and defense beyond their immediate borders. Most American allies have reduced their militaries even more rapidly than the United States. While allies and friends might, under some conditions, be able to counter local aggression without U.S. assistance, the conflict would be longer and more costly with increased danger of spillover. A serious decline in U.S. landpower would erode the confidence of friends and allies, and the very stability on which U.S. interests abroad prosper.

Effective landpower will remain the price of admission for a role in conflict resolution that will serve U.S. interests. Some opponents of investment in U.S. landpower feel that it can be allowed to atrophy during the current period of fragmented threat, and reconstituted if necessary. This idea has a long history. Throughout most of the U.S. experience, landpower was mustered when needed to meet direct threats. From the village militias who rallied against Indian raids to the divisions of draftees and volunteers who defeated the Germans and Japanese in World War II, Americans considered the need for landpower temporary, determined only by imminent danger. As the danger passed, landpower could be demobilized and then rebuilt when new threats emerged. But in the modern era, landpower, if it is to be effective and efficient, cannot undergo cycles of decay and reconstitution. It requires constant cultivation. Improvement must be continuous rather than episodic. Military modernization is a long-term process that must be sustained even in times of low direct threat. The general consensus is that it takes about 2 years to build an army division from scratch, and about 10 years to inculcate new doctrine through the force.

Conclusion.

Assuring the future effectiveness of American landpower is a shared responsibility. The public and policymakers must recognize the enduring significance of landpower and take steps to assure its continued viability. At the same time, Army leaders must embrace the need for fundamental reform in the roles, focus, and structure of their organization. If the public is to make the investment necessary to retain effective landpower, Army leaders must assure that this investment is spent as wisely as possible, with future needs rather than past successes serving as the guide. The current Army leadership recognizes the need for fundamental change. But this is only the first (and easiest) step. The next one is to reach consensus on exactly what the most pressing strategic challenges are. This essay has suggested five. The development of coherent programs to deal with them is the greatest legacy that the 20th century Army can leave the nation.

ENDNOTES

1. The U.S. Army War College Strategic Studies Institute is developing a pilot program to explore the strategic issues and problems that may be faced by the U.S. Army in 2010 and after.

2. Brian Nichiporuk and Carl H. Builder, *Information Technologies and the Future of Land Warfare*, Santa Monica, CA: RAND Corporation, Arroyo Center, 1995, pp. 35, 37.

3. For instance, Alvin and Heidi Toffler, *War and Anti-War: Survival at the Dawn of the 21st Century*, Boston: Little, Brown, 1993; and Donald Snow, comments in Steven Metz, *The Future of the United Nations: Implications for Peace Operations*, Report of a Roundtable Sponsored by the Strategic Studies Institute, Carlisle Barracks, PA: U.S. Army War College, Strategic Studies Institute, 1993.

4. This grim portrait of the third tier was introduced in Robert Kaplan, "The Coming Anarchy," *Atlantic Monthly*, February 1994, pp. 44-76. Its effect on U.S. national security is explored in Steven Metz,

America in the Third World: Strategic Alternatives and Military Implications, Carlisle Barracks, PA: U.S. Army War College, Strategic Studies Institute, 1994.

5. Mark J. Eitelberg and Stephen L. Mehay, "Demographics and the American Military at the End of the Twentieth Century," in Sam C. Sarkesian and John Mead Flanigan, eds., *U.S. Domestic and National Security Agendas: Into the Twenty-First Century*, Westport, CT: Greenwood, 1994, pp. 89-91.

6. See Mark J. Eitelberg and Stephen L. Mehay, eds., *Marching Toward the 21st Century: Military Manpower and Recruiting*, Westport, CT: Greenwood, 1994.

7. See Steven Metz and James Kievit, *Strategy and the Revolution in Military Affairs: From Theory to Policy*, Carlisle Barracks, PA: U.S. Army War College, Strategic Studies Institute, 1995, pp. 7-8.

8. Edward N. Luttwak, *Strategy: The Logic of War and Peace*, Cambridge, MA: Belknap, 1987, pp. 7-10.

9. Nichiporuk and Builder, *Information Technologies and the Future of Land Warfare*, p. 83.

10. See Alvin and Heidi Toffler, *War and Anti-War*, pp. 64-80.

11. Martin C. Libicki, *The Mesh and the Net: Speculations on Armed Conflict in a Time of Free Silicon*, McNair Paper 28, Washington, DC: National Defense University, Institute for National Strategic Studies, 1994, p. 19.

12. Nichiporuk and Builder, *Information Technologies and the Future of Land Warfare*, pp-64-67.

13. *Ibid.*, pp. 58-61.

14. *Ibid.*, pp. 77-79.

15. The only exception was the first few years of the first Eisenhower administration when some policymakers concluded that strategic airpower alone could protect American interests and the Army could be allowed to atrophy. By the end of the administration, even President Eisenhower had abandoned this sort of thinking. See Steven Metz, "Eisenhower and the Planning of American Grand Strategy," *Journal of Strategic Studies*, Vol. 14, No. 1, March 1991, pp. 49-71.

16. See Samuel P. Huntington, "Conventional Deterrence and Conventional Retaliation in Europe," in Keith A. Dunn and William O.

Staudenmaier, eds., *Military Strategy in Transition: Defense and Deterrence in the 1980s*, Boulder, CO: Westview, 1984; John J. Mearsheimer, "The Theory and Practice of Conventional Deterrence," Ph.D. dissertation, Cornell University, 1981; Thomas Boyd-Carpenter, ed., *Conventional Deterrence Into the 1990s*, New York: St. Martin's, 1989; and Gary L. Guertner, *Deterrence and Conventional Military Forces*, Carlisle Barracks, PA: U.S. Army War College, Strategic Studies Institute, 1992.

U.S. ARMY WAR COLLEGE

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DOCUMENT 2

New World Vistas
Air & Space Powers for the 21st Century

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Scientific Advisory Board U.S. Air Force

NEW WORLD VISTAS

AIR AND SPACE POWER FOR THE 21ST CENTURY

SUMMARY VOLUME

NEW WORLD VISTAS

AIR AND SPACE POWER FOR THE 21ST CENTURY

SUMMARY VOLUME

This report is a forecast of a potential future for the Air Force. This forecast does not necessarily imply future officially sanctioned programs, planning or policy.

Foreword

In the fiftieth year of the Air Force Scientific Advisory Board, both the Air Force and the Nation are at the brink of a new era. Our Cold War adversary no longer exists, and we now face threats which are not precisely defined. The situation is further complicated by changing alliances as much as by the absence of well known adversaries. Armed conflict around the world shows us that the world is still a hostile place, but responses which may have been appropriate during the Cold War are no longer appropriate. There appears, however, to be even more widespread pressure for the United States to remain a stabilizing force throughout the globe. Our military forces are involved in dangerous humanitarian and peacekeeping operations at an increasing rate, and anti-terrorist operations can be expected to increase as well. Although participation in these operations may require military action, we are expected to respond effectively with minimum injury and loss of life on both sides. Further, the domain of conflict is moving from earth into space and even into cyberspace. The balance of influence in the information domain has shifted from defense organizations to commercial organizations, and a similar shift will occur in space during the next decade. The crucial importance of detailed and timely knowledge and rapid communications to the successful pursuit of our new missions will demand creative use of commercial systems and technologies. This will produce an intimate intertwining of commercial and military applications to an extent not yet encountered. The intertwining will blur the distinction between threat and asset, offense and defense, and, even, friend and foe. Our future enemies, whoever they may be, will obtain knowledge and weapons better than those we have at present by making rather small investments. New sensor fusion and distributed processing capabilities will make operational distinctions such as onboard and offboard or space and ground obsolete. The rapid operational tempo enabled by complete and current knowledge, the operational demands generated by new missions, and the geographical constraints produced by a decreasing number of worldwide bases will require weapon system performance beyond that of existing systems. New technologies will permit improvement of existing systems, but new systems and new concepts will be needed to cope with the world of the 21st century.

There are strong analogies and contrasts between the world situation today and that at the time of the first Scientific Advisory Board study, *Toward New Horizons*, fifty years ago. We had won a devastating world war in 1945. In 1995, we have won the Cold War -- a war less bloody, but one which always had the possibility of destroying most of civilization. In both cases, we eliminated the threat from a powerful enemy, but then and now we have understood that preparedness and technological superiority are the keys to national security. After 1945, the United States moved to establish bases and influence abroad, but in 1995 we are reducing our physical presence abroad while we attempt to maintain a moral presence. It was clear in 1945 that the technology gains of the first half of the twentieth century should be consolidated to create a superior, technology- and capability-based Air Force which could respond to threats not yet imagined. The world which emerged from the destruction of World War II could not have been predicted in 1945, but the emphasis on technology and capability rather than on assumptions about future geopolitical scenarios served us well as we entered the Cold War. In the intervening 50 years, we have treated increasingly specific problems related to the Soviet threat. Now, that threat has disappeared. It is appropriate to return to the idea that development of broad superior capabilities through application of new technology will maintain the United States Air Force as the most powerful and effective aerospace force in the world and will enable the Air Force to discharge its responsibilities as an equal partner with the other Services in the defense of the Nation.

These considerations and the broad applications of new, largely commercial, technologies which are now, or soon to be, possible have led us to present the conclusions of the participants of *New World Vistas* as an integrated, capability-based, report. Realization of these capabilities will permit future members of the Air Force of all ranks to know, to plan, to act, and to evaluate in the detail appropriate to their responsibilities. One should not doubt that the 21st century Air Force which will be enabled and, indeed, demanded by its new capabilities and responsibilities will hardly be similar to the Air Force of today. The changes will be as profound as those experienced by the Army in moving from horse to tank or by the Navy in converting from sail to steam.

The Board wishes to thank the numerous Air Force people and organizations for their tremendous help in the preparation on *New World Vistas*. Special recognition goes to the United States Air Force Academy and the Air University for their assistance and counsel.

Finally, we have endeavored to define the capabilities which will result from emerging technologies during the next three decades, and we have attempted to point the way toward achieving those capabilities as the Air Force enters the Information Age. We hope that our work will succeed in helping to prepare the Air Force for the approaching revolution in the use of military power.

Dr. Gene H. McCall
Chair, USAF Scientific Advisory Board
Study Director, *New World Vistas*

John A. Corder
Major General, USAF (Ret)
Deputy Study Director

15 December 1995

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Chapter I

Technologies for Arming the Air Force of the 21st Century

1.0 Introduction

New World Vistas is a study about the Air Force. It is about technology. It is about ideas. Most of all it is about the defense of the United States. The Secretary of the Air Force, Dr. Sheila E. Widnall, and the Chief of Staff, General Ronald R. Fogleman, directed the Air Force Scientific Advisory Board to identify those technologies that will guarantee the air and space superiority of the United States in the 21st century.[1] We have taken the charge as an obligation to find and to create new ideas. We believe those ideas will make the Air Force of the future effective, affordable, and capable in seamless joint and multinational operations in which it achieves its purpose "to fight and to win the Nation's wars."[2]

New World Vistas is documented in detail in over 2000 pages of monographs collected in 15 volumes. The study participants are listed, and abstracts of their work are contained in Appendix B. There are many good ideas and careful descriptions of them in the 15 volumes. In addition, there is a Classified Volume[3] and a volume of important ancillary information obtained during the conduct of the study. And finally, this Summary Volume distills the major ideas from the monographs and integrates them into concepts that will produce a discontinuous or quantum enhancement of the effectiveness of the Air Force. We attempt in this volume to provide compelling reasons for pursuing these ideas, and we establish a path that stretches from today into the future. The definition of the path includes suggestions for significant incorporation of commercial technologies and practices into Air Force operations, and it includes suggestions for both change and reinforcement of the ways that the Air Force pursues science and technology goals. Our suggestions are based on the principles embodied in the concept of Global Reach-Global Power, which directs the Air Force to be capable of projecting power and influence worldwide.

We understand the uncertainties that accompany any attempt to predict the future. We may generate ideas that will be notable as humorous objects for future generations rather than notable as accurate visions of the future. We can only base our suggestions on our experience and on our estimates of the needs of the future. Most predictions become increasingly inaccurate with time after a decade or so has passed. Experience has shown, however, that carefully considered predictions are useful in defining new areas of endeavor that lead to new discoveries even if the discoveries are not those predicted. Thus, armed with caveats, confidence, and, perhaps, a small amount of vision we plunge into the task of defining technologies that will arm the Air Force of the 21st century.

We assert that the emphasis of Air Force technology must change. The Cold War presented a single adversary who had well known tactics, systems, and capabilities. Cold War military technology responded to the threat by developing weapon systems designed to respond to particular scenarios. In the process of development, we produced generic capabilities, but they mainly derived from the process of responding to the Soviet threat. System cost was always an important parameter, but it was never the predominant consideration.

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1. Memorandum to Dr. McCall from General Fogleman, CSAF and Dr. Widnall, SecAF - Appendix A.
2. General Ronald R. Fogleman, Address to Air Force 2025, Maxwell AFB, AL, 6 September 1995.
3. Classified Volume - on file in SAB office

Now, however, no well defined enemy exists. There are scenarios that suffice for some planning purposes, but they are of questionable reality. Rather than responding to a few particular scenarios, military technology now must respond to diverse situations. Cost has become a major factor in the development of all systems. We must also recognize that commercial technologies, which are developing at a rapid pace, have significant military applications. The Air Force must take advantage of new commercial technologies and must counter their use in adversary systems. It is essential that future systems be based on capabilities and cost, perhaps on an equal footing, rather than on solutions to specific problems.

There are two subjects about which the report is silent. The first is National Missile Defense. We do not believe the topic to be unimportant, and it will be apparent that several of the technologies we discuss are applicable. We found, however, that National Missile Defense is embroiled in politics too complex to permit detailed concept definitions to be of use at present. The second subject omitted is Nuclear Weapon Technology. That subject, too, is important, but nuclear weapon technologies are developed outside the Air Force, and the nuclear forces are, at present, prohibited from pursuing new ideas of design or delivery. We do, however, address problems associated with defense against weapons of mass destruction.

Chapter II will address the capabilities which are enabled by the new technologies. We will emphasize the interaction of technologies and capabilities, and we will show how new information sciences connect and enhance capabilities. Next, we will delineate the technologies. A striking feature of the list of technologies is that it is short. From a short list of new technologies and their supporting technologies the Air Force will derive amazingly superior capabilities. Chapter III will suggest what the Air Force should do, what they should stop doing, how to pay for it and how to make it happen. Chapter IV will conclude with organizational considerations and recommendations.

2.0 Fundamental Considerations

We have attempted to define capabilities and technologies that transcend particular missions and apply to all scenarios. We have not divided our recommendations into neat, well-defined categories. We tried, but we found that the power of the technologies and concepts that we recommend is that each cuts across several fundamental capabilities. The Attack Panel Volume presents a detailed method for inverting the matrix and discussing capabilities in terms of tasks to be performed.[4] We believe that the applications will be readily apparent when explained in detail. For example, knowledge and control of information is necessary for all missions, whether in peace or war, logistics or combat. All missions depend on communications and reconnaissance and, therefore, increasingly on space assets. As space assets become increasingly important, space control becomes a necessary part of all missions. Throughout the Force, the necessity of accurate, absolute positioning and timing is apparent. The most efficient way to supply this service is through space assets such as an enhanced, countermeasure-immune Global Positioning System (GPS). A technological thread which runs through many future applications is materials development. Strong, lightweight materials and structures will enable many capabilities in space, aircraft, and weapons.[5]

4. Attack Volume
5. Materials Volume

We know that reduced cycle time is a true force multiplier. It is characteristic of reduced cycle time that all components of the Force must operate at a higher tempo. If an airlifter is late with supplies, an attack mission will be delayed, and the choreography of an entire operation can be disrupted. The sensor systems that enable precision delivery of munitions can also be used in aircraft self protection. Technologies and functions will influence all capabilities. The Force will become so tightly integrated in function, and will be so tightly coupled to allies and the other services that boundaries between capabilities will become blurred if they exist at all.

For the purposes of *New World Vistas*, we have assumed that:

- The Air Force will have to fight at large distances from the United States. Some operations may be staged directly from the Continental United States (CONUS). Operations may persist for weeks or months, and they must be executed day and night in all weather.
- The site of the next conflict is unknown. The Air Force must be prepared to fight or to conduct mobility or special operations anywhere in the world on short notice.
- Weapons must be highly accurate, must minimize collateral damage, must minimize delivery and acquisition costs, and must enhance, and be enhanced by, aircraft capabilities.
- Platforms that deliver weapons must be lethal and survivable. They must establish air superiority in areas that are heavily populated with surface to air missiles (SAM's), and they must carry the attack to all enemy targets, fixed and mobile.
- Adversaries may be organized national forces or terrorist groups.
- Targets may be fixed or mobile and may be well concealed. Target classes will span the range from personnel to armored vehicles and protected command centers and information systems. Operational geography will range from classical battlefields to cities and jungles.
- Adversary capabilities will steadily improve and will be difficult to anticipate. For example, the Air Force must be prepared to defend against improved SAM's, low observable aircraft, cruise missiles, directed energy weapons, and information attack.
- The Air Force must detect and destroy chemical, biological, and nuclear weapons and their production facilities.
- There will be peacetime missions in areas of local conflict. Aircraft must be protected against SAM's and ground fire by means other than offensive attack.
- Increasing the pace of operations increases the effectiveness of all operations.
- Cost will be equal in importance to capability.
- The number of people in the Air Force will decrease. Individual performance must be optimized.

2.1 Increased Tempo

All missions establish a cycle of knowing, planning, acting, and assessing. The cycle repeats, and if we are to minimize losses and maximize effect the cycle must repeat as rapidly as possible.

Increased tempo of operations makes the Force appear larger.[6] If an attacker can strike an enemy twice in the time necessary for the defender to respond once, the attacking force appears to the defender to be twice as large as it actually is. Given fixed funding to improve capability, though, one can ask whether it is more effective to spend the allocation on improving the performance of existing weapons or to spend it on increasing delivery, or sortie rate. Improvements in performance are produced by improved accuracy of weapons, for example. The two categories are not completely independent, of course. An accuracy improvement in weapons can reduce the number of sorties required per target. Thus, more targets can be struck in a given time, and the force appears to be larger. A simple mathematical theory to analyze the situation described was devised by F. W. Lanchester,[7] a British aeronautical scientist, in 1907. Although modern warfare is more complex than envisioned by Lanchester, his theory has survived remarkably well, and we use it here to motivate the reader to accept our concentration on increasing

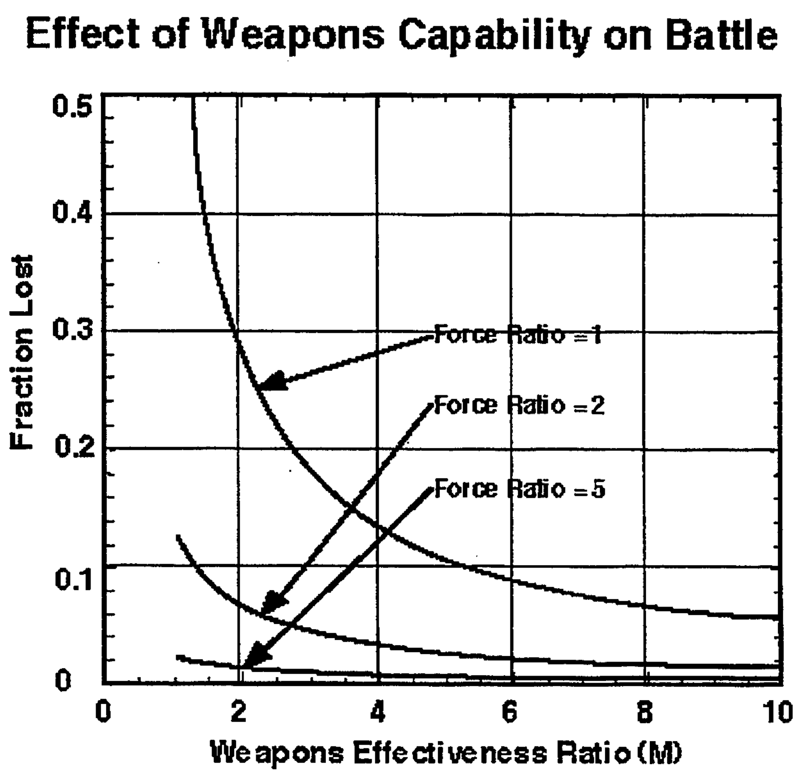


Figure I-1(a)

6. Attack Volume
7. James R. Newman, *The World of Mathematics*, Simon and Schuster, New York, 1956, vol. 4, pp 2136-2157

the tempo of operations. We refer the reader to the reference for a complete description of the Lanchester theory, but we display the results of the theory in figures I-1(a) and I-1(b). Figure I-1(a) shows the fraction of an attacking force lost as a function of weapon effectiveness, M. One can think of effectiveness as accuracy, for example, figure I-1(b) shows the fraction of an attacking force lost as a function of the ratio of the size of the forces. For the purposes of this discussion it will suffice to observe that increasing the force size reduces losses faster than does increasing weapon effectiveness. Because of budget limitations, it is unlikely that we can justify large increases in numbers of aircraft, weapons, or people. Therefore, we will concentrate on technologies which increase the apparent force size through increased tempo of operations.

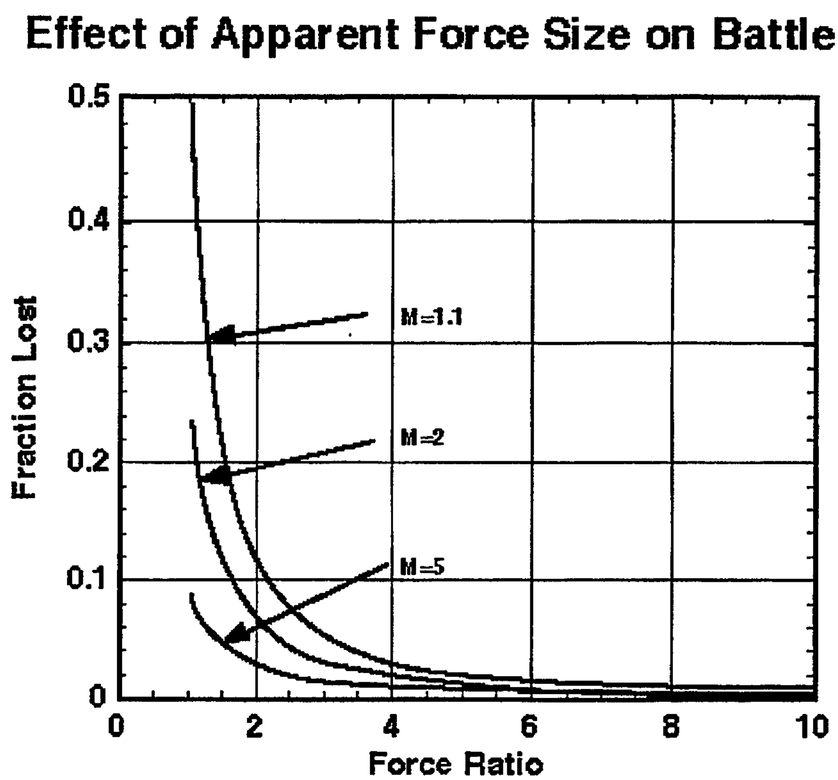


Figure I-1(b)

It is certain that most of the weapon systems that will exist in a decade exist now. The F-22 will be the only new aircraft available in a decade. An aircraft based on the Joint Advanced Strike Technologies (JAST) may appear a decade after that to replace the F-16. By the time that the F-22 and JAST appear, new technologies will be available to enhance their performance, but both aircraft are being designed using extant technologies. Thus, in addition to long range projections, we propose technologies and concepts to enhance the current force during the next ten years. These ideas will also lead to better capabilities for the F-22 and JAST. The technologies that will enhance the early 21st century Force are related to improved weapons, improved communications, and improved generation and exploitation of information. Improvement in the reliability of components such as avionics will be necessary to reduce logistics costs and to maintain extended high tempo operations.

The aircraft now planned for the 21st century, such as the F-22, are superior to existing aircraft in the United States and abroad. They will not, however, produce a discontinuous change[8] in the nature of aerospace warfare. Discontinuous change can occur in several ways. It usually occurs as a result of the introduction of new weapons that rapidly transcend the capabilities of older weapons. Firearms were a discontinuous change over weapons propelled by humans. The machine gun and the tank made the horse obsolete. The airplane destroyed the idea that distance provides protection. To a lesser extent new delivery systems or new tactics can produce a discontinuous change in warfare. The precision guided munition and the stealth aircraft are examples of delivery systems. For certain targets, the precision guided munition increased the destructive power of munitions by as much as a factor of 1000, and the stealthy aircraft reduced the effective range of surface-to-air missiles by a substantial amount. The introduction of naval tactics by Rodney at the Battle of Saints in 1780 and the introduction of the concept we now call reduced cycle time by Nelson at the Battle of Trafalgar in 1805 are examples of the force of a new philosophy of warfare.

3.0 The Future Force

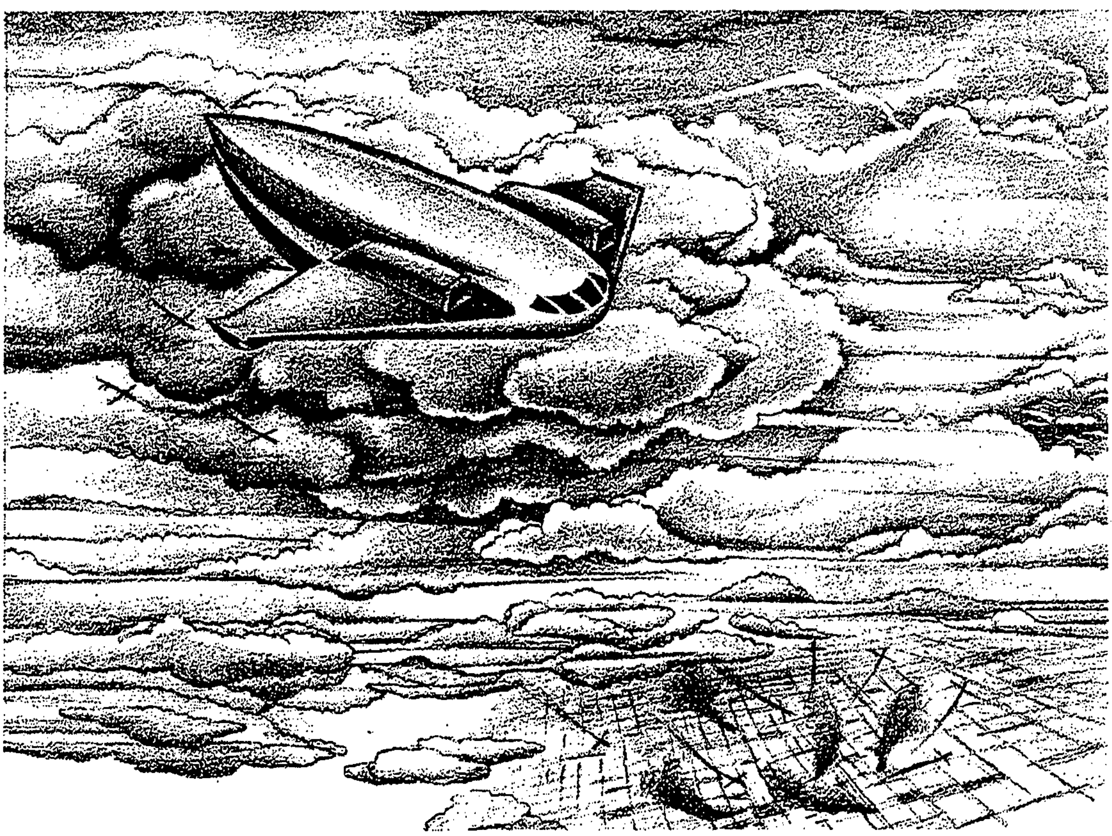
What then are the discontinuous changes of the future, and how are they enabled by technology? Both concepts and technologies are described in detail in subsequent volumes. In this volume we delineate the major features. We will set the stage for the discussions that follow by describing the Air Force that will be built from the concepts and technologies proposed.

There will be a mix of inhabited and uninhabited aircraft. We use the term "uninhabited" rather than "unpiloted" or "unmanned" to distinguish the aircraft enabled by the new technologies from those now in operation or planned. The "unmanned" aircraft of the present have particular advantages such as cost or endurance, but they are either cruise missiles or reconnaissance vehicles. The "uninhabited" combat aircraft (UCAV) are new, high performance aircraft that are more effective for particular missions than are their inhabited counterparts. The UCAV is enabled by information technologies, but it enables the use of aircraft and weapon technologies that cannot be used in an aircraft that contains a human. There will be missions during the next three decades that will benefit from having a human present, but for many missions the uninhabited aircraft will provide capabilities far superior to those of its inhabited cousins. For example, shape and function will not be constrained by a cockpit, a human body, or an ejection seat. We believe that the design freedom generated will allow a reduction in radar cross section by at least 12 dB in the frequency bands currently addressed, compared to existing aircraft. A 12 dB reduction in aircraft cross section will reduce the effective range of enemy radar by a factor of two and area coverage by a factor of four. At this point we reach the limit of passive radar cross section reduction, and active methods must be developed. Also, reduction of infrared emissions is an important area where substantial improvements can be made. Other advantages

8. We will use the terms "discontinuous change" and "revolutionary" interchangeably

of the UCAV will be described later. There is the possibility of extending UCAV performance into the hypersonic range to enable strikes from the CONUS on high value targets in minutes.

Large and small aircraft will project weapons. At present we think of large aircraft as bombers, tankers, surveillance aircraft, or air launched cruise missile (ALCM) launch platforms. In the future large aircraft will be the first to carry directed energy weapons, and their entry into combat as formidable tactical weapons will cause a discontinuous change in aerospace warfare. Eventually, after establishing their value aboard aircraft, directed energy weapons will move into space. Small UCAVs can be carried aboard and launched from large aircraft to provide intercontinental standoff capability.



Attack by Low Observable UCAVs Deployed by Airlifter

Explosive weapons will be substantially more accurate than those of today, and explosive effectiveness per unit mass will be higher by at least a factor of ten than those of today. As a result, a sortie of the future can be ten times more effective than one of today. Weapon types will range from inexpensive enhanced accuracy weapons without sensors to GPS directed weapons with better than one foot accuracy to microsensor directed microexplosive systems that kill moving targets with grams of explosive.

We must extend airlift capabilities. The current generation of military airlifters and commercial transport aircraft will be useful for the next three decades, but replicating these aircraft with evolutionary upgrades will not provide the necessary capabilities. Even the addition of the Civil Reserve Air Fleet (CRAF) cannot provide enough airlift capacity for the future, and while commercial airlifters will form an important component of the future airlift fleet, their capabilities are limited, and they cannot be exchanged one for one with military airlifters. The future airlifter should be large (10^6 pounds gross takeoff weight), efficient (1.3-1.5 times current aircraft), and long range (12,000 nm). It should have point-of-use delivery capability through precision airdrop as a routine delivery process. Full airdrop capability will reduce theater infrastructure requirements for both the Air Force and the Army at forward locations. Rapid tempo of operations will require rapid resupply. As we take advantage of the operational possibilities enabled by technology, the Air Force of the future will be limited by logistics considerations just as surely as were the forces of Hannibal and Napoleon. We must pay close attention.

The future force will become efficient and effective through the use of information systems to enhance US operations and to confound the enemy. The infancy of this capability is represented today in the F–22. Information and Space will become inextricably entwined. The Information/Space milieu will interact strongly with the air and ground components, and it is here that commercial technologies and systems will have the largest presence. Defense will not be a driver of important technologies in this area. Surveillance and reconnaissance will be done worldwide from commercial platforms, and international conglomerates may own some of those platforms. High resolution mapping services from space will be purchased. Worldwide weather monitoring will be possible, although current systems are not capable of adequate precision. Precise timing and positioning services will be provided by a new ultra precise, jam resistant Global Positioning System (GPS). Communication of information and instructions throughout the Force will be instantaneous over fiber and satellite networks. Computers and displays will be common, commercial units. Even avionics processors and data busses will be purchased off the shelf. As we improve the capabilities of information equipment, we should remember that the human is an integral part of the system. We must improve the capabilities of the human-machine interface as we improve the machine.

There is an area where development of defense information systems may diverge from development of commercial systems. Those are *systems used in Information Warfare (IW)*. The use of "information munitions" in offensive operations will become an essential component of warfare. The use of "information munitions" will, however, make unusual demands on software and equipment. At present, it appears as though Information Warfare is more of a "bag of tricks" than a system of warfare. As the technologies are better defined, this will change. We must constantly make IW more robust and more effective. Information Warfare has three components. One is the method, or core, of IW which uses computers and software to deceive and destroy enemy information systems. The second component is deployment. Deployment may be as simple as connecting to the Internet, or it may require special communication systems, high power microwave systems, special forces action, or surreptitious individual action. The final component is Defense. Defensive IW will be pursued by the commercial community because of the obvious effects that malicious mischief can have on commerce. The military problem is, however, likely to be different enough that some effort will be required. The commercial solutions should be monitored closely. It is the union of method, deployment, and defense which creates the Information Munition. These components must not become separated if maximum effectiveness is to be achieved.

Space and space systems will become synonymous with effective operations. In addition to government investment in military systems, US companies will have large investments in space and information systems. The protection of our assets and the denial of capabilities to an enemy will be essential. The future Force will, eventually, contain space, ground, and airborne weapons that can project photon energy, kinetic energy, and information against space and ground assets. Many space and information weapons will destroy. Others will confuse the enemy and weave the "bodyguard of lies"[9] that will protect our forces.[10]

Sensors and information sources will be widely distributed. Sensors onboard fighter aircraft will continue to be important, but they will form a progressively smaller part of the total information source for combat operations. Fighter-mounted sensors, too, will supply information to companion craft as often as they provide information to their bearer. There will be sensors functioning cooperatively aboard small, distributed satellite constellations, sensors aboard uninhabited reconnaissance aerial vehicles (URAVs), sensors aboard weapons, and sensors on the ground delivered by URAVs. We often speak glibly about enhancing capability through information, but we as often forget that information originates as data from active and passive sensors.[11] The power of the new information systems will lie in their ability to correlate data automatically and rapidly from many sources to form a complete picture of the operational area, whether it be a battlefield or the site of a mobility operation. In particular, the accuracy of a single sensor and processor in identifying targets or threats is severely limited. Detection and identification probabilities increase rapidly with sensor diversity and the false alarm probability and error rates decrease correspondingly.

Affordability restrictions demand caution at this point. For the technologist, the intellectual lure of ultra precise sensors and control systems aboard munitions flying at hypersonic speeds is seductive. But, sensors and control systems constitute a large fraction of the cost of a munition, and we see no substantial change to this situation in the future. We properly laud the improvement in capability generated by precision guided weapons. We sometimes forget, however, that Precision Guided Munitions (PGMs) do not always produce an increased operational advantage proportional to their increased cost. This situation can change as a result of reduced sensor costs in the future or as the result of reduced performance requirements. It will always be cheaper to carry reusable precision sensors aboard a reusable delivery platform and either to eliminate guidance and control on board the munitions entirely or to use rather inaccurate onboard systems. The trade between munition precision and platform precision will, of course, depend on the survivability of the platform at appropriate release distances and the dependence of cost on munition accuracy. It may be possible to reduce the cost of precision delivery by building reusable, close approach delivery platforms that have precision positioning and

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9. Winston Churchill, said to Josef Stalin; Teheran; November, 1943
10. General Ronald R. Fogleman, Speech to NDU/NSIA Global Information Explosion Conference, National Defense University, 16 May 1995
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sensing systems, reproducible weapon release, and wind measuring equipment onboard. Munitions can be built with low drag coefficients. Significant cost reduction will result from the reuse of sensors and processors. The munition can either have no guidance or can have simple inertial or GPS guidance and low precision controls. This option favors the low observable UCAV for attack of mobile and protected targets.

Finally, the loop must be closed. The operational components of the Air Force must plan together, function together, command and be commanded, exchange information, and assess results collegially with each other, other services, and allies. Planning and directing must be done in parallel rather than in series to sustain high rate operations. Plans must be analyzed continuously at all levels by simulation. We refer to the construct that makes this possible as a complete "internetting of nodes" and as a seamless "operation across networks."[12] A node can be an airplane, a general, an Army private, a tank, or a UCAV. A collaborating network may be operated by the US Army or by an allied command. Internetting provides for the nearly direct connection of one of the nodes to any other node. Communication channel, processor, and terminal considerations determine the fundamental physical limitations, but with the exception of radio frequency (RF) channels, these limitations are vanishing as practical limitations to the internetting process. Even RF data channel capacities are increasing as the result of new compression algorithms and error correction schemes. Major difficulties remain, however, in establishing priorities for information transfer and in maintaining adequate security. Capture of nodes must not compromise system integrity. Elimination of these difficulties will be neither easy nor inexpensive. *We must solve the important security problems before the full impact of information sciences can be realized.*

This low resolution snapshot of the Force was intended to give the reader an idea of the extensive enhancement and integration of capabilities that will be possible in future decades. We hope that the applications of the new technologies are so profound that they are obvious and compelling, and we hope that they stimulate the reader to create personally pleasing combinations of capabilities. For example, improved stealth provides higher effectiveness against both aircraft and SAMs in establishing air superiority. Improved aircraft performance, say through UCAVs will increase survivability in high threat areas. Together, stealth and performance will reduce the reliance on electronic countermeasures with an accompanying reduction in cost and system volatility, and when directed by offboard information and passive sensors, they have the surprise value of a silent force. Large airlifters with point of use delivery capability can provide the military equivalent of "just in time" supply from CONUS, if necessary, with cost reductions and efficiency increases that are as large as those realized by commercial industries. Accompanied by airlifters carrying UCAVs and directed energy weapons for self defense, the airlifter fleet will become a survivable offensive weapon system in high threat areas. Distributed space systems can revisit areas of interest at rates not now possible. Distributed space sensors can operate cooperatively with staring sensors aboard Uninhabited Reconnaissance Air Vehicles (URAVs), which continuously monitor important targets, to optimize the collection and use of intelligence information.

A word about the application of commercial technologies is appropriate. No one doubts that many commercial technologies are applicable to military problems and that their use can

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reduce system costs and improve utility. There are, however, obligations concomitant with their use. Commercial technologies accompany commercial practices. We must be prepared to change requirements and operating procedures to agree with commercial practice if we are to make efficient use of commercial technology. *In the fields of space, communications, and information, the time from concept to deployment must be no longer than two years. Information systems should be replaced in five years.* Many processes can be improved by an injection of commercial practice, but the price paid for the improvement will be uncertainty in ultimate performance and survivability. Replacement of damaged units will become more acceptable than hardening to reduce cost. A program development culture that generates continuous improvement from humble beginnings rather than ultimate initial performance will be demanded. The new development culture will require an operational culture that can accept less than optimum performance today in exchange for rapid improvement tomorrow. We must demand reduced cycle time in procurement just as we will demand it in execution.

In the following chapters we will provide much more detail about technologies and concepts. Ultimately, however, the Panel Volumes and the Panel Members provide the depth necessary for implementation.

4.0 Revolutionary Concepts in Context

The word "revolutionary" is in common use, and overuse, today. *New World Vistas* proposes concepts that we believe to be revolutionary. The word has been used to mean many things, and it is useful to put the term into a context within which we can discuss new technologies and their use. The word is frequently used to identify a "silver bullet" -- a single concept or device that will immediately produce the ascendancy of the user's forces over those of the user's adversaries. The world is not like that. Science, technology, and military inventions are not like that. Nearly always, it is the evolutionary follow-on of a new concept that produces a revolution in capability. For example, the nuclear weapon was the most revolutionary weapon ever invented. It not only changed the nature of warfare but also it changed the nature of all interactions among nations, and it changed the way all science was viewed by the public. The first two nuclear weapons, however useful as a demonstration of the principle, would not, had they been duplicated many times, have had that affect. It was the evolutionary development of the thermonuclear weapon from the fission weapon coupled with the evolution of the ICBM from the V-2 that produced the profound effects on society. Frequently, too, it is the association of well-known principles in an innovative way that produces the revolutionary result. The geometric arrangement of junction voltages between semiconductors in an unusual way produced a transistor. The evolutionary development of Complimentary Metal-Oxide Semiconductor (CMOS) and integrated circuits has led to the information revolution.

Thus, we can seldom expect to produce truly revolutionary effects with the first manifestation of a new technology. In recognition of this fact, demonstrations should not include all aspects of a new technology. Smaller steps should be taken to minimize the total cost and to permit more flexibility. The first attempt to apply new concepts is a necessary, but not sufficient step. In military systems, the second step in the development of a radically new concept must be determined after operational deployment. The warfighters will use the system in innovative ways not described in the manuals, and it is this experience that will define the path to revolution.

We should keep some general guidelines in mind:

- The relationship between revolutionary and evolutionary concepts is complex and complementary.
- Revolutionary ideas often point the way to later applications which are far more useful than the original idea.
- Early applications of revolutionary concepts should not be required to be complete and final weapon systems.
- Identification and development of revolutionary concepts require intuition, innovation, and acceptance of substantial risk.
- We must be prepared for a failure rate greater than 50 percent.
- Most revolutionary ideas will be opposed by a majority of decision makers.
- We must remember that science and science fiction are related only superficially.

Examples of all these points abound. We invite readers to substitute their favorites.

5.0 The Report

The Air Force must become a force that is tightly integrated within itself, with the other Services, and with allies. It is difficult to write a report on *New World Vistas* that reflects the integration and, at the same time, displays the component parts in a way that makes their development clear. We will try to expose the nature of the problems and their solutions by writing the report from two aspects. In Chapter II, we will remove technologies from their applications and describe them separately, and we will describe concepts that collect the technologies into integrated units. The reader should constantly imagine each technology and each concept feeding and deriving support from the others.

In Chapter III, we will suggest the immediate tasks that will spawn the new technologies. We will even suggest a few fields now pursued which should be abandoned, although our knowledge of Air Force Science and Technology programs is not deep enough to make the list complete. In Chapter IV, we will suggest changing some of the management concepts for the Air Force Laboratories, and we will identify some characteristics of the Scientific Advisory Board (SAB) that can be used to make it more effective. It is well known, however, that self analysis is unlikely to be accurate.

Finally, we observe that the relationship of the Air Force to technology is a living, changing one. It is the character of the relationship and the dedication of the people in the Air Force to the application of the newest principles of science and technology that has made it the envy of the world. To the extent that *New World Vistas* is a part of this process, it should stimulate discussion and analysis as much as it defines new concepts, and its proposals are debatable. If our work causes the Air Force to examine and embrace the notion of discontinuous enhancement through technology, we have succeeded. If a few of our ideas find their way into the Force of the future, our efforts will have been well repaid.

Chapter II

Capabilities and Technologies

1.0 Introduction

We define a set of capabilities which, we believe, are synonymous with an effective Air Force, and we believe that others will agree to their importance. They do not match accepted Mission Areas for two reasons. We experimented with Mission Areas at the Spring Workshop[1] of *New World Vistas*. We found that Mission Areas were closely related to existing capabilities, and we naturally began to think of new technologies as producing evolutionary enhancements to existing capabilities. Many participants thought that the categories were too narrow and restrictive. Second, when we collected the new ideas they formed categories which mapped into the Mission Areas, but the ideas each applied to several areas, and we began to generate a complex set of charts. Constructing the map is straightforward and instructive, but we leave it as an exercise for the interested reader. We decided to form a set of categories which were natural ones for the technologists and, simultaneously, meaningful for the operators. These primary capabilities, as viewed by the technologist, are entirely consistent with the capabilities of Global Reach-Global Power and the Air Force Core Capabilities. These categories form a bridge for discussion between scientist and warfighter, and we felt that to be a dominant factor in an activity such as *New World Vistas*.

We reduced the list of essential capabilities to a basic few. We intentionally made the categories broad to encourage broad thinking about important problems. The list is short and is meant to be viewed in the context of the Air Force concept of Global Reach-Global Power. The primary capabilities are:

- Global Awareness
- Dynamic Planning and Execution Control
- Global Mobility in War and Peace
- Projection of Lethal and Sublethal Power
- Space Operations
- People

One can argue that the categories mix support, or infrastructure, and operational capabilities, and that is, indeed, true. However, the 21st century will be characterized by an increasing reliance on devices which operate at the edge of technology and by an increasing worldwide infrastructure in space. Therefore, the education and training of Air Force people will enable all operational capabilities. We must remember, too, that space will contain major threats to the security of the Nation and its Forces as well as containing important operational assets. We believe that Space Operations and People deserve equal footing with the other capabilities.

Each of the capabilities expand to include many subcategories, and each depends on many technologies. In this chapter, we will describe the capabilities and relate the technologies to them. The major technologies will be listed in Chapter III. Do not expect completely logical one-to-one correlations or extremely detailed expositions in this volume. Those features are

1. *New World Vistas* Spring Workshop, Maxwell AFB, AL, 2-5 May 1995

characteristic of the Panel volumes. We will direct the reader to the appropriate volume through footnotes.

It is our intent to emphasize the close integration of the technologies and the capabilities with one other. Therefore, we will refer to some systems or technologies several times in the chapter. This is not an unintentional redundancy. It is to impress on the reader that capability is based on dependency. We can not afford -- financially or operationally -- to have all systems self contained to the extent that they are now. Offboard sensors and weapon control provide enhancement of capability far beyond their cost. Replicating information functions on all weapon platforms is not only extravagant, it is also less operationally effective than central information processing.

The list of essential capabilities reflects the effect of uniting the Air Force with technologies that will produce a discontinuous enhancement of Air Force capabilities. Those technologies are variously named "high leverage", "revolutionary", or "explosive growth" technologies. A more useful and accurate description is that certain technologies are "coming of age". Information technologies are now an essential part of all Air Force activities, and they will be even more important a decade from now. We should remember, though, that computer programming was an undergraduate course at many universities in the 1950's. The transistor, which makes it all possible, was invented in the 1948. We illustrate this concept intuitively in Figure II-1, which is a graph of a parameter, which we call "importance", that started with a value of 1 and doubled every four years. Importance could be computer speed, PGM performance, or another important measure of the value of a technology.

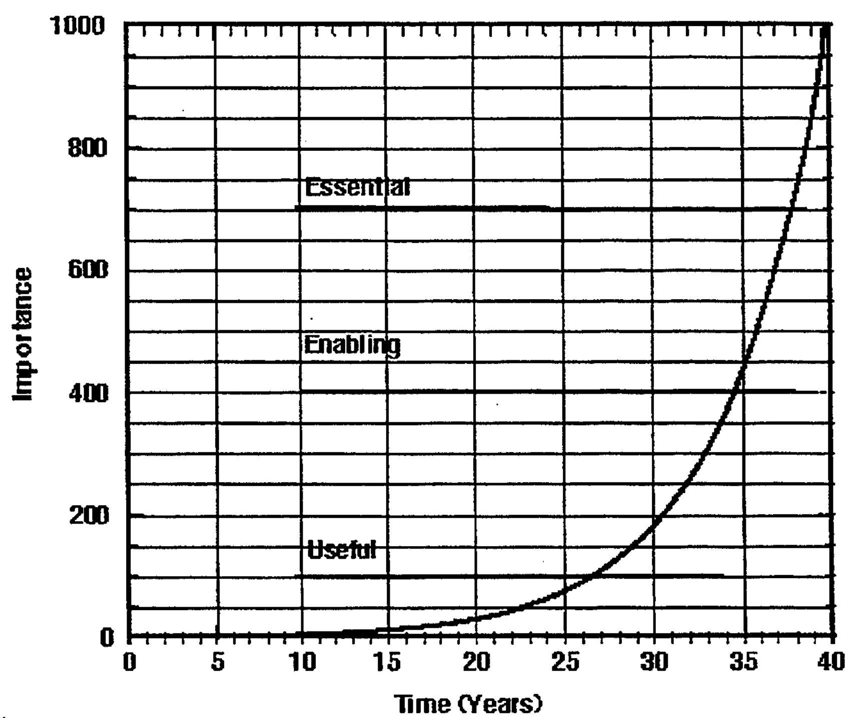

Figure II-1

If one looks back from a period when the importance has grown by a factor of 1000 from its initial value, the growth seems to be explosive for the past most recent decade, but it seems that nothing much happened for the first 20 years. In fact, the relative growth was constant. This is not a new observation, but it makes the graphical point that in *New World Vistas,* we are trying to define capabilities that make immediate and efficient use of technologies which have passed the "700" point. Next, we will show uses and effects of the technologies which have passed the "400" point. Finally, we will suggest new capabilities which will demonstrate the use of technologies at the "100" point. One could, for example, identify these states with information technologies, space technologies, and directed energy technologies, respectively.

2.0 Global Awareness

Global awareness means that the Air Force can use affordable means to derive appropriate information about one or more places of interest after a delay which is short enough to satisfy operational needs. This is the goal of the capability we call Global Awareness, but the definition is far too vague to be of practical use. We will explore the idea by describing the strengths and weaknesses of the systems which can make it possible. There is a strong commercial component here, and we will show the connection between military and commercial applications. The systems which enable Global Awareness form a truly joint capability. Although we describe Global Awareness in an air and space context, the application to sea and land should be clear.

Technology has for years made it possible to build relatively inexpensive observation platforms in space which will deliver images from optical or radar sensors at resolutions better than one meter. Images from a few systems are commercially available now, and there will soon be competition among companies to deliver the best product. The Air Force, or the Defense Mapping Agency, should purchase these products for mapping the world at a resolution of one meter. This provides Global Awareness of a sort, but the latency time for a world map is expected to be 90-180 days with local updates of, say, 100 mile square areas in 24-48 hours. A dedicated system could provide high resolution images of several small areas daily. This is an essential capability, but it is not completely adequate.

Mapping at present consists of a huge number of products both digital and analog constructed on an array of coordinate systems with varying precision and accuracy. First a common grid based on WGS-84 should be defined. It may be useful to supply maps which are expressed in unique coordinates, but the source for all these maps should be a common database. The database can be supplied by the commercial imaging system described above. It is not likely, however, that absolute accuracy will be one meter, but it is possible to devise a GPS-based method of calibrating the images. Collaboration with the commercial supplier in satellite design could make the calibration task easier. The goal of precision mapping should be to equip each aircraft and planning system with a map of the entire world to one meter accuracy. The map will require 10-20 terabytes with suitable compression. After the creation of the initial map, only updates need be supplied routinely. Onboard storage will minimize data transmission needs. Storage density will be adequate in a decade. We refer to the high resolution onboard digital map as the "onboard world."

The "onboard world" will enable the ultimate in moving map navigation and self contained, undetectable terrain avoidance. The information can be coupled with navigation aid and airport information supplied by commercial vendors. All Air Force aircraft will have the navigation database to fly anywhere, anytime, on any route independent of external data.

2.1 Distributed Satellites

The manifestation of the concept of Global Awareness is one of distributed constellations of small satellites[2] which cooperate with airborne and ground sensors. We must divest ourselves of the mindset that spatial resolution is the only criterion for evaluating surveillance systems. There are indications that one can derive target information from spectral data coupled with low resolution position information. A system of satellites each having a spatial resolution of 10 meters and, say, 100 spectral bands in the visible and infrared could provide worldwide coverage instantly on demand. Communication limitations will restrict the number of areas which can be covered simultaneously, but even this restriction will disappear as laser cross- and downlinks become commonplace. Laser links will approach the capacity of fiber, where 40 Gb/s is becoming routine. Onboard processing and compression can increase information transfer rates. Because of higher cost and the $1/R^4$ dependence of signal on satellite altitude, Synthetic Aperture Radar (SAR) systems will be fewer than optical systems, and SAR images will have a latency time of an hour or two.[3] Active systems could also include Light Detection and Ranging (LIDAR) for chemical and biological agent detection in clear weather and for precision weather observations. These systems will provide missile warning and will enable the tracking of mobile rocket launchers and SAM systems. They can also provide weather information at a level of detail appropriate for combat and mobility operations. High resolution active and passive systems can augment the lower resolution data at revisit rates of one per day. The cooperative, distributed satellites will establish long baselines for precise location of radio frequency emitters on the surface and in space. It will be possible to locate an emitter to an accuracy that will permit the launch of a precision guided munition using GPS coordinates even if transmissions cease.

Onboard processors will make it possible to identify and track moving targets to the extent that tracking and identification can be done by infrared hyperspectral systems. Complete Airborne Warning and Control System (AWACS)-like performance will be enabled at the second stage of deployment[4] with a combined air and space based system. High resolution radar from space can be enabled by the capability to deploy large, lightweight space structures. Given power available in space, continuous operation of high resolution radar will necessitate antennas having diameters of kilometers. Development of appropriate structures and materials coupled with technologies for correcting RF wavefronts to compensate for antenna imperfections will make space based radar possible. If one requires only limited coverage, say 500 km (the limited diameter), the peak power of a space based radar system can be increased by operating at a duty cycle of only 1/250. It is then necessary, however, to launch enough satellites to provide continuous coverage. Such a system is not likely to be affordable. A bistatic space-based arrangement with transmitter and receiver separated may provide some relief. The receiver can be composed of a distributed constellation to construct an instantaneous synthetic aperture.

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3. The fundamental equation of RADAR shows that the detected signal is inversely proportional to the fourth power of the distance, R, to the target. It is this strong dependence on distance that severely limits the range of a RADAR system.
4. Sec. 2.2 of this chapter

A detailed design of a bistatic system may point the way to cost savings, but the prospects are not encouraging for the next decade. The Uninhabited Reconnaissance Aerial Vehicle (URAV) appears to be the most cost effective vehicle.

Observe that 10 meter resolution does not restrict location to 10 meters. Centroid location is a question of signal-to-noise, and there is no reason that centroid location cannot be done to 2-3 meters. Thus, lower spatial image resolution can be coupled with precision targeting. If the target can be identified with a low resolution hyperspectral imaging system, the aimpoint can be located to approximately 2 meters. It appears that, if preliminary experiments are verified, the 10 meter hyperspectral system will provide a global observation system which is affordable and effective. We have defined the following space based system to provide maximum affordable coverage world-wide:

1. Continuous multi-spectral observation at 10 meter resolution with 2-3 meter targeting
2. Continuous location and targeting of RF emitters to 10 meters
3. SAR with 1 meter resolution once per hour
4. Sub-meter resolution once per day, multispectral and SAR

2.2 Standoff Systems

The systems described in Sec. 2.1 are non-intrusive. At the next level of involvement other possibilities arise. If it is possible to position vehicles within 200-300 nm of a region of interest,

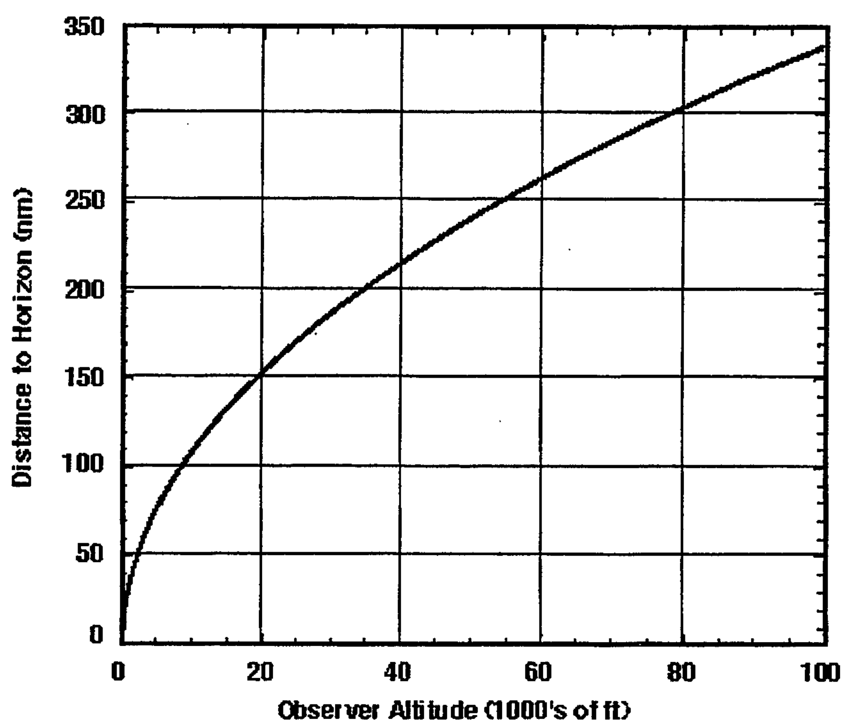

Figure II-2

high resolution staring sensors and SAR's can be carried on URAVs that loiter at 50,000-100,000 feet. Figure II-2 shows range to the horizon from a given altitude.

Continuous monitoring at a resolution of one meter or less is possible. URAVs can work cooperatively with satellite constellations by projecting high power RF beams over the area of interest. The satellites receive reflected signals from targets near the earth to form a distributed bistatic synthetic aperture radar system. Clutter rejection is improved because of the varying reflection angles to different satellites. Moving and fixed targets can be detected with high resolution as the result of the long baseline between satellites. This arrangement limits the number of expensive spaceborne transmitters by restricting coverage to a region of interest. We have added:

5. Continuous Multispectral and SAR observation at 1 meter resolution
6. Continuous bistatic detection and tracking of fixed and moving targets over a limited area

2.3 Overhead URAV Systems

Further improvement in resolution can be obtained in situations where overflight of enemy territory is authorized. Low observable URAVs can carry staring and scanning sensors which produce multispectral and SAR images and LIDAR returns at few centimeter resolution. The URAVs can deploy low altitude or ground based chemical sensors for accurate discrimination of Chemical & Biological (CB) agents and the effluents from Chemical, Biological, and Nuclear (CBN) manufacturing plants. These sensors can be interrogated by driving readout with an RF or optical signal from a satellite or a URAV. The remotely read sensor will have reduced size, weight, power, and vulnerability. Now, the system consists of:

7. Continuous multispectral and SAR observation at 1 centimeter resolution
8. Contact sensors for CBN detection.

2.4 Unattended Ground Sensors

We mentioned the integration of ground sensors into the Global Awareness network as CBN detectors, but a few specific observations should be made. Unattended ground sensors are at present difficult to deploy and to monitor. Deployment by manned intrusion, air or ground, is the norm.[5] It is not clear that deployment and operation are Air Force missions. Technologies now under development and the need for detailed awareness in specific areas of the world can change the situation completely. In addition to CBN detectors, ground sensors are natural candidates to monitor the local weather. *Weather monitoring from space is possible, but ground monitoring can be more accurate, more continuous, and far less expensive.*

Ground sensors can be deployed by miniature UAV's carried aboard larger UAV's. Microsensor development is proceeding, and, as noted, novel readout methods which have a low probability of intercept (LPI) have been proposed. *The Air Force should investigate the advantages of ground sensors for local monitoring before committing to more expensive space and airborne sensors.*

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2.5 Practical Considerations

It is in the region where friendly and enemy airspace meet that the AWACS and Joint Surveillance, Target Attack Radar System (Joint STARS) systems will begin to participate. These systems will continue to be very valuable for the next decade, but it is now time to consider the next generation. Some of the functions of these systems can be implemented in space, but for continuous coverage aircraft, deployment appears to be more practical. The $1/R^4$ factor in the radar equation exacts great concessions from a space based system. The geometric factor and the limited power from the satellite power bus will limit coverage area severely. The deployment of airborne transmitters and satellite receivers in a bistatic geometry as described above is possible, and this may be the ultimate system. After a decade from now, URAV deployment is likely to be the method of choice, although there is a long term possibility for shifting the balance of continuous surveillance completely back to space. It has been proposed that very large, lightweight structures can be deployed in space to create optics and antennas having dimensions of kilometers.[6] It is the product of power and aperture that determines signal-to-noise, all other factors being equal. The URAV and space options are attractive as replacements for AWACS and Joint STARS. Both the AWACS and the Joint STARS use much of their volume for crew and displays, and loiter time is restricted by fuel consumption and crew limits. The systems of the early 21st century should use high speed processors which will exceed current performance by a factor of 10,000 for AWACS and 1000 for Joint STARS. Processor volume should be no more than 1 m^3. Communication rates of 100 MHz to satellites will be practical almost immediately, and lasercom will appear in a decade. Multiple URAVs can detect and process signals coherently to provide large increases in resolution, and loiter times of tens of hours without refueling are possible.

It is unlikely, of course, that the entire collection of sensors would be deployed simultaneously in a single area of interest. The arrival of higher resolution systems can free the lower resolution systems for use at the periphery of the area of interest.

These systems offer the possibility of monitoring the entire world continuously at reasonably high resolution. By now, the reader has realized that the data rate may be impossibly high. Consider that the actual information content from a 10 m system is one bit per pixel spatial and 100 bits spectral. Both SAR and visible images assume that the total information content is 100 bits/pixel over the entire world once per hour. The data rate is approximately 40 GBits/s continuously. If we observe one percent of the world, $1.3X10^6$ km^2, at a rate of once per second the data rate is $1.3X10^{12}$ /s (1.3 TB/s). State of the art for a single optical fiber is 40 GB/s, and 1.3 TB/s necessitates only 40 fibers. In 10-20 years laser cross- and down-links will be capable of these rates, too. The important issues, however, are: Why would one want so much information? Who would look at it? How much would be stored? How would it be analyzed? The possible is not necessarily the sensible.

Surveillance of all of Iraq at a rate of once per hour would produce a data stream of only 85 MB/s, and once per minute would require 5 GB/s. More reasonable problems produce more reasonable communication rates. Certainly, these rates are not out of the question today, and they will be delivered routinely in a decade.

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6. Space Applications Volume

Satellite numbers are given in the Panel volumes.[7] We mention number here because it is connected to significant issues of cost and commercial involvement. There are many factors involved in determining the satellite number, but the range will be 100-300 satellites. These numbers are similar to those of the Iridium or Teledesic systems, because the coverage considerations are also similar. The 10 m resolution chosen for the distributed system is also consistent with the size of the commercial satellites. In fact, it may be possible to install passive multispectral sensors on the commercial satellites and to share satellites and communication systems. Ownership of satellite systems by multinational corporations may make sharing undesirable from both the US Government and from the corporation points of view. It may be possible, however, to buy standard satellites from the commercial organizations and to modify them for military purposes. *We estimate the cost of modification for an independent military system to be $10-20M per satellite. Active sensors are more expensive but they will be fewer. For launch costs of $10,000/kg, the weight should be kept below 100 kg to make deployment cost effective.*

2.6 Dissemination of Information

So far we have discussed the part of Global Awareness related to learning about an adversary or about a situation. We have also described it mostly in terms of sensors. There is much more to it than that. We must have a perfect picture of our own and allied forces as well. The picture should include aircraft maintenance status, crew health and availability in addition to location and mission status. The mass of data associated with our own forces is large, but it can be organized by common agreement. It is probable that each Service will configure its databases and information systems in a unique way, and it is certain that our allies will do so. *There is no reason for the differences to limit system effectiveness, but a generic capability to operate across dissimilar networks will be essential.*

Another class of information is essential to Global Awareness. That is information derived from the databases of the adversary. Techniques for mapping and penetrating the military and commercial systems of the enemy are needed. The penetration of enemy databases will, frequently, be more valuable than destroying a Command, Control, Communications, Computers, and Intelligence (C4I) system for obvious reasons. The inverse of penetrating enemy systems is protecting our own. As we become more dependent on integrated information systems we must protect them vigorously. *The Air Force must develop protection technologies.*[8]

We have discussed the collection of data. It has been shown that the communication of data to analysis stations is within the state of the art. The information will be processed and correlated at a few centers . This is not a trivial problem, but we know how to solve it. *Analysis and correlation of data must be done across databases having thousands of variables.*

The final action is the transmission of appropriate information to the nodes which need it.[9] Transmission and request must be done in both directions from operational nodes to information centers and from node to node. There is a growing tendency to demand wide area broadcast of information. Broadcast will be of use while ground based fiber networks are not available and where only a few geosynchronous satellite channels can be used. Broadcast will be useful

7. Space Technology Volume
8. Information Applications Volume
9. Ibid

in the near future when the total volume of sensor data is small, but the amount of information increases, broadcasts will become cluttered or will contain many frames. The full internetting of nodes will enable each node to construct data flow and presentations which satisfy the unique needs of that node. Broadcast of information tends to generate specialized transmission and receiver systems which can be of limited utility. The need for broadcast rather than unique presentation to each node should be verified carefully. It is certainly true that Direct Broadcast Television (DBTV) has become a commercial product with 100 channel capability in a ground station which sells for less than $1000. Most of the cost, of course, is in the space segment and in the generation of programming. *Information broadcast in the DBTV mode will be an important interim capability, but eventually it should be integrated into an "information on demand" system.*

2.7 A Necessary Adjunct System

Almost all of the processes related to Global Awareness need precise and absolute positioning and timing. The most reliable and the least expensive way to provide it is through a space based Global Positioning System (GPS). As the precision of all operations increases, so must that of GPS. *We strongly suggest that the Air Force develop a system that has 30 cm spatial accuracy and 1 ns timing accuracy.*[10] All services are now dependent on GPS, and as that dependence grows, and it will, protection of GPS capability is essential. The receiver enhancement methods now proposed will not be completely adequate as the capabilities of our enemies grow. The satellites and codes must be redesigned to provide both adequate performance and adequate protection.[11] *Code chip rate can be increased by a factor often, and signal power can be increased by a factor of 100 to give an improvement in jamming protection of 30 dB.*

2.8 Databases

The concept of Global Awareness is a complex one. Much of the information which is needed to construct the global picture exists today in computers somewhere. *The problems of the next decade are to identify the relevant databases, to devise methods for collecting, analyzing, and correlating them, and to construct the needed communication and distribution architectures.*

2.9 Strategy

The summary of Global Awareness is an extended one. We justify the length by noting that it is here that the commercial interface is likely to be most extensive. *Close attention must be paid to the use and optimization of commercial information, satellite, and space launch capabilities.* This task is not a familiar one to the Air Force. It involves major changes in the ways needs are interpreted and in the ways that systems are designed, procured, and discarded.

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10. Space Technology Volume
11. Munitions Volume

3.0 Dynamic Planning and Execution Control

3.1 Planning and Simulation

Dynamic Planning and Execution Control exploits the information derived through Global Awareness. It is not possible to increase the tempo of operations without increasing the tempo of planning.[12] Planning time should be reduced from days to hours or even minutes. Joint planning will be essential. Reduction of planning time also reduces the time available for review and checking of plans, and the burden of verifying accuracy and effectiveness must shift to automatic systems. Verification of plans will be done by the continuous simulations of the plans using current information about all forces. Consistency checks should be part of all planning and command systems. Displays and planning tools will permit commanders to compare simulations and plans, and to change both easily and consistently. People and databases involved in the Planning and Control process may be separated by thousands of miles. The system will support collaboration through virtual meeting facilities.

3.2 Execution Control

We refer to Execution Control rather than Battle Management as a way of emphasizing that planning and control systems should integrate Mobility and Attack planning in both war and peace. Mobility resources are at least as limited as combat resources,[13] and supply and use of supplies must be coordinated at the same rate as combat operations. Resources used to provide Global Awareness must be integrated into the Execution Control system to supply the information needed for planning and execution at the rate needed to support mobility and combat operations. In an integrated force, the tempo of operations can be no faster than the cycle time of the slowest component of the system. It may be necessary to automate the interpretation of voice commands[14]and responses and to provide automatic translation from one language to another.[15] Although automatic translation may appear to be a distant dream, one should realize that many situations use highly stylized language which should be amenable to machine interpretation and translation.

We should not concentrate solely on producing plans and execution orders at the highest possible rate. The planning and simulation facilities should provide long range estimates at all times. For example, the procurement of a replacement part and its shipment to the point of use may require days. A long range estimate of parts requirements should be produced days ahead of a projected use time. Building munition stocks requires time, but overbuilding stocks is an improper use of mobility resources. This does not mean that long-term plans will not change from, even, hour to hour, but estimates should be consistent and reasonably constant. The automatic systems should be aware of "commitment" times after which changes cannot be made. It is apparent that the execution control system will use expert system technologies extensively.

12. Attack Volume
13. Mobility Volume
14. Information Technology Volume
15. Human Systems/Biotechnology Volume

3.3 Processors and Communications

The computer and communication systems which are needed can be defined in a straightforward way.[16] The Air Force should be prepared to procure high speed parallel computing systems to make the Dynamic Planning and Execution Control system work. Parallel computing over networks is well along in development and will be perfected by the commercial world. The Air Force should take advantage of these developments. Distributed satellite systems, partly or wholly commercial, are a natural way to provide affordable connectivity where fiber is nonexistent. We depend more and more on commercial terrestrial communications networks, because they are redundant, reliable, survivable, and cost effective. We seem to insist, however, on developing military satcom systems in spite of their exorbitant cost and limited performance. During the next decade commercial satcom systems will exceed the capacity and reliability, if not the survivability, of the military systems. Commercial systems will have multiple ground stations which connect to the worldwide fiber system. They will eventually use laser crosslinks and downlinks that will dramatically increase redundancy of the systems. It is likely that the commercial systems, or DoD-owned commercial-like systems, can be used for military purposes more reliably than can completely unique military systems. This will be especially true if other nations develop anti-satellite systems. *The Air Force should consider carefully before investing further in dedicated military satcom systems.*

Digital communications to and from aircraft will be an important aspect of future warfighting. Links of interest include those for one-way broadcast and two-way command and control. For one-way broadcast, adoption of civilian satellite technology is an interim solution which will enable cheap one-way reception of information on a theater-wide basis. Such a wide-area broadcast service would permit all aircraft to receive critical warning messages, weather, and real time surveillance regardless of their location in the theater.

Two-way links for high performance aircraft, whether to satellites, URAVs, or large aircraft, continue to present a challenge. Current systems (low cost modems and higher cost JTIDS) already permit digital links to fighters. Wide area networks can be established through use of gateways on URAVs or large aircraft (such as the Joint STARS or AWACS). Figure II-3 shows the line of sight range between a relay transmitter and a fighter for various altitudes. A URAV at 60,000 feet can transmit line of sight to a fighter at 20,000 feet over a range of more than 400 nm. We recommend that technologies appropriate for direct satellite links to fighters be explored, but the Air Force should continuously evaluate the cost and utility of direct satellite links compared to links through aircraft.

Direct Satellite link to large aircraft and to URAVs is a much simpler and less expensive option. Certainly direct satellite links should be provided to all airlifters, AWACS, Joint STARS, URAVs and tankers. Commercial carriers will probably suffice for the airlifter links and, perhaps, for the tanker links.

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16. Information Applications Volume

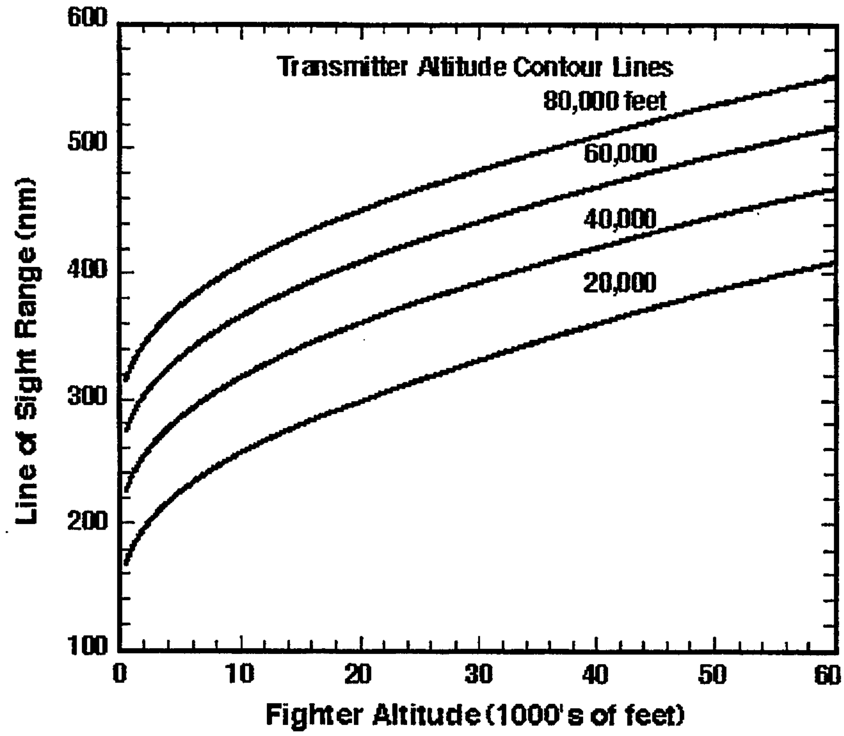

Figure II-3

3.4 User and Developer Interactions

The interaction of users with all systems must be flexible, secure, and situation dependent. Intelligent Agents[17] can be developed to support the interaction. Flexible connectivity can be achieved with commercial operating systems, network protocols, and programming languages. Some argue that only unique military operating systems and government standardization of equipment and protocols can guarantee security. Exactly the opposite is likely to be the case. Creation of a single unique universe increases the probability of a single point failure which can destroy the entire system. The folly of that logic was recognized millions of years ago in biological evolution, because the absence of biological diversity in a species makes the entire species susceptible to a single virus. The Air Force must beware the natural human tendency toward absolute standardization.

It will be necessary to develop security and priority systems which overlay or integrate into commercial systems such as UNIX, the Internet, and C++. These additions should be constructed such that commercial software development tools can be used. The Air Force should not be in the software tool business. Nor should the Air Force be in the computer language and compiler development business. A capability for the use of Ada should be maintained for special cases where it is appropriate. In general, however, Ada has become irrelevant in the information world. Other languages are developing much faster. Insistence upon its use increases

17. Information Technology Volume

cost and development time of systems and reduces the availability of commercial software and tools. It is time that the use of arcane languages such as Ada be relegated to situations where nothing else will suffice.

3.5 Caveats

We have suggested what to do, but it is as important to say what not to do. At all cost the Dynamic Planning and Execution Control System must not be planned as a closed, finished product. If it is to utilize rapidly developing technologies it must be open ended. It should be a growing organism which incorporates advances naturally and gradually. *The Air Force must avoid designs which demand permanent adherence to particular hardware, languages, or operating systems.*

An organic, growing system can be planned and built one section at a time. It is now time to get on with it.

4.0 Global Mobility in War and Peace

Mobility can be the limiting factor in operations. Airlift is also in demand during peacetime for humanitarian operations. Humanitarian operations bring special problems to the Air Force, because they may require airlift aircraft and people to enter regions of high danger. It may not be possible to provide external protection for airlifters or external response to attack. The safety of mobility operations will be increased greatly by Global Awareness and by Dynamic Planning and Execution Control. The Air Force airlift system will be integrated into both systems. Today, it is technologically possible to track shipments and aircraft in real time at reasonable cost. New commercial satellite systems, such as Iridium, can be used to enhance that capability at lower cost and higher reliability.

Airlift is the only transportation mode which can respond to a crisis worldwide in days. The capacity of the system planned for the next two decades is less than that required to support existing forces,[18] even with the addition of the Civil Reserve Air Fleet (CRAF). Airlift capacity depends on storage areas, cargo handling equipment, refueling facilities, and airport capacity as well as on aircraft. Reduction in cargo handling equipment, which includes Army supply trucks, increases capacity, because that equipment is frequently delivered by airlift. We need to improve the efficiency of both aircraft and of delivery methods.

We should search for mobility improvements which are not related to increasing the number of carriers. The capacity of the mobility system depends on lift capability and velocity of the carriers. It is unlikely that the speed of ships, trucks, or aircraft will increase significantly during the next three decades for the bulk of delivered cargo. It is possible to increase the size of vehicles by 50, or even 100 percent, but cost per unit mass delivered will not decrease by as much. Therefore, we seek technologies which reduce the time enroute by other methods and which reduce the amount of materiel needed.

18. Army Science Board 1994 Summer Study - *Capabilities Needed to Counter Current and Evolving Threats*, April 1995

4.1 Future Airlifters

Worldwide coverage will require aircraft that can fly 12,000 miles, deliver cargo, and return without refueling at the terminal point. Air refueling is a logistics intensive operation, and airlifter refueling can be eliminated. Cargo capacity for airlifters of the 21st century should be 150,000 pounds. With improvements in aircraft and delivery methods, the gross takeoff weight will be 1,000,000 pounds.[19]

First the aircraft. Aircraft such as the C-17 or the B777 are impressive airplanes that outperform their predecessors. They are, however, evolutionary improvements over earlier designs. We asked whether there are aircraft technologies that could give much better performance. The answer was -- yes.[20] The technology lever appears to be large improvement in lift to drag (L/D) ratio of a wing coupled to evolutionary improvement in engines. We examined the Wing in Ground Effect (WIG) as a possibility. Improvements of 20 percent appear possible at altitudes of 0.1 times the wingspan, but there are many drawbacks in the WIG system. It operates at altitudes of a few feet and is restricted to over water transport. We then asked whether there are improvements possible to wings operating out of ground effect. Again, the answer was -- yes. It has been observed that high L/D wings have high aspect ratio. For heavy loads, the wings become quite long and they twist. If the twisting effect can be eliminated, the efficiency of the wing can be increased significantly. A possibility which has been investigated is to add a second fuselage.[21] Calculations indicate that a 40 percent increase in aircraft efficiency can be obtained. The drawback of this system is that wider runways and larger parking areas are needed. Ultimately, new materials should add adequate stiffness to a wing without increasing weight.[22] *In general, it appears that wing research could pay off in significantly higher aircraft efficiencies.*

Engines are undergoing noticeable, if evolutionary, improvements, too. Efficiency increases of 20 percent should be realized during the next decade or two.[23] Significant increases in engine efficiency may be possible through applications of modern adaptive control methods to engines. Fast response controls can reduce the operating margin now reserved to provide protection against engine surges. Improvements of 10 percent appear possible. Further improvements of a few percent may be achieved by using magnetic or air bearings rather than mechanical bearings.

4.2 All-Weather Operation

An improvement that could increase delivery rates substantially in many parts of the world is all weather operation. Auto landing (Category III) using differential GPS and the civil Clear Access (C/A) codes has been demonstrated. The GPS autoland system can also guide the aircraft during taxi in zero-zero conditions (Category IIIc). A wide area differential system, which does not require nearby ground stations has been proposed and demonstrated through the Joint Direct Attack Munition (JDAM) program. Accuracy of 30 cm has been demonstrated. This capability will enable autoland and "blind" taxi anywhere in the world without the addition of equipment on the ground. Installing this capability in airlifters should certainly be a high

19. Mobility Volume
20. Aircraft and Propulsion Volume
21. Mobility Volume
22. Materials Volume
23. Aircraft and Propulsion Volume

priority. Commercial equipment can be used extensively to construct the wide area differential system. Jamming resistance is not improved by the differential system. Its primary advantage is that it can be done now. *It should be done immediately.*

4.3 Point-of-Use Delivery

Next -- delivery methods. An item shipped by military airlift from one point to another will usually spend more time on the ground than in the air during the shipping process. Technology can help to reduce the ground time by providing planning and scheduling of delivery and distribution as mentioned earlier. Efficient planning coupled with real time simulation can help one make the most efficient use of facilities and equipment. It cannot, however, compensate completely for too few cargo handling devices, too little ramp space at receiving airports, diversions because of weather, or damage resulting from enemy attack. If we attempt to deliver to austere runways near a combat area, we place airlifters in danger. Even in peacetime, such as now in Bosnia, delivery is sometimes canceled because of dangerous conditions during landing and takeoff. Bosnia is also an example of a theater where point-of-delivery and point-of-use are separated by hostile territory.

The technologies needed for evolutionary improvements which will enhance capacity are clear. For example, in addition to the planning and execution improvements noted above they include improvements in onboard and offboard handling equipment. We sought ideas that could provide more substantial improvements in delivery rate. The one we have chosen to describe in detail is "point-of-use delivery". The purpose of point-of-use delivery is to reverse the ratio of cargo ground time to cargo air time. Approach and landing delays will be eliminated. All weather operation will be possible. If cargo can be delivered directly to the user, airport bottlenecks will be eliminated. Secondary benefits will further increase delivery rate. Many of the K-loaders that unload the aircraft will not be needed. Many of the trucks that carry cargo from airport to user will not be needed. The warehouses that store cargo waiting for user pickup will not be needed. Some airports will not be needed. The amount of cargo handling equipment delivered by airlift will be reduced, and the space can be used for cargo. Land transport through enemy territory will be avoided. Cargo density on the ground will, of necessity, be lower than in storage areas, but average delivery density can be higher than on an airport.

If point-of-use delivery can become routine, the effect on Army operations will be profound. This is a truly revolutionary capability. It will be impossible for an Army unit to outrun its supply train. Mobility and maneuver flexibility will be that of the fighting unit rather than that of the supply unit. Supplies will be delivered by large airlifters rather than by truck or helicopter. Possibilities for enhancing maneuver effectiveness are nearly endless. Point-of-use delivery is more than precision airdrop, although it includes precision airdrop. The problems:

- Deliver cargo without landing the aircraft to an accuracy of 10-20 meters from altitudes up to at least 20,000 feet.
- Load aircraft with cargo and drop equipment at the same efficiency as for land delivery.
- Extract cargo in random order.
- Recover and reuse drop equipment unless cost per drop unit is negligible.

At present airdrop is an emergency procedure. Accuracy is poor. Two methods have addressed the problem of improving accuracy. One is to measure wind profile with a LIDAR[24] or a GPS dropsonde and to compute a release point (CARP) based on the wind. The accuracy of this method is limited to 100 meters by parachute reproducibility and measurement accuracy. The second method uses a large, steerable parafoil with GPS based guidance. Both the parafoil and the control system are expensive, and the cargo lands with high forward velocity. A combination of the methods where the parafoil is replaced with a much lower cost system may be effective and affordable. Standard, non-steerable parachutes exhibit forward motion at a few knots. If wind measurements can be made, the forward or "drive" velocity will be adequate to compensate for wind measurement errors. The system can be steered by a GPS controlled steering system on the load. Load mounted steering will permit the use of balanced aerodynamic forces, or trim tabs, and the guidance power will be greatly reduced. A "de-reefing" system deployed at an altitude of a few feet will effect a soft landing with acceleration comparable to forklift handling. The cost of the entire system should be a factor of ten cheaper than currently proposed precision systems. Recovery of equipment can be done by air pickup, an area in which we have much experience. Precision release is an integral part of an airdrop system, but little work has been done in this area. Immediate improvement can be made over the archaic system now used. *In the future, the problem of airdrop should be treated as seriously as the problem of bomb drop*. For example, airlifters equipped with belly doors could deploy cargo randomly, and release precision could be much higher than for deployment through rear doors. *Future airlifters should be designed for point-of-use delivery.* Existing airlift aircraft have all been designed for air-land delivery. An airlifter designed for point-of-use delivery will be quite different.

The question of how to deliver personnel should not be ignored, but we admit to having no completely new ideas. Airdrop of personnel in individual parachutes is inefficient and dangerous. The density of troops on the ground is low, and there is an extended period of vulnerability after landing. There is no reason that personnel could not be dropped in containers using the same equipment as described above for cargo if accuracy and safety can be guaranteed. Personnel drop vehicles could be armored with lightweight armor of the type now used on airlifters. Rather than carrying all equipment on the soldier's body, arms and supplies could be carried in holders onboard the delivery vehicle.

4.4 Special Operations

A comment about delivery of Special Forces is in order. This subject has been studied many times, and Vertical Takeoff and Landing (VTOL) aircraft are being produced. We observe that while a few VTOL aircraft will, undoubtedly, be very useful, almost all missions can be completed with Short Takeoff and Landing (STOL) aircraft which have takeoff and landing distances of 100 meters or less. Engine power required is 50% less than for VTOL aircraft, and range and payload can be far higher for a given aircraft size and weight. A Short Takeoff and Vertical Landing (STOVL) aircraft can increase flexibility even more without large increases in weight or cost.

24. Mobility Volume

4.5 Aircraft Protection

Point-of-use delivery may place airlifters in locations where the threat level is higher than those now encountered. At least, though, the airlifter operates at high altitude, and the time available to respond to a threat will be longer than for an aircraft on approach or climbout at an airport. Airlifters should be equipped with a self protection suite which includes the following three capabilities (only the third requires development):

- ECM protection against radar seeking and RF command guided missiles.
- Fighter protection against other airborne threats, such as guns.
- Laser, High Power Microwave (HPM), or kinetic energy missile-killing systems against IR guided missiles, including focal plane arrays.[25]

5.0 Projection of Lethal and Sublethal Power

The Air Force understands well the issues associated with projecting power from airborne platforms. The subject of Precision Guided Munitions (PGMs) and their benefits needs no elaboration. We do, however, present ideas for making PGMs more effective. We will discuss power projection methods and devices which are different from those now in use. The Global Awareness and Dynamic Control capabilities will enable power projection capabilities not now possible in both existing and new platforms. Many of the fundamental tasks presented to the Air Force will not change much during the next decade. Added to the traditional air-to-air and air-to-ground missions, however, will be the countering and destroying of weapons of mass destruction and operations in urban areas. It is likely, too, that the availability of low cost SAM's will establish a premium for the their efficient destruction.

It is intellectually satisfying to discuss power projection in the abstract, and the technologist will frequently promote new and effective weapons without reference to their specific use. Such discussions are important, but they are usually too general, and they do not motivate the development of specific technologies and systems very well. We have discussed the control inputs to power projection in the sections on Global Awareness and on Dynamic Planning and Execution Control. These capabilities also provide target type and location. Here we will address the reasons and methods for projecting power. A more detailed discussion can be found in the Attack Panel Volume.[26]

The Air Force must project power globally. The methods by which this is done will vary depending on whether the nearest bases to the targets are within the range of fighter aircraft or not. In the worst case, only bases in the CONUS will be available. We expect situations to be more varied in the future than they were in the past. This statement is partly based on assessment of current world politics and partly on our ignorance of the future. In particular, we may execute more missions over "mixed" territory where the distinction between ally and enemy is blurred. We may also expect more operations in urban areas.

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25. SAB Study - *Aircraft Self Protection Against IR Seeking Missiles,* Phase II, December 1994
26. Attack Volume

5.1 Aircraft and Systems for Power Projection.

We explored the enhancement of existing aircraft and weapon systems during the study on *Life Extension and Mission Enhancement for Air Force Aircraft.*[27] The study identified avionics and training as the highest leverage technologies for improving the capabilities of the existing fleet. Those suggestions are appropriate for integrating the current fleet into the capabilities described in this report. Here we describe the justification of the Uninhabited Combat Air Vehicle (UCAV).

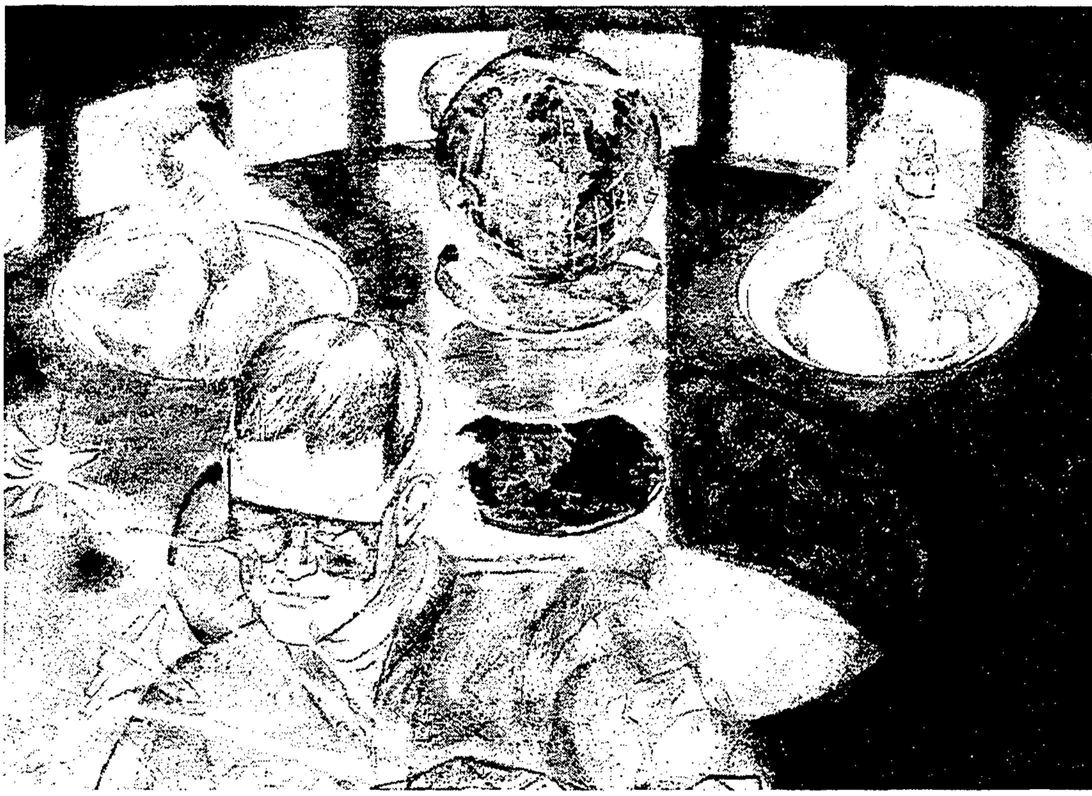
5.1.1 UCAV

An effective UCAV will be enabled in the next century as the result of the simultaneous optimization of information flow, aircraft performance, and mission effectiveness. The UCAV will not completely replace the inhabited aircraft for decades, if ever, but the presence, or absence, of a pilot is now a design trade that can be made in a logical way.

It is the improvements in sensors, processors, and information networks which make the UCAV possible. Information will increasingly be derived from sensors outside the air vehicle itself. Current concepts call for transmitting information derived from many sources over a satellite or ground-based link to the pilot of a high performance combat aircraft. The amount of information which can be injected into the cockpit is enormous. Discussion of pilot overload is common. More displays are needed in an already crowded cockpit, and more attention is demanded from an already overworked pilot. The question which must be asked, then, is whether it is more efficient to bring the pilot to the information rather than to bring the information to the pilot. The usual UAV issues, such as survivability, are secondary if performance is not compromised. When one considers the volume of information which will be necessary to conduct precision, high intensity operations of the future, it is possible that the most economical use of communication resources will be to transmit low bandwidth control, or control correction, information to the aircraft rather than to transmit mission information. The decision to use UCAVs will, of course, depend on the theater environment which has many variables such as the density of enemy jammers.

Information gathered from many sources, included from the UCAV, itself, will be brought to the Execution Control Center, which is located in the US, over high speed, massively redundant fiber and satellite communication routes. A permanent environmentally controlled installation will permit extensive use of state-of-the-art commercial equipment. Vehicle cost and weight will be reduced because of the absence of displays, pilot life support equipment, and manual controls. Volume, area, and weight of displays, processors, and controls in the Control Center can be large. Well rested mission specialists will be available to provide support for one or more UCAVs, and a cadre of expert, possibly civilian, maintenance technicians will also be available. The number of support personnel in the theater will be reduced, and it will not be necessary to transport a large number of shelters, workstations, and environmental control units. Extremely low observability of the UCAV will result in the reduction of standoff distance at the weapon release point and will, in turn, reduce weapon sensor, guidance, and propulsion costs.

27. SAB Summer Study 1994, *Life Extension and Mission Enhancement for Air Force Aircraft,* August 1994



UCAV Control Center

Control technologies for UCAVs are not mature. The interaction between airframe and pilot will be cooperative and variable to a much greater extent than in existing aircraft. The pilot(s) will provide general direction in realtime when necessary. Control functions will be enabled by software agents transmitted from the Control Center. Agents will permit function changes such as from ground attack to air defense during a mission. Unplanned maneuvers can be generated in realtime.

UCAV survivability can be increased by increasing maneuverability beyond that which can be tolerated by a human pilot. Acceleration limits for inhabited aircraft are, typically, +9 g or 10 g and -3 g. A UCAV can be designed symmetrically to accelerate in any direction immediately. Anti-aircraft missiles are usually designed with a factor of three margin in lateral acceleration over that of the target aircraft, although a few missiles have acceleration capability as high as 80 g. A UCAV with a ±10 g capability could outfly many missiles, and an acceleration capability of ±20 g will make the UCAV superior to nearly all missiles.

Removal of the pilot from the aircraft also makes possible more options for signature suppression. Inhabited aircraft have limited options of shape and cross sectional area which limit the options for minimizing drag and radar cross section. Maneuvers and flight attitudes not appropriate for inhabited aircraft can also be executed to reduce the cross section presented to an adversary. The UCAV will also provide design flexibility for active stealth systems when they are developed.

The Air Force should pursue the design of a UCAV. It appears logical to begin with cruise missile parameters such as those of the Advanced Cruise Missile and then to increase capabilities by scaling. The inverse procedure of scaling down from an inhabited aircraft, say the F-22, may lead to higher cost and cross section. Operational concepts should be developed, and new weapon options should be pursued. Novel methods to optimize the interaction of remote pilots with a UCAV should be explored through simulation. Control and communication methods should be developed. The point to be made here is that the UCAV is a unique aircraft, and it should be designed as such.

5.2 Critical Tasks

There are a number of tasks which must be accomplished. Particular targets of importance are:

- Aircraft
- Fixed
- Mobile
- Chemical, biological, and nuclear weapons and production facilities
- Urban[28]
- Enemy directed energy weapons
- Short dwell targets
    - Theater ballistic missiles
    - Surface to air missiles
    - Vehicles - armored and unarmored
- Cruise missiles
- National forces
- Terrorist groups
- Concealed
- Personnel
- Protected command centers
- Information systems

We will not address all categories in this chapter, but we will discuss the ones which involve new technologies. It is frequently true that operational considerations dictate the technological philosophy applied to the development of a new weapon system. In the case of

28. Classified Volume - on file at the SAB Office

targeting in the Future Force described in Chapter I, the converse is true. Accuracy, reliability, and cost considerations dictate a discipline of delivering a weapon to a particular set of coordinates using GPS/Inertial guidance, if possible. We realize that it will not always be possible. There will be targets which demand specialized sensors or remote control. Of those two, automated remote control from a precision platform, such as a UCAV, is preferable. We encourage the weapon designer of the 21st century, though, to consider non-coordinate options as a last resort—not as a method of choice. Generic attack tasks for important targets are discussed in the following paragraphs.

5.2.1 Fixed Targets

We define fixed targets as those which remain nearly stationary long enough that they can be struck by a weapon which is directed to a particular set of coordinates. Many types will come to mind. Airbases, storage depots, command centers, and rail yards all fit the description. Not so obvious are parked or very slowly moving vehicles such as missile launchers, SAM, and artillery pieces. A "nearly stationary" target is one whose movement is less than the accuracy of the weapon during the weapon flight time. Targets may be fixed for minutes or permanently. In general, a fixed target is one that is detected by sensors on- or off-board the delivery platform, and the weapon is targeted by coordinates alone. The distinction is useful, because weapons which can be targeted by coordinates alone can have sensors and controls which are far simpler than those needed by weapons which attack moving targets, as mentioned above. In fact, if adequate precision can be obtained in platforms, release mechanisms, and weapon cases, it will be possible to achieve precision munition performance with no sensors onboard the weapon. There appears to be no fundamental physical reason that a weapon released from a high speed aircraft cannot be as accurate as a rifle bullet. Reentry vehicles delivered by Intercontinental Ballistic Missile (ICBM) are at least that accurate. Platforms must be low observable, fast, and designed around the weapons. We believe that the UCAV is the ideal platform for delivery of unguided weapons. Extensive, reusable, (and, therefore, affordable) sensor suites can be aboard the UCAV. A class of fixed targets which will be addressed separately is that of short dwell targets.[29]

Although all fixed targets can be addressed with common sensors, or no sensors, and delivery methods may be very much the same for all, the energy applied to the target may vary considerably with the target type. If sublethal response were in order, High Power RF (HPRF) weapons could be used against vehicles and electronic devices. The deployment of HPRF by cruise missile is discussed in the Munitions Panel Volume.[30] Flexibly fuzed munitions will be the weapon of choice against structures. Area coverage will continue to be provided by multiple small munitions, but we observe that multiple fixed targets do not, necessarily, demand multiple sensors onboard the weapon. However, autonomous precision micro munitions based on low cost electro optical systems may become inexpensive enough to alter the tempo of warfare dramatically. Interdiction will continue to be the most uncertain of operations in terms of weapon requirements for a particular mission, but technology can produce more flexible weapons to increase mission effectiveness.

29. Sec. 5.2.6
30. Munitions Volume

5.2.2 Mobile Targets

Mobile targets deserve particular attention for many reasons. They offer opportunities for technology to increase the effectiveness of air to ground attack. It is more important, though, that a future target set may contain more mobile targets than fixed targets. Critical fixed targets can be nonexistent or prohibited by policy. We have endured both cases in the past. In fact, since World War II, the Gulf War was the only war where nearly all important targets could, in principle, be attacked. Fixed targets of the future may only be those associated with close air support and interdiction.

Mobile targets are special because of the variability of hardness as well as because of their motion. We possess specialized munitions which are nearly as varied as the weapon set, and which have special sensors, special explosive systems, special propulsion systems, and special delivery methods. It is the variability of weapons which makes planning for an interdiction mission much more difficult than planning for other missions. We may point proudly at a large variety of munitions which attack a large variety of targets, but we must remember that in interdiction the cycle time increases, and the sortie rate decreases, with an increasing number of weapon types. The absurd limit of type proliferation prohibits loading of weapons on aircraft until all targets for an interdiction mission are identified precisely. Effective use of camouflage and concealment measures by the enemy will complicate the process even more. Targets of opportunity could be restricted to those which fit the weapons already onboard the aircraft when the target is detected. The immediate solution for the commander, of course, will be to load aircraft with munitions which will destroy the most difficult targets that may be encountered during the mission. These are likely to be the heaviest or the most expensive munitions in the inventory. An alternate strategy is to load specific aircraft with specific weapons. Either strategy reduces overall sortie effectiveness.

Advances in sensor, fuzing, and control technologies offer a partial solution to the problem. Focal plane sensors and low mass, low volume processors can be developed to select the most vulnerable point on a given target, and precision controls can direct the munition to that point. One must think of accuracy in centimeters, not in meters, because advances in these areas are materializing at a rapid rate. Weapon effects can be varied by detonating the munition in various modes. For example, a shaped charge penetrator can be created for armored vehicles, and more uniform blast or fragmentation effects for softer targets can be produced by varying the detonation sequence in a single device.

Cost is a major factor in precision weapons, but commercial developments will reduce component cost. Further cost reductions can be attained by placing most of the processing and sensing functions on the delivery platform and communicating target information to the weapon.

It is often sufficient simply to stop moving targets. Unarmed vehicles can be left immovable. An immobile armed vehicle becomes a fixed target which can be destroyed with simple munitions. Of course, stopping and destroying an aircraft are equivalent processes. HPRF weapons can be effective against vehicle ignition systems and aircraft control systems.

5.2.3 Weapons of Mass Destruction

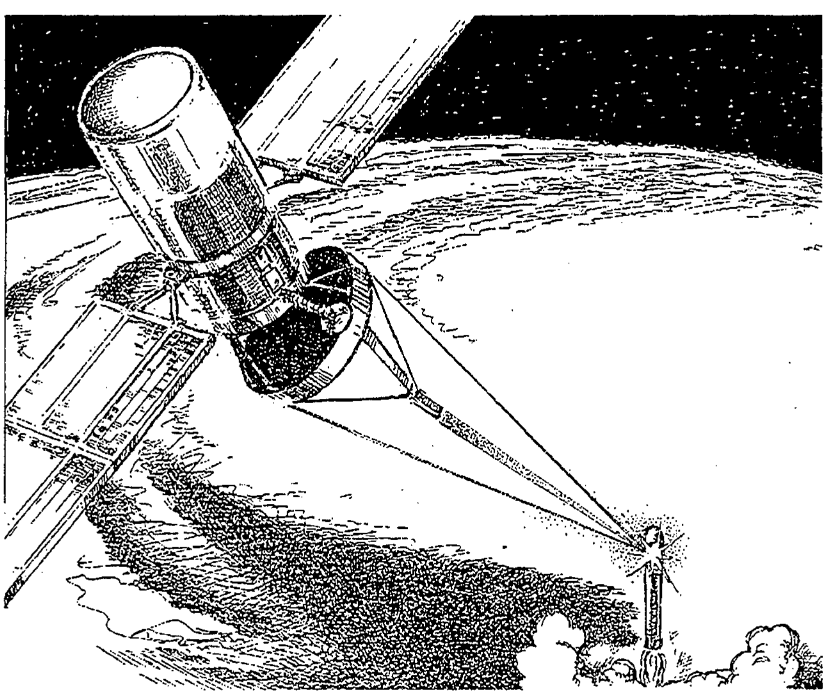
There are no weapons which address all threats. The danger of attacking weapons of mass destruction is in spreading toxic or biological active materials. Therefore, most solutions will immobilize, not destroy, these weapons. Destruction of production facilities will be deferred by isolating facilities and rendering them inaccessible or unusable. An entire stable of advanced precision and directed energy weaponry will be necessary.

5.2.4 Terrorists in Urban Areas

Terrorist operations are usually characterized by the proximity of noncombatants. Hostage situations are possible. These situations are treated at present by special teams using appropriate weapons. Air Force participation is limited to delivery of combat teams and supplies. In the future, however, the development of sublethal weapons deployed from aircraft and URAV sensors will increase Air Force responsibilities in this area. *A weapon which can have a very large impact on urban warfare and hostage situations is discussed in the classified section of the report.*

5.2.5 Directed Energy (DE) Weapons

We have identified directed energy weapons as coming of age. We cannot discount the possibility that an adversary will develop such weapons. It is well known that development of directed energy weapons was well supported in the Soviet Union. The technologies involved may be for sale in the future. Therefore, as we develop these weapons, we should define countermeasures.



Space Based Global Precision Optical Weapon Attack on Boosting Ballistic Missile

Development of hardening standards for probable enemy weapons is the first step. Seekers for lasers and HPRF can be developed. Ranges need only be consistent with the ranges of DE weapons. The sensing problem is not difficult, because of the high intensities involved.

5.2.6 Short Dwell Targets

We define short dwell targets as those that are vulnerable for a time short enough that their vulnerability is determined by the exposure time rather than by characteristics of an attacking weapon. Mobile missile launchers are an example. Launchers can be concealed, camouflaged, or protected by a structure until ready for use. After use they can be moved rapidly to a protected, or concealed, position. It is the protection of the target which distinguishes it from a mobile target.

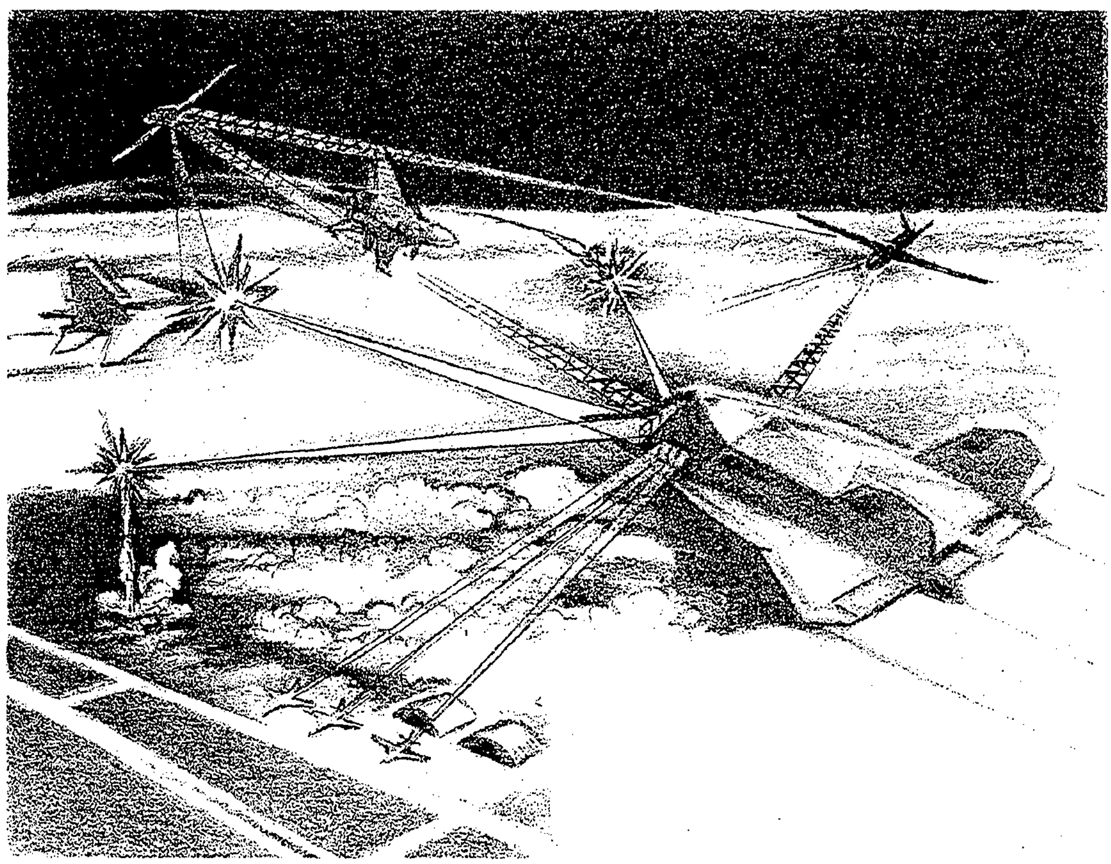
Attack on short dwell targets is enabled by two factors - identification and weapon delivery. The Global Awareness system will detect and identify a target. If there is a URAV staring at the area of interest,[31] the Global Awareness system will deliver target coordinates to an accuracy of one meter or better, and the Dynamic Planning and Execution Control system can target a coordinate-seeking weapon in seconds. Detection by satellite constellation to an accuracy of 2-3 meters is adequate for the deployment of weapons having warheads of 50-100 kg. Targets such as Multiple Launch Rocket Systems (MLRS) and Transporter Erector Launchers (TEL) for theater ballistic missiles will be particularly vulnerable to this weapon system if weapon delivery times are short enough. If observation is by a URAV, an accuracy of 30 cm or less can be obtained, and warheads as small as 0.1-1 kg can be used. These weapons can be carried aboard the URAV. SIGINT detection by a distributed satellite constellation followed by coordinate transfer to a weapon will be extraordinarily effective against SAM sites and other facilities which radiate infrequently.

The best known short dwell target is the theater ballistic missile (TBM). The airborne laser (ABL) is an excellent first attempt to destroy TBM's in boost phase. The program will develop the user database for future applications of lasers as well. We encourage the development of the ABL and associated research to improve capability.[32] The ABL will require a high speed command and control system. Experience in the development of this system will provide a guide for addressing short dwell targets in general in the future.

Short dwell targets of importance are also high value targets. Therefore, a short dwell attack weapon can be useful even if the probability of destroying the target is low, and the cost is high. Attack at considerable distance is usually necessary. Warheads of 100 kg mass can be delivered by a 500 kg missile at a velocity of 2-3 km/s. A target having a 5 minute dwell and a 2 minute targeting time at a range of 400 km can be attacked. This appears to be a reasonable goal for a short dwell attack weapon which will be useful when used with URAV surveillance for the next decade and for a distributed satellite system the decade after that. Affordability is a significant issue. If coordinate targeting is used, a unit cost of $250K-$500K is possible. Other seekers and higher weapon velocities will cost more. Average weapon velocities as high as 4 km/s can be attained, but missile cost may be $1M.

31. Sec. 2.3 and 2.4 of this chapter
32. Directed Energy Volume

The UCAV can be designed as a hypersonic weapon delivery platform. Reusable UCAVs which deliver unguided or coordinate guided weapons may be cost effective when compared to individual missile costs of $1M. For the UCAV, air breathing propulsion or a combination of rocket and air breathing propulsion may be the system of choice. Design and construction of a hypersonic aircraft at 4-5 km/s, Mach 12-15, will be complex and will require new airframe and propulsion technologies. Flight altitudes will range from 25-45 km (85,000-150,000 feet). A hypersonic UCAV will, undoubtedly, be far less expensive than a manned vehicle, and performance will be superior. For example, higher skin temperatures can be tolerated. The vehicle will transition from subsonic to supersonic to hypersonic flight as altitude increases and will transition back to lower speed and altitudes near the target. Velocity transition will obviate the need for a new class of weapons for hypersonic release.[33]



UCAV Fotofighter Attacking Air and Land Targets with High Power Laser Beams

5.2.7 Cruise Missiles

Large numbers of cruise missiles are extant worldwide. The success of the Tomahawk in the Gulf War demonstrated their efficacy to the entire world. We can expect sales and use of

33. Aircraft and Propulsion Volume

cruise missiles to increase during the next decade. Cruise missiles present special problems of detection and destruction. The missiles are small, and they present low radar cross sections. Missiles which fly at high altitude can be attacked as are conventional aircraft. Cruise missiles are slow, vulnerable, and maneuver little. They can be intercepted and destroyed by existing air-to-air missiles.

Low flying missiles are far more difficult to detect than their high flying analogs. The bistatic radar system described in Sec. 2.2 of this chapter is the best candidate for an affordable detection system with wide area coverage. Command guided missiles with IR sensors to provide terminal guidance can be developed. An airborne laser system can intercept and destroy low altitude cruise missiles at a range of a few 10's of kilometers. HPRF systems aboard large aircraft and ground based systems can be effective at similar distances.

5.2.8 Concealed and Camouflaged Targets

Detection is the primary issue associated with these targets. Detection probability will increase as sensor spectral range and number of viewing angles are increased. The Global Awareness system of Sec. 2.0 is well suited to the detection of concealed targets. The spectrum covers RF to optical wavelengths, and multiple viewing angles are provided by the distributed satellite and bistatic radar systems. Emissions are detected by the distributed satellite synthetic aperture signal locating system.[34]

5.2.9 Information Systems

Methods for attacking information systems are under development, and we believe that the technologies being pursued in many areas are appropriate. An important issue to be addressed is the integration of information system attack with the capabilities described in this Chapter. The computer oriented attack methods should be integrated with the Global Awareness and Dynamic Planning and Execution Control systems. For example, techniques developed for locating enemy information systems can be integrated with these systems to permit attack with explosive munitions. Location of threat information systems is also an integral part of Global Awareness. *The entire fabric of Information Warfare should be joined to the fabric of more conventional warfare.*

6.0 Space Operations

Space operations will become increasingly important to the successful completion of most missions in the 21st century.[35] The essential role of Space in Global Awareness and Dynamic Planning and Execution Control was discussed, and, in particular, the value of distributed satellites was addressed. The interaction between military and commercial space applications has not begun to evolve. It is time, now, for the Air Force to define its relationship with commercial and international space organizations. Commercial organizations have used satellites for communications for years. Geosynchronous satellites form an important part of the worldwide communications system, particularly for the relay of one-way broadcasts. For two way communications, fiber is rapidly becoming the medium of choice. Commercial applications

34. Sensors Volume
35. Space Applications Volume

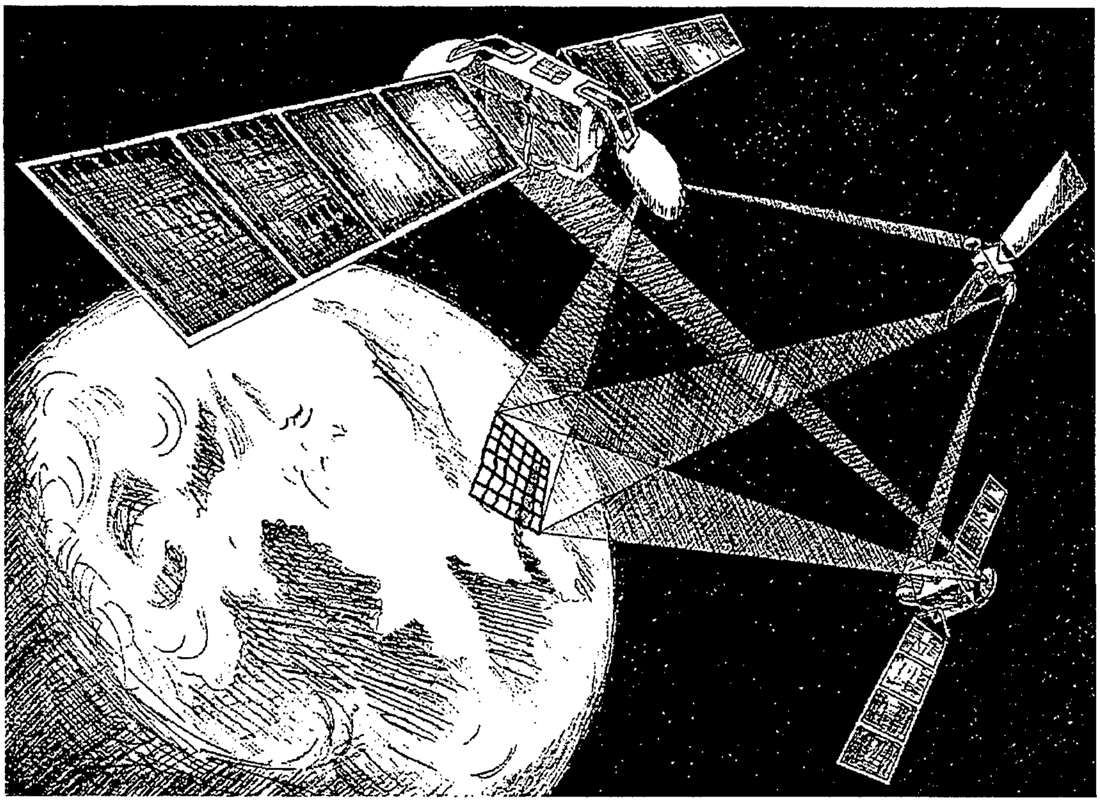
during the next decade will include distributed constellations for cellular communications of voice and data from low power ground transmitters and high resolution imaging systems. The direct use of these systems for military purposes will be cost effective. We must realize, however, that commercial systems will not provide a one-for-one replacement for analogous military systems. The way in which the systems are tasked and the way in which their information is used will require changes in requirements for communication and imaging products.

6.1 Distributed Satellites

Affordable use of distributed satellite constellations will require discipline in the design and launch of space vehicles. The launch of a satellite is now an unusual event. Each launch resembles a technology demonstration. It is common for a satellite to contain many unrelated devices solely because volume or launch mass is available. The result is high cost and mass. If lightweight distributed systems are to be of use, this practice must be controlled. Single, or dual purpose satellites must be the rule rather than the exception. If two or more systems coexist on a single satellite, their functions should be complementary. Pressure to include unrelated devices results from excessive cycle time. Cost is also proportional to the time required to design and build a satellite. *Time from design to launch should be reduced substantially. A goal of two years is reasonable.*

Small distributed satellite systems can provide the warfighter with relevant, timely information at a cost below that of large systems. Humans tend to be visually oriented, and we have depended on images to provide us much of what we know about the battlefield. During the past decade, or so, we have learned that imaging outside the visible band, particularly in the infrared, can give us important information beyond that obtained from a visible image. More recently, Synthetic Aperture Radar (SAR) images have begun to contribute important data. The relaxing of image resolution requirements results in smaller sensor packages which can be flown on small, less expensive satellites. The addition of hyperspectral capabilities does not add weight or volume as rapidly as does image resolution, and a hyperspectral sensor with a spatial resolution of 10 m probably optimizes cost and coverage. Systems can be inexpensive enough that advances in processor and sensor technologies can be incorporated in a timely way. Technologies are improving significantly on a timescale of two years—a time consistent with commercial satellite system development times. *A two year period from the beginning of design to launch should be a firm goal. Opportunities for leveraging commercial technologies are many in this area.*

The ultimate utility of a distributed satellite system, a distributed URAV system or a distributed information system of any type derives from cooperative action. Multiple systems which improve performance linearly with the number of objects deployed are not properly classified as distributed systems. True distributed systems increase performance at a rate which is faster than linear with the number of systems deployed. In some cases, for example, a single satellite can perform processing tasks for a large number of special purpose satellites if an onboard communication link is smaller or lighter than a dedicated processor. A central processor will reduce the processing requirements of individual satellites in the constellation. Processors usually are sized for peak rather than average loads, and a central processor can be operated more efficiently than a large number of small ones. In addition to central processing, cooperative detection is possible. For example, several satellites, each of which has a view of a particular region of interest could measure the phase of a transmitter simultaneously to determine the phase of an emitter. The long baseline will make precise location of the emitter possible.[36] We have discussed the use of commercial imaging for mapping[37] and the use of commercial constellations for providing communication services for onboard military hyperspectral systems.[38] Those discussions will not be repeated here. Rather, we will concentrate on access to space, control of space, and the projection of power from and to space.



Distributed Satellites Cooperatively Scanning a Target Area

6.2 Access to Space

The use of space has been limited by the high cost of placing satellites in orbit. The cost of mass on orbit is approximately $20,000 per kilogram. Many studies of space launch have searched for ways of reducing cost, but none have proposed a definite way of reducing cost substantially. We have no specific solutions, but we will suggest long term research which may help.

The computational design of molecules is becoming possible as the result of increasing computation power. *The Air Force should substantially support research into the*

36. Sec. 2.1 of this chapter
37. Sec. 2.0 of this chapter
38. Sec. 2.5 of this chapter

computational design of energetic materials.[39] Both explosives and rocket fuels should be included. It may be possible to develop fuels which have higher specific impulse, Isp, than those available now, but the use of these materials is not a simple matter. Higher Isp is related to higher exhaust velocity which, in turn, is related to higher combustion temperatures. Thus, an increase in Isp can require combustion chamber materials which will operate at temperatures and pressures higher than do those currently available. We should, therefore, search for Isp increases which are not achieved by increasing combustion temperature.

Of course, lighter satellites can reduce the cost of launch for a particular function even though the cost per pound is not reduced. Mass reduction can be achieved through the use of lower density, stronger materials and through the use of stronger lightweight structures. In the longterm biological structures may be useful.[40]

Reusable launch vehicles have been proposed as a way of reducing launch cost. It appears, though, that the cost of vehicle preparation dominates the cost of vehicles. Launches are prepared and monitored by a "cast of thousands" operating a vast array of equipment. Reusable vehicles amortize their cost over a large number of launches, but unless they have greatly reduced logistics tails, little reduction of cost can be expected. If a reusable vehicle is to be cost effective, it must need little refurbishing and testing between launches. The goal should be to achieve "airplane-like" operation of space launch vehicles. Today, space launch is more akin to a science experiment than to a routine takeoff. This situation must be changed if cost reductions are to be achieved. Utilization of the rapid increase in capability of information systems should reduce the number of people required to launch a space vehicle.

Automated launch control and mission monitoring systems should be designed to reduce the number of people involved in launch and mission control by at least a factor of ten.

Orbit transfer from low earth orbit to geosynchronous orbit can be addressed by electric propulsion. Research in this area should be strengthened.

Although military launch capability must be maintained as a vital part of national security readiness, *our goal should be to launch most military satellites aboard commercial launch vehicles.* The use of commercial capability will necessitate the design of military satellites which are compatible with the available launchers. The distributed constellations do just that. The norm should be satellites of volume and mass similar to those of Iridium or Teledesic. It will require discipline to produce satellites that have only one function, but cost, functionality, and reliability will demand single, or perhaps dual function satellites. Reliability is now a problem with commercial launch vehicles, but this situation will improve. We should be prepared for launch failure probabilities of 10-15 percent in the initial years of deployment of constellations. Reduced reliability dictates lower cost satellites, and smaller, distributed systems are, again, favored. Miniaturization, reduced design and planning time, and single or, at most, dual purpose satellites will make space systems affordable.

39. Space Technology Volume
40. Materials Volume

6.3 Space Control

Control of space will become essential during the next decade. We will depend on satellites to provide Global Awareness and Dynamic Control for our Forces, and *commercial services may be a threat to those Forces.* As commercial involvement of US companies in space increases, *the United States may be called upon to protect nonmilitary space assets from attack by terrorists or a rogue nation.* We should be prepared to execute three missions:[41]

- Protect US military space assets and launch capabilities.
- Deny the use of threat assets.
- Protect allied, non military space assets.

Various antisatellite (ASAT) weapons that direct projectiles or fragments against threat satellites have been developed or proposed. Kinetic energy systems such as these are expensive. The vehicles are complex, and tracking and guidance must be precise. Most of the cost, however, is the result of maintaining readiness to launch within an acceptable time, such as 24-48 hours. There appears to be no way to reduce the cost of readiness in the near future. In the main, space based communication systems are not invulnerable to jamming. The task of directing a laser at a satellite is not an easy one. Laser power of a megawatt or more will be needed, and precision tracking and pointing systems must be developed. We believe, however, that it is possible to develop such a system in less than a decade. *Therefore, we recommend ground-based Directed Energy weapons to attack threats in space.*

It is less obvious that high power microwave (HPM) systems may have a role in space control, such microwave systems could be attractive because they have the potential to produce electronic upset without damaging the structure of a threat satellite. Thus, HPM systems may be more effective at producing temporary denial of capability than a laser. Phasing technology used in radio astronomy could be applicable to the problem. *We should consider the possibility of a very large array of independently phased dipoles spread over a kilometer diameter.* The diodes could be phased to form a sparse synthetic aperture for projecting microwave power into space.

Protection of military satellites might be enhanced to some extent should the application of stealth techniques be possible, but if distributed systems become the norm, the redundancy of systems will provide protection. Solar panel area is large, and panel position cannot always be set to minimize observability. *Even if possible, we do not believe that the increased cost of low observable satellites will be justifiable.*

Because of cost, it is unlikely that many countries will develop ASAT weapons. It is well known that GPS is vulnerable to jamming because of the low power in the navigation message.[42] Power of a few watts can jam the Clear Access (C/A) code at a distance of 10-20 km. Nulling antennas can provide increased jam resistance, but the only long term solution is to increase the signal-to-noise ratio as described above.[43] Protection of other systems can be

41. Space Applications Volume
42. *Journal of Navigation*; Spring 1993, and SAB Report - *GPS Survivability and Denial*, November 1993
43. Sec. 2.6 of this chapter

enabled by munitions directed by coordinates to the jammer. Current practice is to launch missiles which home on the signal whether it be a jammer or a communication or radar source. Accuracy and kill probability could be improved dramatically by the distributed satellite signal detectors described in Sec. 2.1 coupled to GPS munition guidance. It is possible to field a system whereby cooperative satellites could provide signal coordinates quickly to an accuracy of a few meters, and GPS guided munitions can strike to a comparable accuracy even if the source emits only for seconds, or less. Overall accuracy should be 5-10 meters. It should be possible to build coordinate-targeted missiles having range of 100 km at a cost of $100-150K. This system will provide robust protection against the most common threat to US and allied space assets.

6.4 Force Projection from Space

There are political issues related to the projection of power from space, but we treat only the technological ones. Two classes of weapon have applications from space—directed energy and kinetic energy. Of the two, only the directed energy weapon offers attractive features such as reusability, speed-of-light response, and training and testing features. Kinetic energy weapons having the same energy as orbital weapons can be delivered by ICBM from the CONUS. Response time can be nearly that of an orbiting weapon, and the cost of readiness is lower. *We recommend that the ICBM option with terminal, coordinate guidance be used if delivery of kinetic energy weapons from space becomes an operational requirement.* Of course, the issue of distinguishing nuclear weapons from conventional weapons must be addressed. Therefore, we will discuss space deployment of directed energy weapons.

Because of the large distances from space to target high power radio frequency (HPRF) weapons will require antennas having diameters of 5-10 km and powers of at least kilowatts. If development of extremely lightweight structures and wavefront compensation methods in the microwave frequency range succeed, such weapons will be possible. We believe, though, that the short wavelength and high power of lasers will favor the space deployment of high power lasers rather than HPRF.

Two deployment options are available. First, a laser device can be deployed in space along with beam directing optics and control systems. Space deployment of lasers will involve significant problems in logistics, resupply, and training in addition to those of targeting and control. Consumables in the laser system will result in very high system costs. The minimization of these costs will demand electrical lasers and compact energy storage systems. Phase locked solid state diode lasers are the preferable device because they achieve electrical efficiency of 50 percent and they have excellent beam quality. Large optical elements with wavefront compensation will be essential for long-range capability.

The second option is to construct the laser system on the ground and to deploy targeting mirrors in space. Again, large structures and wavefront compensation to compensate for optical imperfections will be necessary. But, many logistics problems associated with space basing will be eliminated, and more choices of laser will be available. Laser power will not be limited by satellite power or by available fuel. The system satisfies that most basic of principles that one should always minimize the complexity of the space component. The idea of directing ground based lasers with space based mirrors is not new. The new technologies which can be applied to the problem, though, are those of lightweight structures[44] and nonlinear optics.[45] Control technologies will also improve during the next decade. We believe that if projection of directed energy from space becomes a reality it will be in the form of ground based lasers and space based relay mirrors.

7.0 People

New World Vistas looks decades into the future. We predict increasing dependence on autonomous weapons and information systems. During the entire period, we see people as central to Air Force operations. *Therefore, the design of systems must include the "human system" as an integral part.* Increased tempo of operations and reduced Force size will demand that people interact with weapons systems more efficiently than ever before. Science and technology can assist the process of human interaction with the machine of the future. Improved and specialized training can assist the process of interacting with the machine of the present.

7.1 Modeling the Human

We are accustomed to modeling the performance of weapon systems and interactions among systems. We model groups of humans such as Army units in engagement and maneuver models. We do not, however, model the individual behavioral characteristics of humans. Significant improvements in simulations of engagements could be made by including human qualities such as leadership, cohesion, experience, intelligence, and level of training. It has been noted by General Fogleman that simulations have been unable to explain what modelers assessed to be the apparently irrational behavior of the Iraqi Republican Guard during Desert Storm.[46] He correctly notes that continuous bombing by B-52's is likely to provoke strange behavior in anyone. The goal of human psychological modeling should be to include individual behavior in the design of systems and in engagement models.

Detailed physical models of humans will be valuable in the design of weapon systems. Improved modeling of human structure, motion, and performance will provide valuable input to the design of new weapons. These models should describe the response of humans to weapons as well as the interaction of the human with the system.

7.2 Training

Training is one of the largest consumers of Air Force funds. Training efficiency can be greatly improved by making it more individual.[47] The tailoring of training to the individual had its embryonic beginnings in the computer and video training systems which are now common. We believe that it is necessary to further develop technologies related to:

- Personnel selection and classification systems

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44. Space Technology Volume and Materials Volume
45. Directed Energy Volume
46. General Ronald R. Fogleman; Speech - NATO Brunson, Belgium, NATO Air & Ground Component Commander Conference, September 95
47. Human Systems/Biotechnology Volume

- Cognitive and non-cognitive models of the learner and the instructional process
- Computer technology to support training simulations, training equipment, and training management systems

Improved training can be affected through distributed interactive simulations. Simulations which use humans as foils in training will be more realistic than those which use scripted or probabilistic computer responses. Commercial organizations have begun to use interactive simulations in futuristic video games.[48] Participants note realism far superior to that of other video games. It is possible that displays and methods developed by the entertainment industry can be applied to Air Force training problems.

7.2.1 Flight Simulation

Flight simulation is a special case of training which is of special interest to the Air Force. The utility of simulators in commercial airline operations has been demonstrated to be profoundly effective in increasing pilot performance while reducing aircraft training hours. The Air Force must acknowledge that the aircraft it now owns will be the largest part of the fleet in the early years of the 21st century. It is essential that those aircraft be capable until they are replaced by newer ones.

Simulators for transport aircraft use well known technology and training procedures, and equipping the Air Force with simulators which could eliminate almost all training in aircraft is a straightforward process. The initial capital cost will be high, but the life cycle cost of transports will be far less than if aircraft are used for training. There should, however, be continued research into the minimum requirements for meaningful simulation of Air Force flight conditions. For example, can a substantial fraction of flight training be done in simulators without motion? A considerable body of work exists in this area, and the Air Force should integrate it into planning of the simulator "fleet."

Simulators for high performance aircraft are another matter. Only the Air Force, Navy, and Marine Corps can develop the necessary technology and the necessary training and testing programs. It may be that the sense of "being there"[49] requires the simulation of sensations which are not required for a transport aircraft. However, total fidelity of "being there" in simulation is very expensive and may not be necessary. *The relationship of artificial sensation* [50] *to training effectiveness should be investigated carefully.* For example, it is possible to build a simulator which will produce appropriate g-forces on the pilot. The forces would be produced by a rotating device with smaller radii of curvature than experienced in a fighter aircraft, but the sensation could be made quite accurate. It is likely that joint programs in this area could be very productive.

7.3 Education

Training and education differ in that education is less specific and more encompassing than training. Training produces the capability to perform a limited number of specified jobs

48. Sec. 7.4.1 of this chapter
49. Sec 7.4 of this chapter
50. Information Technology Volume

with high efficiency while education prepares a person to respond effectively to unanticipated situations. The Air Force of the 21st century will be far more complex and technical than the current Force. That situation will be partly the result of the use of higher technology in weapon systems, but it will result mostly from the integration of systems as we have described. Air Force people of the next century must be problem solvers in a milieu which is constantly changing. The only known approach to such issues is through education.

Internal technical capabilities in the Air Force Laboratories will decline as the result of political and budget forces. The people who purchase weapon systems must be "smart buyers," but it is unlikely that they can achieve "smart buyer" capability unless they are educated in a technical field and have some experience working in that field.

We suggest that the Air Force increase the number of technical degrees at the Masters level substantially through funding of degrees at both AFIT and at Universities. PhD. degrees should be increased as well, but a careful study should be done to determine appropriate staffing levels. Quality of a degree should be a factor rather than simply its existence. Rating system for Universities and Colleges exist. AFIT should participate to the extent that its curriculum overlaps that of civilian schools. *Degree quality should be a factor in civilian and military promotion.*

Practical experience beyond degree should be a part of technical education. As Defense Laboratories accommodate fewer people, experience can be gained by assignments to industry and National Laboratories. Buyers with lab or industry experience will be far "smarter" than those without.

7.4 Human-Machine Interaction

The Air Force will depend increasingly on computer-driven operations at high tempo. Errors and delays associated with the interaction of human and machine can cost lives. The human is fundamentally an analog device, and the computer is a digital device. We communicate with computers through the keyboard and the mouse or through modifications of those devices. Neither permits much creativity. Both operate at bandwidths below that of the brain-eye-hand combination. Rapid unanticipated trained response such as that of a fighter pilot in combat is not possible, in general, with current computer input systems. Flight simulators are, of course, exceptions.

Technology can increase the speed of interaction by reducing the inertia of mouse and keyboard. For example, one can use eye motion to direct a computer cursor rather than a mouse or roller ball. Marginal speed increases can result, but the fundamental nature of the interaction does not change. Speech interpretation technology is developing, but it, too, will not lead to a substantial increase in the speed of interaction. Speech, after all, is highly redundant. The rate of information flow in speech is much slower than the rate of human motor response, such as, pushing a control button.

We admit to having no specific suggestions for increasing the bandwidth of human-machine interactions. *We do, however, recommend that research in methods which have the potential for changing the inherent qualities of that interaction while increasing the speed of interaction* *be aggressively pursued.* The ultimate interaction is thought control.[51] The direct coupling of brain and machine is beginning now with applications in injured and diseased victims. The Air Force should aggressively encourage and exploit this emerging technology.[52]

7.4.1 Commercial Technology

Entertainment companies are developing at breakneck speeds new ways for humans to interact with machines . The intensity of the battle among companies is indicated by their being among the most profitable corporations in the world. While companies do not publish their investments in technology development, it is probable that these investments dwarf that of the Department of Defense (DoD). It is certainly true that the best students in computer and information science are vying for positions in entertainment companies.

It may be that no specific products of the entertainment industry will be of use to the Air Force. However, the thrust of entertainment technology is to convey a sense of "being there" to an audience or to a group of participants. Successful development of such a technology would qualify it as revolutionary. The impact on teleconferencing, collaboration at a distance, flight simulation, UCAV operation, and many other applications would be enormous. *We urge the Air Force to establish continuing contact as closely as possible with entertainment organizations.*

7.5 Chemical Intervention

It is a fact that human operational performance can be enhanced or extended in time by chemical means. The issue is to what extent enhancements can be achieved without side effects. Air Force people will be called upon to travel large distances and to operate at peak performance immediately for extended periods. *Research on means, chemical and other, to reduce the physical and psychological effects of large changes in longitude ("jet lag") should be continued.* In life-threatening situations it will sometimes be necessary to extend the time over which a person can function at an acceptable level without rest. *Although we believe that such extension of performance can never be completely free of side effects, the search for effective drugs which minimize these effects should be continued.*[53]

8.0 Primary Technologies

At this point the reader has probably concluded that the technological Air Force of the 21st century may be effective, but that it will certainly be incredibly complicated and unaffordable. If the capabilities described earlier were developed as the sum of many systems, both statements would be true. In fact, if the overall capability of the Force were merely the sum of capabilities of individual systems, a modern Air Force would be unaffordable. We have emphasized that the strength of *New World Vistas* technologies lies in their integration. To demonstrate this assertion we will identify the individual technologies necessary for achieving the result we propose. A detailed list and recommended actions will be given in Chapter III. Technologies marked with a (R) will generate revolutionary capabilities. Technologies marked with an asterisk (*) will be pursued in both commercial and military forms. It is currently not clear whether the Air Force decision should be to develop or to buy. They are duplicated on the list.

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51. Information Technology Volume
52. & 53. Human Systems/Biotechnology Volume

Technologies to be developed:

- (R)UCAV structures and engines - including hypersonic operation
- Remote control technologies
- Composite, tailored materials for air and space
- (R)Large lightweight structures for optics and antennas
- Nonlinear optic compensation
- (R)High power, short wavelength lasers with emphasis on phased arrays
- (R)High power radio frequency sources
- (R)Active and IR stealth
- (R)Point of use delivery starting with low cost precision airdrop
- Next generation airlifter - higher wing and engine efficiencies
- (R)Automated, reusable space launch vehicles with "airplane-like" operations
- High Isp engines for low earth orbit flight
- High bandwidth laser communication for satellite and aircraft cross- and down-link*
- (R)Distributed satellite vehicles and sensors
- Precision station keeping and signal processing for distributed satellite constellations
- Radiation resistant satellites
- Precise positioning overlaid on military and commercial information
- (R)High precision, jam resistant GPS
- Hyperspectral sensing and target identification at low spatial resolution
- (R)Human-Machine interactions*
- (R)Information munitions
- Information protection
- Chemical enhancement of biological functions
- Continuous simulation
- Secure operations across large networks having secure RF components*
- Language translation of stylized language
- Micro-electro-mechanical systems for sensing and manipulating*
- Nuclear hardened electronics

Technologies to buy:

- Software tools and languages
- High bandwidth laser communication for satellite and aircraft cross- and down-link*
- (R)Human-Machine interactions*
- Information protection*
- Operations with large databases*
- Secure operations across large networks having secure RF components*
- Micro-electro-mechanical systems for sensing and manipulating*

Services and equipment to buy without development:

- Mapping of the world to 1 m[53]
- High speed processors
- Space launch
- Satellites
- Focal Plane Arrays
- Database software
- Data compression systems
- Computer displays
- Networking technologies
- Direct downlink broadcast equipment
- Satellite to aircraft communication equipment
- Fiber and satellite communication services
- Training systems

There are, of course, support technologies which accompany the major ones. We believe that the reader will agree that the list is manageable if not short. Much of the work listed is in progress today either in DoD or commercial laboratories. Most of the components of information systems can be purchased today.

9.0 Conclusion

We have described the technologies which will make the United States Air Force the most capable and respected Air and Space Force in the world of the 21st century. All of the capabilities enabled have connections to the other Services, and provisions are made for allied

53. Wall Street Journal, November 30, 1995, pp1

operations across networks, databases, and languages. Response times enabled by these technologies and concepts will be measured in seconds for mission generation or, even in microseconds for information responses. The technologies described are at the edge of the currently possible, or, even beyond the edge for a few years. Some of them may not materialize as warfighting capabilities. Forecasting is not an exact science, and the path will wind as it disappears into the shadow of the future. We guarantee the journey to be productive even if the road ends at an unexpected place.

It is incumbent upon the members of the SAB, Air Force technologists, and warfighters to discuss and refine the concepts presented here. The capabilities described are natural ones for scientists and technologists, but we must transform the technical-operational concepts into forms more useful to the operational Air Force. Then, we must transform the concepts into technology programs. Finally, we must transform the programs back into capabilities. When the product of the three transformations is unitary, that is, the result is the same as the starting point, we will have reached a true understanding among all participants.

Chapter III

Recommended Actions for the Air Force

What to Do and What to Stop Doing

Resources to Get There and How to Make It Happen

1.0 Introduction

Up to this point, this Summary Volume has presented a list of essential capabilities for the Air Force of the 21st century and provided rationale as to why. The purpose of this Chapter is to propose to the Air Force a top level summary of what technology groups should be developed to produce Air Force future capabilities necessary for it to continue into the 21st century as the world's best and most respected. As described in Chapter II, these six capabilities are outlined as follows:

- Global Awareness
- Dynamic Planning and Execution Control
- Global Mobility in War and Peace
- Projection of Lethal and Sublethal Power
- Space Operations
- People

In the interest of brevity, our intent is to suggest the major "leap ahead" technology areas that need to be pursued. We have referenced the Panel Volumes by footnotes, and the readers are asked to consult the appropriate Panel Volume for details. Those volumes are the major works of *New World Vistas*. They contain the details needed to build and execute specific research programs. After recommendations on what to do in each of the capabilities mentioned above, recommendations, where appropriate, on what to stop doing or not to do will be provided to help focus time and resources. And finally, after the discussions on what to do and if needed, what not to do, will come a funding proposal to get the effort started in the right direction and a suggestion concerning how to track matters to see that the undertaking remains *on course and on glide path.* We shall begin with consideration of the six generic capabilities mentioned above.

2.0 What the Air Force Should Do

2.1 Global Awareness

A future goal of the Air Force should be to know at all times the relevant global military situation given the existing political and economic conditions and the state of military conflict. Such awareness should be in near real time (in time enough to understand and act) and with near real perfect knowledge (knowledge good enough to make good decisions in the time available to decide and act). This is the idea of Global Awareness. Some will argue, and we do not disagree, that this is or is not a part of Information Warfare. In this regard, we recognize the importance of Information Warfare in the future and that much of what we present in this summary volume is Information Warfare said another way. The key technologies to make Global Awareness possible lie in the right mix and integration of sensors, communications, and processing to collect data and convert it into information and knowledge in a meaningful time frame over the area of interest. The reader is invited to study closely the Information Technology, Information Applications, Sensors, Space Applications, and Space Technology volumes of this study for details. A top level list of the relevant technologies are outlined without comment as follows:

- Clusters of cooperating satellites
  - Precision station keeping
  - Autonomous satellite operations
  - Signal processing for sparse apertures
- Laser cross and down links
- Precise global positioning, time transfer, and mapping[1]
- Large, sensitive focal plane arrays and associated read out
- Radiation resistant satellites and components
- Spectral sensing at all relevant wavelengths
- Active sensors
  - Large light weight antennas
  - High efficiency radio frequency sources
  - High energy lasers
- Micro-electro-mechanical systems[2]
- Communications and networking
- Automated fusion[3]
- Automated target recognition[4]

2.2 Dynamic Planning and Execution Control

The first step toward acquisition of Dynamic Planning and Execution Control capability is to *make this idea or concept part of Air Force and Joint Doctrine.* Next is to *pursue a joint architecture* definition to implement the doctrine. The concept of Dynamic Planning and Execution Control is to exploit the Global Awareness acquired through the technologies just listed above. As such, this idea will make possible the most efficient use of the mobility, power projection, space operations and people associated with the military capabilities of the United States. The attainment of relevant Global Awareness and its exploitation through Dynamic Planning and Execution Control will be a high leverage capability to win America's future wars quickly, decisively, with minimum or no human losses (on both sides). As with Global Awareness and the capabilities in this chapter, this topic is replete with information warfare aspects and can be viewed in that context as well as in the functional categories used for this presentation. The following technologies summary applies to support Dynamic Planning and Execution Control:

1. Space Applications Volume
2. Sensors Volume
3. Information Applications Volume
4. Sensors Volume

- Support for Planning. Faster than real time interactive, predictive, continuous running simulations for planning and mission rehearsal will the driving technology for planning side for future employment of air and space power.
- Support to mission execution. Execution of the plan is where the true flexibility and speed of employment of air and space power will be realized. Technologies which permit near real time changes and updates to on-board databases as well as other planning and situational awareness databases will be key. Rapid capture of information from onboard sensors, including the crew, into these databases will also be very important. Finally, concurrent faster than real time simulations for near real time mission execution, planning, and attack will insure we remain inside any enemy's timeline for action.

2.3 Global Mobility in War and Peace

The United States military has a long tradition of going where necessary in the world to conduct military and peaceful operations. Such a capability will perhaps be even more important in the 21st century. The Air Force brings speed and reach to the global mobility equation. The current introduction of the C-17 will serve the country well as we enter the next millennium. The following technology areas are recommended to make a difference in the use of the C-17 and after the C-17.

- *Point of Use Delivery.* The idea here is that supplies delivered by aerial transport should be delivered directly to where they are to be used without landing the transport aircraft. Delivery of medical supplies beside the hospitals, food directly to the soldier or feeding facility, and weapon system load and reload ammunition to the weapon in its firing position are possible examples. Secure dependable communications, precision airdrop, multi- spectral sensors for weather and intelligence, intransit visibility of cargo, aircraft situational awareness and aircraft self protection are the key technologies.
- *Low Cost Precision Airdrop.* A key driver in making "point of use delivery" possible will be the need for a low cost way to dispense air cargo in modules, containers, or pallets with appropriate guidance, control and arresting mechanisms. A proper balance of expendable and reusable components is needed to achieve the results within a reasonable cost.
- *The "Million Pound" Airlifter.* Thinking needs to begin now for the next generation airlifter. High lift over drag wing/airframe design and testing needs to begin. Engineered materials[5], high temperature engine components, composite fabrication and fastening, and next generation material for airframe and skin are needed.

2.4 Projection of Lethal and Sublethal Power

The four major technology directions that the Air Force should pursue to project lethal and sublethal power in the 21st century are outlined as follows. There is a fifth technology having to do with Space, but it will be covered later in the Space Operations section of this chapter.

5. Mobility Volume

- *Uninhabited Combat Aerial Vehicles (UCAV).* As this technology is developed it will offer potential for significantly more capable weapon systems at lower cost. Such vehicles serendipitously accommodate the probably inexorable trend of American society which are more and more expecting no human losses during U. S. military operations. The technologies to realize the UCAV include new high efficiency, high supersonic engines; advanced structures; avionics, control systems, and observables; very high altitude/low speed cruise, very small/miniaturized "micro-air vehicles"; very high dynamic pressure cruise vehicles; intelligent signal and data processing; secure and possibly redundant control data links; control science and applications for mission and vehicle management of a complex, highly coupled system, control criteria to achieve optimal performance based on that used for missile control; and human/machine interface for off board air vehicle control.

- *High Power Microwave and High Power Laser Directed Energy Weapons.* Speed of light weapons with the full spectrum capability to deny, disrupt, degrade and/or destroy will leap past and could eventually replace many traditional explosive driven weapons and self protection countermeasure systems. There are five innovative technologies required for "energy frugal" practical directed energy weapons.[6,7] They are large, lightweight optics, HPM antennas using thin membrane fabrication; high-power short-wavelength solid-state lasers; high average-power phase conjugation; new approaches to adaptive optics and phased arrays of diode lasers.

- *Stealth-the Next Plateau.* Active radio frequency and next generation passive infrared stealth capability will replace what we have today with another quantum leap forward in vehicle survivability.

- *Hypersonic Air Breathing Platforms/Vehicles.* Even with the tremendous increase in space operations in the future there will continue to be a major place for air breathing platforms/vehicles. Time is now, always has been, and even more so in the information age future, will be of the essence in military operations especially those of the Air Force. All distances on the earth are fixed. If the Air Force is to execute faster than an enemy in the 21st century, then to reduce time, the only alternative is to go faster. Hypersonic air breathing flight is as natural as supersonic flight. Advanced cycle, dual mode ramjet/ scramjet engines and high temperature, lighter weight materials which allow for long range, long endurance, high altitude supercruise are the enabling technologies.[8]

2.5 Space Operations

Space operations will grow rapidly as a factor in United States military capabilities limited primarily by affordable access. Space operations already contribute much to global observation and global situational awareness. Space control and projection of force from space technologies will become as important in the 21st century as space becomes more available to many countries of the world.

6. Directed Energy Volume
7. Space Technology Volume
8. Aircraft and Propulsion Volume

- *Access to Space.* Affordable access to space will require many advances in technology. Such technology includes lower mass of the components for power, energy storage and conversion, attitude control, propulsion, large-thrust, high-specific impulse chemical propulsion, multi-functional structures that integrate spacecraft bus functions into the structure of the spacecraft itself, high temperature materials, ultra-light-weight integrated cryogenic structures and miniaturized sensors.
- *Global Observation and Situational Awareness.* Sensors, the conversion of sensor data to information and knowledge, the necessary communications to move the data, information and knowledge when and where needed are necessary for global observation and situational awareness. Although such activity may be conducted in both the air and space medium, the use of space will continue to grow and begin to dominate in the 21st century. The technical trades and costs associated with global observation and situational awareness from either air or space will have to be made as the decisions to replace or improve current capabilities are faced. In the mean time, there are many technologies needed regardless of whether the job is done from air or space. These technologies are outlined in the previous section on Global Awareness.
- *Space Control Technologies.* The Air Force must begin to think and bring forward the technologies necessary for space control. Capabilities to defend our own space based resources and to disrupt, degrade, deny or destroy that of the enemy will be needed sooner or later in the 21st century. The technologies needed to protect our space resources from enemies include high thrust, high specific impulse electric propulsion, large constellations of low cost satellites with distributed functionality or networking across the system and autonomous guidance & navigation.
- *Force Projection from Space.* The laser directed energy weapon mentioned above in the "Projection of Lethal and Sub-lethal Power" section may be employed from space. Alternatively, the laser can be ground based with directing mirrors deployed in space. Short wavelength, electric lasers along with large optics and antenna technology will be needed. In addition, for space deployment of the laser, large electrical prime power such as nuclear or power beaming along with power storage in advanced capacitors or secondary advanced flywheels will need to be pursued. The sensor, communications and autonomous guidance and navigation technology needs mentioned above will contribute to force projection from space.

2.6 People

There can be no question as we enter the 21st century that the idea of the individual's central importance will continue to be a driving force in our culture. As such, the expectation of the American people (perhaps unrealistic but nonetheless powerful) is that there should be almost no casualties during the conduct of military operations. In addition to the capabilities and technologies mentioned above, attention must be paid to the technologies which will improve the human part of the military capability equation. Those entrusted with the defense of our country must be well trained, able to control and work with machines and information systems in the most efficient way and be mentally and physically superior within moral and ethical bounds to any enemy. The five human-related technology areas that will allow significant improvements in human performance are summarized as follows.[9]

- *Training*. Training can be significantly improved and made less expensive through personnel selection and classification technologies which more closely match skills and aptitudes to the task. In addition, interactive individual and group training using virtual reality and other distributed interactive simulation where appropriate will be the training technologies of the 21st century.

- *Human/Machine System Fusion*. Voice recognition and voice generation, gesture recognition and response, multi-lingual translation and generation and brain control of computer technologies will all contribute to making sure that the human is not the limiting factor in rapid exploitation of Global Awareness through Dynamic Planning and Execution Control.

- *Operational*. In order to better understand, design and operate the weapon systems of the next century a more detailed understanding of the human is needed. Technologies associated with cognitive and non-cognitive models of the human learner and of the instructional process are needed. Such understanding not only will help with the training needs listed above, but will make possible the most cost effective human machine fusion in such areas as displays and controls, brain control of computers, etc.

- *Biological*. Technologies which temporarily enhance human performance and provide for emergency mission extension should be developed. The technologies should be brought forward into capabilities under the social and ethical standards of our country and leave no short or long term after effects. It is expected these capabilities will only be used on the most difficult and dangerous missions. We owe with proper controls, such capability to our people who must do the military job just as much as we do the best tank, ship or aircraft if we truly believe that wars are best fought to win quickly, decisively and with no or minimum human losses.

- *Scientific and Technical Personnel Management*. Air Force leadership from the days of General Hap Arnold to the current Chief and the Secretary recognize that science and technology is the life force of our country's air and space capability. We must have a path for more scientific and technical officers to attain the highest positions in our Air Force. We, therefore, recommend that the Air Force officers who command laboratories be given the status and be treated in the promotion system like other operational wing commanders. Please refer to Chapter IV on "Organizational Considerations" for more on the management of Air Force scientific and technical personnel.

9. Human Systems/Biotechnology Volume

3.0 What the Air Force Should Not Do or Stop Doing

Much work and study has gone into how the Air Force can leverage its science and technology resources with the technologies the commercial world will bring forward to the Air Force in the coming years. There are also technologies or development initiatives internal to the Air Force which have little chance of being converted to actual capabilities. With this in mind, the following is a representative summary list (which is probably incomplete) of technologies the Air Force should stop doing all together or at least by itself.

- Stop Buying Bandwidth to the Theater
- Stop Software Development of Software Tools
- Stop Development of Compiliers
- Stop Mandatory Use of Ada
- Stop Selective Availability of GPS
- Stop Environmental Protection Research in Air Force Labs
- Stop Aircraft Cockpit Design Work - Depend on aircraft manufacturers
- Stop Ejection Seat research and development - Depend on aircraft manufacturers
- Rethink MILSTAR
- Stop Military Only Launch Access to Space - Exploit commercial systems
- Rethink the design of and investment in dedicated Military Satellite Communication Systems[10]

Defocus Air Force investments to utilize commercial and university developments in the following areas:

- High capacity communications "backbones"; global telephone networks; world-wide wireless infrastructure, Internet, ATM
- Cryptography routinely embedded in systems
- Compression (except intelligent compression)

In some areas, the Air Force laboratories should recast themselves as *users* of commercial and university research, rather than basic developers. These areas include:

- Multimedia technologies
- Natural Language Understanding, including Speech Understanding
- Computer displays
- Data mediators, request facilitators, information broker software

10. Chapter II, Sec. 3.3

- Basic directed-action software agents
- Software for the "business" functions of the AF: logistics, personnel, finance, etc.

For example, the Air Force may make heavy use of commercial smart agents within its command and control systems. However, the core research in these areas is best left to the university and commercial communities.

As with many things in life, the decision on what to stop doing is not simple. Complicating factors include a sincere entrenched bureaucracy which will resist.

We recommend that the Air Force establish an independent, outside panel to review priorities of S&T programs. A concentrated effort should be made to eliminate 5% of S&T programs each year. Funds for the discontinued programs can be applied to new programs.

4.0 Resources to Get There

We recommend that the Air Force invest 15% of its S&T resources over the next five years in new start S&T areas directly related to *New World Vistas* proposed technologies. Such an investment policy will do two things. First it will cause the Air Force to invest in long term key technologies which are not under the current mandate of immediate short term pay off. Such activity will make possible the longer term view needed to create the quantum leaps in capability in the next century. Second, such a policy will act as a forcing function on what to stop or curtail to find the resources for the longer term investments.

5.0 How to Make "*New World Vistas*" Happen

We recommend the SAB sponsor and coordinate workshops, briefings, SAB member participation on panels and forums, and other appropriate activities to extensively communicate the essence and details of New World Vistas.

We recommend the Principal Deputy Assistant Secretary of the Air Force (Acquisition) (SAF/AQ) be responsible for leading the effort within the Air Force to determine what and how *New World Vistas* is to be implemented and how progress will be measured and tracked.

Chapter IV

Organizational Considerations and Recommendations

1.0 Introduction

New World Vistas describes a new way of combining and integrating Air Force technologies and capabilities. It is natural to assume that the structure and philosophy of the organization must make some concessions. The operational capabilities enabled by the new technologies are closely paralleled by today's capabilities. While the ratio of forces in various commands may change and the equipment and individual tasks may change, the generic functions will be quite similar. It is in the technology and procurement organizations that fundamental change will manifest itself. There should be changes made in personnel practices as well. We will recommend changes that we believe to be constructive and positive. Finally, we will recommend some functional changes within SAB operations.

2.0 Procurement and System Development

Everyone rails at the procurement system as the source of all unjustified expense and interminable delays. We will not repeat the well known arguments. We will only suggest that completion dates have the same status as other specifications of a system. Many of the systems suggested by *New World Vistas* can be built a piece at a time, and funding reductions should be reflected in the extent of the system rather than by extending the procurement time. The systems need to mesh with one another, and, therefore the relative phasing of procurements is important. These considerations suggest that systems be procured in blocks which continuously replace older blocks and continuously insert new technology in later blocks. One can argue that this has been the philosophy of many procurements, and we have chosen the nomenclature to suggest this argument. While this is true to some extent, the procurement cycle time for many of the concepts in *New World Vistas* should be no more than two years, and replacement time for information systems should be no more than 5 years. The system should be redesigned to accommodate these times. It is known in the commercial world that extended development periods lead to excessive costs. The Defense procurement system stretches programs in time so that many programs can be pursued in parallel. Both Government and Contractor have become too comfortable with this situation. We should consider the possibility that programs in series with rapid completion may be more economical.

The existing organization is optimized for the development and procurement of independent systems. It was emphasized many times that the effectiveness and affordability of capabilities depends on their close integration. The ideal situation would be one in which all participants in all procurement and development projects interacted at all times to produce systems which naturally worked together in the most efficient way. The ideal situation is impossible. Even if people could be convinced to behave in the proper way, they would spend so much time cooperating that they could get no work done. While we must instill the importance of the concepts of integration and cooperation of systems in all Air Force people, government and contractor, we must realize that focus on an individual product is the natural tendency of techno-humans.

Therefore, integration and interoperability must be assured at a higher level than that of individual system development and procurement. We recommend that an Integration Authority be established to guarantee integration and interoperability. We use the terms assured and guaranteed rather than dictate to indicate that the function of the Integration Authority is not to hand down specifications. That has been tried before, and it tends to stifle innovation and to stagnate technology. The specification of Ada is an example. Rather, we envision an Integration Integrated Product Team (IIPT) approach under the command of the Integration Authority. The IIPT would be composed of knowledgeable members of all interacting development projects. They would be responsible for proposing program and system modifications to facilitate integration and interoperability. The teams could also specify common components which could be separated from several projects into a common procurement to reduce cost. The purpose of the IIPT's would be to produce global optimization of systems rather than the sum of local optimizations that we have today.

We believe that the Integration Authority and IIPT approach could produce significant economies even in the short term. Avionics modernization of existing aircraft, and GPS installation in those aircraft are areas where enforced commonality could result in substantial savings Air Force wide.

3.0 Air Force Laboratory Organization

The Air Force Laboratories are now under the control of the AFMC Product Centers. The organization was established because the Labs had become unresponsive to the needs of the operational Air Force. We believe that the decision was correct. The new organization focused the work of the Labs on problems which were important to the Air Force and, simultaneously, gave the Labs enhanced stature in the eyes of the Operational Force. The position of Air Force Technology Executive Officer (AFTEO) was established to coordinate the programs.

We believe that the current organization has served its purpose well, but the pendulum has begun its inexorable swing from improved focus to myopia. Each of the Labs has important programs which are not directly associated with its Product Center. Those programs will eventually suffer because of their being labeled as outsiders. The impact of new technologies is to demand closer integration and "flattening" of organizations to provide better integration of the technologies themselves. Recognizing that no organizational structure remains viable forever, we recommend that all the Laboratories be placed under the authority of an S&T Executive. The S&T Executive should have authority over both personnel and programs. We avoid recommending either civilian or military control. A civilian S&T Executive could provide continuity, but a military S&T Executive could provide closer ties to the operational Air Force. The S&T Executive should be, at least, at the level of a Product Center Commander, but the exact structure and identity of the S&T Executive should be the subject of further debate and study. The S&T Executive should be charged with maintaining the pressure on the S&T organization to recognize and pursue transition opportunities. The executive pressure coupled with better integration across the S&T organization should increase transition opportunities.

4.0 Personnel Practices and Opportunities

We observed that technically educated people will be extremely important to the Air Force of the 21st century.[1] Technology will touch all facets of Air Force life and operations. Although the Air Force can recruit intelligent and productive people by offering funding for advanced and undergraduate degrees, retention of those people will be possible only if career opportunities

1. Chapter II, Sec. 7.0

exist in the long term. For technically educated military personnel, it should be possible to establish a path through the Lab Commander position to Flag rank. The designation of Lab Commander as equivalent to Wing Commander will place the Lab Commander in a promotable position. If Lab Commanders have impeccable technical credentials, the young officer will feel that a technically oriented career has significant advancement possibilities. Fewer will abandon the Force for industrial jobs. We do not suggest that a technically oriented career be pursued only in Laboratories or SPO's. There should be diversification during a career. We suggest only that the majority of a career be devoted to technical matters. *The Air Force should consider career management of technically oriented officers with the same vigor as that of the rated force.*

5.0 SAB Focus

The SAB consists of 50 members. The members are assigned to a Panel such as Sciences, Avionics, etc., but in fact there is no formal organization. A part time, volunteer organization composed of scientists, technologists, and administrators truly has no need of formal organization. There is no evidence that the absence of an enforced formal structure has had any effect at all on the operation of the organization. Members respond to requests for their time to the extent that they can. Their dedication to the organization is indicated by an average yearly participation of more than 20 days. Most find the collegiality and informality of the organization refreshing, and strong friendships develop. Therefore, we believe that the organization, or lack of one, is appropriate.

The tasks performed by the members could be altered somewhat. The Board performs studies at the rate of a large summer study and one or more ad hoc studies each year. Occasionally, a small group of Board members will respond to a specific request for a study requiring three or four members to meet once or twice to consider a specific, limited issue. Also, Mission Panels respond to requests for help from a Major Command once or twice a year. A large portion of the Board's work is directed toward the quality review of Air Force Laboratory programs. We believe that all these functions are appropriate and should be continued.

Over the past few years the Board has provided members to moderate and evaluate the output of two Workshops. The first was the Laser Mission Study which was convened by Phillips Lab at the request of Maj. Gen. Robert Rankine when he was AFTEO. The study was a great success, and its recommendations are being pursued with equal success. Last year, a three day workshop on munitions with a structure similar to the Laser Mission Study was organized at the Munitions Directorate of Wright Lab. It was also judged a success in that it gave direction to Air Force efforts to develop higher energy density explosives and more effective munitions. In January or February 1996, a workshop on atmospheric propagation and compensation of laser beams will be held under the auspices of the SAB, the Naval Research Lab, and Phillips Lab. We expect the workshop to define research directions in the field.

We believe a workshop should be a yearly feature of the SAB. It is not only effective but also it amplifies the work of the Board and produces useful results with less effort on the part of the SAB Secretariat.

We also believe that the "quick look" study could be used more effectively in support of ongoing projects.

Finally, there should be a significant effort in the current year to generate a migration plan for *New World Vistas* technologies and to make the output of the *New World Vistas* study useful input to the Air Force Long Range Planning effort.

Appendix A

General Fogleman's, CSAF, and Dr. Widnall's, SecAF, memo to Dr. McCall, SAB Chair, subject: *New World Vistas* Challenge for Scientific Advisory Board (SAB), dated 29 Nov 94.

SECRETARY OF THE AIR FORCE
WASHINGTON

29 Nov 94

MEMORANDUM FOR DR McCALL

SUBJECT: New World Vistas Challenge for Scientific Advisory Board (SAB)

During the recent commemoration of the 50th anniversary of the Scientific Advisory Board (SAB), we recognized its significant accomplishments over the past half century. In addition to the high profile aircraft and weapons systems General Arnold and Dr von Karman foresaw, these two visionaries also reminded us that *"only a constant inquisitive attitude toward science and a ceaseless and swift adaptation to new developments can maintain the security of this nation."*

This reminder is even more relevant today than it was 50 years ago. There has never been a period in our country's history when "swift adaptation to new developments" was more important. One need only look at the blistering pace of computer technology and information system development to appreciate that the security of our nation depends on a "constant inquisitive attitude."

We want you to re-kindle that attitude toward science. In that spirit, we challenge the Air Force Scientific Advisory Board to search for the most advanced air and space ideas and project them into the future. Fifty years ago, the SAB was challenged with looking "Toward New Horizons." Today, we launch our search for "New World Vistas."

New World Vistas should be a truly independent, futuristic view of how the exponential rate of technological change will shape the 21st century Air Force. We'd like to begin this effort immediately, and complete the forecast within one year. Our goal is to publish New World Vistas in December 1995, on the 50th anniversary of the publication of Toward New Horizons.

New World Vistas should offer a ten year technological forecast which:

1) Predicts how the explosive rate of technological change will impact the Air Force over the next ten years. Identify fields of rapidly changing technology and assess their impact on the modern Air Force. Some possible areas to explore include the rapid advances in information, C4I, and space technology. Your challenge is to identify those areas which will most likely revolutionize the 21st century Air Force.

2) Predicts the impact of these technological changes on affordability of Air Force weapons systems and operations.

3) Predicts Science and Technology (S&T) areas where we can minimize Air Force investment and turn to the commercial world for technology development. Highlight opportunities for dual use, possibilities for defense conversion, and mechanisms for capitalizing on technology advancement in the commercial sector. Identify areas we can rely on, or partner with, commercial industry for technology development. Also, identify the areas where we are not the innovator, but a large high tech customer. Offer advice on how the Air Force can be a better customer.

4) Predicts S&T areas we will have to develop, where no commercial market exists or will likely develop. Highlight related industrial base issues.

5) Offers advice as to whether our lab structure is consistent with these new vistas, and what changes, if any, should be made.

6) Offers advice as to whether the current SAB charter is consistent with these new vistas, and what changes, if any, should be made.

7) Evaluates your proposal in light of how the Air Force contributes to the joint team.

Roughly every ten years the AF has launched a major S&T forecast. The relative success of these forecasts depends on the degree of interaction with and ***commitment of senior AF leadership.*** We are fully committed to New World Vistas. We are empowering you to tap the resources in any Air Force organization, including the Secretariat, Air Staff, Air University, or others. We would appreciate quarterly updates on your progress.

A fundamental part of Air Force culture has always been our high technology orientation. In the face of ultra-rapid technological change, the Air Force must take bold steps. New World Vistas is such a step. We know that asking you to formulate a new technological vision for the Air Force capitalizes on the strengths of the Scientific Advisory Board. We have the utmost confidence in your leadership, and anxiously look forward to your report.

RONALD R. FOGLEMAN
General, USAF
Chief of Staff

Sheila E. Widnall
SHEILA E. WIDNALL
Secretary of the Air Force

Appendix B

Abstracts

Aircraft & Propulsion Volume Abstract

The Aircraft and Propulsion Panel was chartered to identify and recommend aircraft and propulsion technologies and concepts that have potential to favorably impact the ability of the USAF to accomplish its mission in the future.

The panel held five fact-finding meetings with DoD scientific agencies. Six attributes are identified as critical to future USAF air vehicles: affordability, lethality, flexibility, survivability, speed and range. In conjunction with the applications panels and considering these critical attributes, seven air vehicle concepts are identified to fulfill future USAF requirements: modular vehicles, uninhabited aircraft, hypersonic vehicles, future attack aircraft, large transport aircraft, special operations aircraft, and long endurance aircraft.

The key technologies required to develop these vehicle concepts have been identified and evaluated as to criticality and readiness. An overall assessment of enabling aircraft and propulsion technologies is provided along with a discussion of important infrastructure concerns including test facilities and USAF laboratory structure.

Recommendations are made for the USAF to pursue air vehicle technologies that are required to support future missions, to retain and modernize its ground test facilities and to pursue experimental and flight research programs. These actions will protect the technology base and air vehicle development capability necessary to provide air-vehicle systems superior to those of any adversary.

Dr. Richard G. Bradley, Jr.
Chair, Aircraft & Propulsion Panel
15 December 1995

Panel Membership

Dr. Richard G. Bradley, Jr., Chair
Prof. Eugene E. Covert
Dr. Douglas L. Dwoyer
Dr. William H. Heiser
Mr. William J. King
Dr. James D. Lang
Dr. James G. Mitchell
Dr. G. Keith Richey
Prof. Terrence A. Weisshaar
Capt Christopher N. Berg
Maj William B. McClure
Maj Michael K. Reagan

Attack Volume Abstract

Shaping the Air Force to meet the needs of the future is a daunting undertaking. We chose a fundamental and operationally oriented approach for revealing and defining the types of operational capabilities most relevant for any future. Stated at the most generic level, the purpose of military power is to protect the nation to the extent possible within the constraints imposed. *We seek those operational capabilities that allow us to conduct any missions, meet any contingency, and win any war.*

The role of military power is to control (dictate and enforce) the operations of all types of enemy forces. We *define* in detail the enemy operations we wish to control and the *tasks* required to achieve those objectives, *framing operational capabilities* down to the tactical level. These *tasks are* by definition *enduring, important and there is considerable opportunity and need for improvement*. Finally, we *define* the *operational concepts* to accomplish the tasks. These *concepts establish* the needed *functional capabilities.* We then, *define the systems and capabilities required to provide* these *functional capabilities*—for three time periods: 1995, 2000-2010, and 2005-2025.

Mrs. Natalie W. Crawford
Chair, Attack Panel
15 December 1995

Panel Membership

Mrs. Natalie W. Crawford, Chair
Dr. John M. Borky
Maj Gen Gerald J. Carey, USAF (Ret)
Mr. Ramon L. Chase
Mr. Jerauld R. Gentry
Mr. Dennis L. Holeman
Lt Gen Glenn A. Kent (Ret)
Mr. Sherman N. Mullin
Maj Steve W. Martin
Capt Donna J. Williams

Maj Michael K. Reagan

Directed Energy Volume Abstract

Directed energy weapons, both lasers and microwaves, will have widespread application over the next few decades. A substantial technical data base now allows confident anticipation of weapon applications. Initial airborne weapons to provide boost-phase defense against ballistic missiles and defense of aircraft against missiles will lead the way to space-based, or space-relayed, weapons. Global presence with weapons capable of destroying or disabling anything that flies as well as most unarmored ground targets will drive a new warfare paradigm.

This volume discusses directed energy applications that are most probable as well as most important in three time periods: 10, 20, and 30 years in the future. The technologies that should be supported to enable these applications are discussed leading to several conclusions and recommendations. Our intent is that these recommendations are sufficiently detailed to provide rapid definition of technology thrusts in laboratory programs. Reference is also made to a number of classified annexes that cannot be discussed herein.

Maj Gen Donald L. Lamberson (Ret)
Chair, Directed Energy Panel
15 December 1995

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Human Systems/Biotechnology Volume Abstract

All Air Force systems must be human-centered, from design to operations. People are central to all Air Force activities. No matter how the battlefield of a particular future conflict evolves, and no matter what mix of power is used, there will always be a human in every loop, to exercise command and control.

Human-centered design, development, manufacturing, and fielding provide the only way to ensure maximized human performance, especially for the "most-certain-to-come" capability of fusion of the human/machine interface into one being. Air Force goals of better human information-processing and decision making, and better understanding of mental processes such as reasoning and memory, are central to situational awareness of the future battlefield, and to winning.

Air Force investment in cognitive science and neurobiology now, at the Air Force Office of Scientific Research and the laboratories, must be protected at all cost. These sciences are enabling. The huge savings in training costs, up to 50%, the huge savings in logistics management through new human-centered visualization technology, and the saving of lives through neutralization of human fatigue in combat, all flow from these enabling sciences. They enable us to win in a world where everyone has pieces of our national technological array of capabilities.

Dr. Garrison Rapmund, MD
Chair, Human Systems/Biotechnology Panel
15 December 1995

Panel Membership

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Dr. Henry L. Taylor
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Dr. Harry L. Wolbers, Jr.
Capt Teresa A. Quick

Capt Sandra M. Eisenhut
Maj Michael K. Reagan

Information Applications Volume Abstract

The US Air Force is a young service, and is about to experience its first paradigm shift. The expanded use of information systems will radically alter the tasks associated with putting energy on targets. In addition, early in the next century, warfare will take place within these same information systems.

Coupling new information systems with the global reach of the Air Force will form the basis for a potent new form of military aerospace power. Dealing with information warfare in a fundamental way will bring about a profound cultural shift in the Air Force. This shift will begin in earnest over the next decade, and may be wrenching for those imbued with the cultural heritage of manned aircraft.

To respond to these changes, the Air Force must expand its traditional role as the leading proponent of air and space power to include an equally important role in cyberspace. To the extent the Air Force can effectively unite aerospace power with information based power, it will remain a dominant factor in the defense of our nation. To help accomplish this goal, the Information Applications Panel monographs provide details of long term research and development for:

- Situation awareness
- Communications
- Battle planning and execution management
- Computer security
- Information warfare

Dr. Charles L. Morefield
Chair, Information Applications Panel
15 December 1995

Panel Membership

Dr. Charles L. Morefield, Chair
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MG John F. Stewart, Jr., USA (Ret)

Maj John D. Davidson
Capt Kevin L. Taylor
Capt Dean F. Osgood

Information Technology Volume Abstract

The task of the Information Technology (IT) panel is to project the visible trends of the continuing revolution in information technology and, where projection fades at the horizon, to envision further progress. We have done this in two ways.

First, systematically we surveyed the areas of IT work. Examples are communications, computer system architectures, the interface between computers and people, software and the technologies for its development, the emergence of artificial intelligence software that emulates human-like thought processes, software that learns and adapts itself to user needs, technologies for crypto-secrecy and for assured access to systems and networks, and several more.

Second, we projected and envisioned specific achievements, stretching out over twenty years or more -- highlights of the information future. Some are evolutionary, "big wins" with high probability of being achieved. Others represent discontinuities; we do not know if they will arrive but if they do, their impact will be revolutionary. Still others represent technological, educational and organizational concerns for the future of the Air Force in the era of the information revolution.

Military needs no longer drive this revolution. The good news is often we can buy off-the-shelf hardware, software, and communications that are much better than, and very much cheaper than, what we can have custom-built for us. The Air Force is challenged to adapt to this new way of doing business, and to benefit from the best commercial technology can offer (just as our friends and enemies can). But some information technologies the Air Force needs will not emerge from the commercial marketplace. Our panel made judgments about what these will be as a set of recommendations for continued Air Force and DOD R&D funding priorities for information technology. Our panel also points out where the Air Force can benefit from starting to rethink right now how information technology can improve its weapon system design, acquisition, management, education and career development processes.

Dr. Edward A. Feigenbaum
Chair, Information Technology Panel
15 December 1995

Panel Membership

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Dr. Randall Davis
Prof. John E. Hopcroft
Dr. Robert W. Lucky
Dr. Donald L. Nielson
Mr. Paul Saffo
Prof. Gio Wiederhold
Col Roderick A. Taylor
Col Harvey D. Dahljelm

Maj M. Clarke Englund
Maj Earl H. McKinney
Capt Dean F. Osgood

Materials Volume Abstract

Air Force battlefield superiority is maintained, to a significant extent, by the use of advanced materials that enable weapons and weapons platforms to accomplish specific aerospace missions. The driver for the introduction of new materials in the past has been improved performance, and performance will continue to be the driver in the future. We are now entering an age when these materials will be designed to have specific properties using advanced computational techniques at the atomic/molecular level. The Air Force must strive to maintain a leadership role in new materials science and technology, because it is unlikely that commercial suppliers could meet critical Air Force needs in the absence of large commercial markets. The Air Force must also develop pathways for the more rapid introduction of new material into new and existing flight systems; these pathways must enable the introduction of new materials in a rational manner even if significant initial risk exists. Finally, in light of tightening environmental regulations, the Air Force should move to life cycle costing to ensure that the cost of disposal or recycling of specific materials is adequately covered and will not become a burden on future Air Force budgets.

Prof. Digby D. Macdonald
Chair, Materials Panel
15 December 1995

Panel Membership

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Mobility Volume Abstract

The political changes around the world result in US forces being primarily based in the US. Consequently, heavier demand falls on the Mobility Command to provide true global reach and global power. After reviewing the needs associated with this requirement, the Mobility Panel selected five areas embodying revolutionary technology to improve mobility.

1. Information Dominance -- world-wide communications, information on demand in the cockpit, and intransit visibility of cargo.

2. Global Range Transport -- new airplane weighing about 900,000 pounds, carrying 150,000 pounds cargo for 12,000 nautical miles unrefueled.

3. Precision/Large Scale Airdrop -- 100 foot accuracy, integral wind sensing, family of airdrop systems.

4. Directed Energy Self Defense Weapon -- a kilojoule laser system to defeat ground-to-air and air-to-air missiles.

5. Virtual Reality Applications -- use of holographic displays, synthetic sensory environment, communication networks, etc. for mission training.

The key technologies needed to attain these capabilities are: 1) accurate, timely, and dependable information through computer controlled satellite and fiber optic networks, 2) high temperature materials for advanced turbofan engines, 3) low cost composites for airframes, 4) airborne laser, 5) airborne wind-measurement sensors, and 6) synthetic environment generation.

Mr. Robert J. Patton
Chair, Mobility Panel
15 December 1995

Panel Membership

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Mr. Harry Sutcliffe
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Munitions Volume Abstract

The Munitions Panel identified several high payoff munitions concepts that address recognized and future US defense needs. The weapon concepts are achievable within the next 10-30 years and will significantly enhance the warfighting capabilities of the US Air Force. In general, we focused on smaller, lighter, agile, more lethal, and more affordable weapons that respond to a spectrum of Air Force missions and the target strike capability of delivery platforms. Some of the enabling technologies for these weapon concepts exist today, others are just ahead, and certain key ones await fundamental breakthroughs in technologies. Combined with innovative and creative approaches to weaponry design, all offer significant enhancements to Air Force warfighting.

The following recommendations will effectively exploit and implement the high pay off munition concepts identified to address projected US defense concerns: an Airborne Interceptor Missile to counter theater ballistic missiles; an RF Attack Cruise Missile to prevent enemy electronic operations; a Self Protect Missile for aircraft self defense; Autonomous Miniature Munitions to stop invading armies; an Airborne Interceptor Missile to counter low observable cruise missiles; Hard Target Munitions and Robotic Micro Munitions to attack deeply buried hard targets; and a Hypersonic Missile to attack quickly.

As an example of the importance of these concepts, we highlight autonomous miniature precision munitions which are small, self piloting, highly lethal munitions. These are capable of halting advancing armies because they are capable of autonomous target acquisition and classification. They incorporate adaptable warheads appropriate for a wide range of soft and hard targets. The autonomous precise miniature munitions offer a powerful way to defeat enemy forces rapidly. The conventional strategic bomber and tactical aircraft force could deliver over 20,000 self targeting munitions in one strategic tactical raid -- shutting down enemy forward air defenses, halting his armored assault, suppressing surface-to-surface missile operations, and impeding second echelon forces.

Additionally, key enabling technologies and capabilities are identified with specific science and technology approaches. Further, we have specified several munitions technology integrating concepts, and finally, we cite next step actions to implement the most important munition concepts.

Mr. Milton Finger
Chair, Munitions Panel
15 December 1995

Panel Membership

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Dr. Joe C. Foster
Dr. Paul L. Jacobs
Dr. Sam C. Lambert

Lt Col Edward V. Davis
Lt Col Kurt J. Klingenberger
Lt Col David G. Hincy

Sensors Volume Abstract

"To Know More and to Know It Sooner"

Sensors are essential elements of virtually every Air Force weapon and support system. The hardware and software associated with sensing functions are generally major, and sometimes predominant, contributors to the performance, reliability, supportability, and cost of such systems. They can exploit the full electromagnetic spectrum by intercepting reflected or naturally occurring electromagnetic radiation, detect various forms of mechanical energy (e.g., seismic and acoustic), and physically sample and analyze a diverse set of chemical and biological components. Many of the technologies associated with sensors are in a state of rapid evolution and will remain so for the foreseeable future. Moreover, many sensing functions and devices that are important to the Air force have counterparts in commercial, industrial, and medical applications. This combination of ubiquity, operational impact, technology leverage, and dual use potential makes the subject of sensors especially important to the themes of *New World Vistas*.

The Sensors Volume describes the future of sensors from the viewpoints of operational pull and technology push. Operational tasks that stress current sensors are described along with key enabling technologies. Seven illustrative sensor system concepts are then presented to indicate the importance of integration of multiple sensors. Finally, based on a survey of the overall sensor technology arena, nine high potential technology areas are described in some detail.

Dr. Jack L. Walker
Chair, Sensors Panel
15 December 1995

Panel Membership

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Space Applications Volume Abstract

The application of space in future military operations will facilitate global presence, knowledge on demand, space control and power projection.

Successful integration of space with information based warfare capabilities will be critical to maintaining information dominance of the battle space and winning at information warfare. Key capabilities are space-based observation, space communications, and global positioning, mapping and time transfer.

The proliferation of commercial space systems gives our adversaries unprecedented access to militarily significant capabilities that will reduce the information advantage our forces presently enjoy.

The need to disrupt, deny and influence the enemy's perception of the battle space while assuring our use for information based warfare is essential, and thus space control takes on new significance in this environment.

In the future to support global presence it will become feasible to project force from space directly to the earth's surface or to airborne targets with kinetic or directed energy weapons.

All of this is possible with the continued improvement of space systems operations with reduced manpower at lower cost, design of spacecraft with modern low cost techniques, adaptation of innovative architectures incorporating distributed satellite systems and the development of affordable access to space.

Dr. Michael I. Yarymovych
Chair, Space Applications Panel
15 December 1995

Panel Membership

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Dr. William M. Mularie
Dr. George A. Paulikas
Maj Betsy J. Pimentel
Lt Col Randy K. Liefer
Lt Col David G. Hincy

Space Technology Volume Abstract

The Space Technology panel's recommendations for technology investments derive from a vision of the Air Force in space in the 21st century, in which the Air Force has achieved survivable, on demand, real time, global presence that is affordable. This vision represents a revolutionary increase in capabilities for the Air Force and is achievable with targeted Air Force technology investments and adaptation of commercial developments.

Several key technologies offer the possibility of a substantial increase in the exploitation of space by the Air Force, the potential impact of which is so great that the Air Force must invest now. These technologies are:

- High-energy-density chemical propellants to enable spacelift with high payload mass fractions—specific impulses of 1000 seconds or greater (in high-thrust systems) should be the goal of this effort
- Lightweight integrated structures combining reusable cryogenic storage, thermal protection, and self diagnostics to enable a *responsive* reusable launch capability
- High-temperature materials for engines and rugged thermal protection systems
- High performance maneuvering technologies such as electric propulsion (with thrusts greater than tens of Newtons at specific impulses of thousands of seconds at near 100% efficiency - the goal for electric propulsion) and tethers for momentum exchange
- Technologies for high power generation (greater than 100 kilowatts) such as nuclear power, laser power beaming, and electrodynamic tethers
- Technologies for clusters of cooperating Satellites (e.g., high-precision stationkeeping, autonomous satellite operations, and signal processing for sparse apertures)

Prof. Daniel E. Hastings
Chair, Space Technology Panel
15 December 1995

Panel Membership

Prof. Daniel E. Hastings, Chair
Dr. William F. Ballhaus, Jr.
Maj Gen Roger G. DeKok
Dr. Edward Euler
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Col Bob Preston
Col Ron Sega
Dr. Babu Singaraju
Dr. Barbara A. Wilson

Dr. Antonio F. Pensa
Dr. Clifford R. Pollock
Col Pedro Rustan
Maj Edward J. Berghorn
Maj C. Lon Enloe
Lt Col David G. Hincy

Classified Volume Abstract

The classified volume report is a compilation of classified material (text and charts) that could not be discussed in this Summary Volume nor in any of the 12 unclassified panel report volumes. The panels that wrote material containing sections of classified material found in this volume and referenced in their volumes are: Munitions, Space Applications, Directed Energy, and Information Applications. A brief unclassified description of some of the topics found in this volume are provided below:

- **Munitions** - A concept of preventing enemy electronic operations using radio frequency (RF) attack cruise missiles; and a concept of using a self-protect missile for aircraft survivability. Over the past decade, electromagnetic technology has been sufficiently developed to consider practical development of weapons of this kind.
- **Space Applications** - An emphasis on space control capabilities, both offensive and defensive, are discussed as possible means in future warfare. These means could be applied to any element of the space system to include: the ground capabilities; the spacecraft links; the spacecraft itself; and the processing and distribution of the information. Also, a discussion of space tethers as a spacecraft survivability concept is provided.
- **Directed Energy** - Various concepts of directed energy weapon systems playing a role or as a means of future space control or supporting military missions are discussed.

- **Information Applications** - In the widely distributed global information system of the future, it will be difficult to determine sources of adversary information. This section discusses technologies and concepts for intelligence gathering and information attack in the commercially based, distributed global information system of 2025.

Ancillary Volume Abstract

In November 1994, the Secretary of the Air Force, Honorable Sheila E. Widnall and the Air Force Chief of Staff, General Ronald R. Fogleman, challenged the Air Force Scientific Advisory Board to "rekindle their inquisitive attitude" which had originated one half century before when Dr. Theodore von Kármán was tasked by General of the Army, Hap Arnold, to look to the future and make a report—a blueprint—on which to build an independent Air Force . As part of this current study, *New World Vistas*, Dr. Gene McCall, SAB Chairman, asked the members of the Board to take an individual shot at the future. The nature of forecasting in the Air Force has gone through many iterations. The first forecast was produced by only 31 of the nation's finest minds. The current forecast team is nearly five times that size. But times have changed.

Today, it is no longer possible to gather the majority of America's aeronautical scientists in one university auditorium. The surreal explosion of computer technology and the expansion of aeronautics into astronautics, and all of the disciplines which are related to advances in these areas, makes comprehensive individual reports a true impossibility. No longer can one scientist know all there is to know in one field of study.

But many scientists will tell you that, every once in a while, an individual brilliant thought triggers a breakthrough. This is the purpose behind these essays. Perhaps in reading these individual thoughts about the future, a moment of brilliance will result within you and trigger a breakthrough in your field . It may not happen this year or in ten years, but it might happen someday. Fifty years ago this kind of individual thought resulted in the creation of *Toward New Horizons*, the blueprint upon which was built the supremacy of today's Air Force.

This volume contains these essays and several interviews conducted by Mr. Jim Slade and Maj Dik Daso during the production of a one hour video program dedicated to the 50 year history of the USAF Scientific Advisory Board.

DOCUMENT 3

Full-Dimension Operations Planning Constructs: Thinking "Out of the Box" for the 21st Century

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A Monograph by
Lieutenant Colonel Timothy S. Heinemann
May 1995

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FULL-DIMENSION OPERATIONS PLANNING CONSTRUCTS: THINKING "OUT OF THE BOX" FOR THE 21ST CENTURY

A Monograph
By
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SCHOOL OF ADVANCED MILITARY STUDIES

MONOGRAPH APPROVAL

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Accepted this 19th Day of May 1995

I. INTRODUCTION

"The real challenge is not to put a new idea into the military mind, but to put the old one out. . . ."[1]

TRADOC Pam 525-5
Force XXI Operations
1 August 1994

The Revolution of Military Affairs (RMA), occasioned by technological advances and the shift-drift-rift of paradigms born of multi-polar world realities, is rich with vision, but hobbled by lingering Cold War mentalities. Nowhere is this more apparent today than in the way the U.S. Army approaches situation analysis and operations planning. Certain time-honored constructs, long ingrained in the Army's psyche from foot soldier to war-fighting four star, continue to survive as "inviolates"--somehow eternal despite compelling evidence to the contrary.

Three such "inviolates" are firmly entrenched as the critical "first steps" to successful operations. First is the inclination to perceive battlespace largely in terms of **PHYSICAL AREA**. Second is the instinctive tendency to analyze situations according to **METT-T**. Last is the nearly unqualified adoption of the seven **BATTLEFIELD OPERATING SYSTEMS (BOS)** as a universal planning and analysis construct.

The past success of these intellectual tools belies the reality that individually and collectively they are not adequate for addressing the dynamic dictates of *full-dimension operations*--the Army's acknowledged challenge of dominating the full spectrum of dynamic battlespace spanning the war-OOTW continuum.[2] It is thus the intent of this paper to illustrate the fundamental shortcomings of these old constructs in the light of

20th Century events, as well as to deduce more comprehensive replacements equal to the task of serving commanders now and into an uncertain and challenging 21st Century.

II. THE MAN IN THE MIDDLE. . . ILL SERVED

> "Everything comes to this: to be able to recognize the changed situation and order the foreseeable course and prepare it energetically."[3]
>
> Field Marshall Helmuth Graf von Moltke

Today's tactical-level commander finds himself at an intellectual crossroads with inadequate analytical tools to chart his course. To be sure, there is no shortage of descriptive doctrine, as he is faced with mega-volumes and mega-bytes of it at every turn. His dilemma is seen in the Army Chief of Staff's depiction of him as the man-on-the-ground "at the nexus of, tactical operational, strategic and diplomatic" spheres.[4] This reflects modern military reality in which a mis-aimed bullet, word or effort can have far-reaching consequences amplified under the media's microscope. Still he and his brothers are mainly on their own to "sort it all out" and come up with the practical steps essential to successful operations--whatever, whenever, and wherever they might be.

What then might these operations be? It is in answering this question fully and objectively according to the world "as is," that practical steps to success can be deduced--steps that are not so much a matter of a commander's personal ingenuity, but instead ones reflecting a scientific, methodical approach applicable for the "total force"--a force which faces the same future:

> ". . . The future strategic landscape will be varied and multi-faceted and have a greater potential for surprise across the operational spectrum. . . . while war will likely continue. . . . war is no longer deemed a productive means of pursuing strategic objectives. . . . during this period the United

> States Army, along with other services, civil agencies, and nations will be called to defend and promote national and collective security interests throughout the world, often on short-notice and often in combinations of nations and armed forces previously not experienced."[5]

This vision and statement of purpose, however, is not backed up by utilitarian tools of analysis that aid "the man in the middle" and drive him to decision and decisive action. FM 100-5, Operations (June 93), which is the Army's doctrine for "full-dimension operations," talks principally in terms of conventional combat, while devoting 8 pages to the topic of OOTW out of the manual's 153 pages.[6] The Army's admission of this FM's shortfalls is demonstrated by the drafting of FM 100-20, Operations Other Than War. The result is a flawed attempt to define full-dimension operations spread across two different publications. The Army Chief of Staff's comments below are instructive on the matter:

> "Categorizing 'war' as separate from all other uses of the military may mislead the strategist, causing him to believe the conditions required for success in the employment of military force while one is conducting 'war' differ from use of military force in "Operations Other Than War."[7]

The commander who faces the prospect fighting a war with the accompanying dimensions of terrorism, insurgency and humanitarian assistance (to name but a few plausible OOTW add-ons) hardly needs disjointed doctrine and certainly could benefit from multi-purpose analytical tools. These are essential in picking apart multi-faceted situations and turning available information into decision. Rather than lament the realities of evolving doctrine, it is instead more important to accept the flux and, as TRADOC PAM 525-5 proposes, stress "principles to be learned and understood. . . . and translated into action in scenarios that cannot be predicted. . . "[8] It is in this light of *dynamic, practical principles translatable into action* that "*men* in the middle" will not be *ill-served,* but rather *well served.* Thus the challenge for "nexus man" is to find flexible analytical constructs that enable him to process information (containing tactical, operational, strategic and diplomatic implications) into decision and action, which in turn ensure intended end-states. It is specifically the end-state of *control*--control of people and territory--which the Army of Force XXI values and envisions as not being so much physically-imposed as rather "knowledge-imposed."[9] The functional intellectual tools that translate raw knowledge into wisdom of action thus take on paramount importance. "This is the important link between information operations and the human dimension."[10] For the tactical commander this link is unfortunately missing .

III. THE FIRST THREE STEPS TO SUCCESSFUL FULL DIMENSION OPERATIONS

". . . . A victorious Army wins its victories before seeking battle."[11]
Sun Tzu

The relationship of forethought and analysis in predisposing an army to victory is one of the oldest lessons in military history--a history which continues to produce ever-new instances of "blundering in kill zones." The military commander intellectually predisposes himself to success or failure by his ability to accomplish essentially three tasks:

- Understand the full scope of the problem and environment.

- Analyze all dimensions in detail to discern what is important.

- Link desired end-states with plans based on this analysis.

The simplicity of these basic steps belies the fact that, in practice, they can be difficult to accomplish. Aside from the variables of leadership, logistics and luck in military operations, it has not infrequently been *flawed situation analysis* and *failure to link these three tasks* in concert, that have spelled both military and political disaster. One has but to reflect on the narrow-mindedness of the French at Dien Bien Phu or the short-sightedness of Hitler in Operation Barbarossa--failures which underscore the criticality of intellectual and analytical preparations for operations.

Much is expected of General Sullivan's "nexus man" His pre-battle preparations have become increasingly important in light of the following stresses:

- The "zero defects" expectations of the military
- Ambiguous political and military end-states
- The decline of military force structure
- Increased OPTEMPO and PERSTEMPO
- Diversity of operational environments
- Wide range of potential missions
- Uncertainty of short-notice deployments
- Diversity of threats

All this places increased emphasis on him "getting it right the first time." "Right" analysis and mastering information operations thus emerge as the Army's "first-step" on the road to multi-spectral dominance.[12] The Revolution in Military Affairs, with its emphasis on hi-tech systems, must thus first defer to the needs of the human "system."

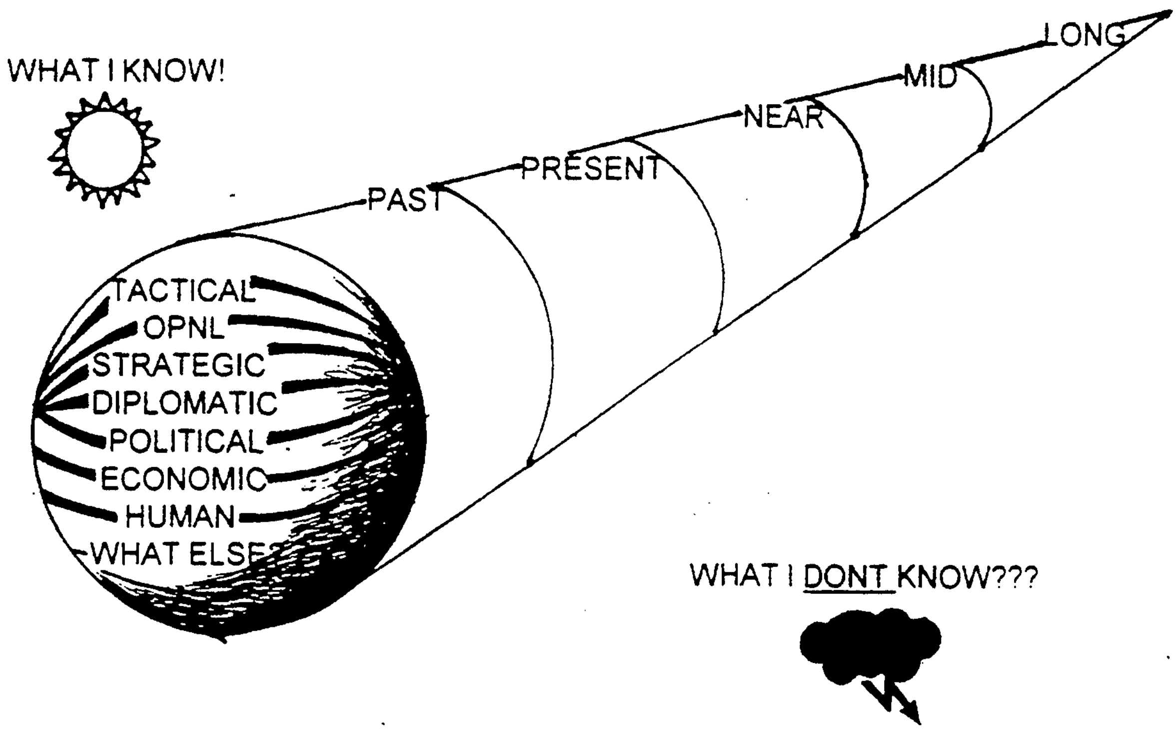
The evolution or revolution in how this system sees, thinks and analyzes can predispose him to victory.

A. FOCUSING BEYOND "TURF"

In spite of all the conceptual writings on *battlespace*, there is yet to appear a set of practical principles for systematically dissecting this multi-dimensional concept of "turf," and then deducing appropriate action (or in-action). Today's Army still tends to think of area of responsibility (AOR) in terms of *terrain*. FM 100-5 reflects this somewhat two-dimensional view in its depiction of AOR in terms of physical boundaries--theater of war, theater of operations, joint operation's area, etc. The FM goes on to state: ". . . . CINCs focus their effort through the designation of an AO."[13] It is precisely this limited focus that is ill-suited for General Sullivan's man at the nexus of tactical, operational, strategic and diplomatic "turf"--turf which may extend beyond a physically delineated AOR.

While designating a geographic AOR has an important function in military planning, its boundaries can tend to limit its owner's focus. In Vietnam "TAORS. . . often provided VC with room to operate in the "seams" between areas. . ."--theater areas of responsibilities thus proving to be inadequate in scope.[14] Whether one adheres to General Sullivan's nexus model or prefers a more detailed depiction of the other potential dimensions of battlespace (the psychological, cultural, economic, etc), it is apparent that today's Army operates not in 2-3 dimensional areas, but in *multi-dimensional spheres*. The model in Figure 1 is illustrative of this reality and is intended to prompt the military mind to think "out of the box." Before carving it up into manageable sub-sets, the

<u>SPHERE</u> OF OPERATIONS



HOW MANY SPHERES IN BATTLESPACE?

FIGURE 1

commander and his staff must first grasp the fullest possible magnitude of the battlespace they are about to enter.

The model at figure 1 serves as an conceptual starting point--Step 1 in a 3-step process--for ultimately determining what types of information and operations belong (and don't belong) in a commander's battle focus. It is important to understand the limitations of this model, because it cannot, in and of itself, drive the commander logically to decision and action. The model which, however, may better serve this purpose, is one that gives definition to the gray or fog of battlespace... an architecture for conceptualizing what is *important*, what is *possible* (given unit capabilities) and what is *not important*. The U.S experience in Vietnam is of utility here, because four distinct spheres emerged to define Vietnam battlespace:

- Sphere of Responsibility
- Sphere of Influence
- Sphere of Importance
- Sphere of Consequence

In Vietnam the military was compelled to look beyond its assigned AOR to *important* "turf" in neighboring sanctuaries and even as far as the "turf" at home and in Paris. The *influence* of military operations reached far beyond its assigned boundaries and targets into political, psychological and personal realms. Finally, the *consequences* (both bad and good) of military action exceeded still again the bounds of AOR in terms of politics, perceptions, doctrine, ethics, environment, research and development technology--to name but a few "spin-offs."[15]

While each sphere is significant, it is the convergence of these spheres that produces distinctly different parts of battlespace's generic landscape--13 parts in all....

each with a different reason for existing. . . . each with a different message for the commander in his battle focus development. This constitutes Step 2 of the analytical process which consists of the commander and staff (1) seeing these distinctions clearly and (2) understanding why they exist. (See Figure 2)

The table of Figure 3 further defines each of the 13 PARTS OF BATTLESPACE in terms of their meaning to a military planner. This step, Step 3, is intended to provide a mutually understood construct which enables all key participants to quickly assess and categorize incoming information, intel, tasks and orders; and then to deduce appropriate action. The mere common awareness of these distinctions both prior to and during operations can both enable and prompt commanders and staffs to consciously sort and process the massive volumes of information typical of full-dimension operations. This in turn can cause them to question or challenge things, request outside support, augmentation or advice, ask for adjustments in mission, boundaries, constraints or timetables, and knowingly accept or refuse risk. These all appear to be common sense actions, yet complex battlespace and high OPTEMPO can cause important distinctions to blur. . . sometimes with tragic results. The recent humanitarian assistance mission in Somalia, Operation Restore Hope, found the United States military pursuing a Somali warlord as a part of battle focus--a focus which arguably was pursued for one or several of the following reasons explained by an appreciation of battlespace's generic parts (See Figures 2 and 3):

- Part 5 - Operating in an area without *means* to deal with contingencies

- Part 10 - Operating in pursuit of objectives of *questionable importance*

THE 13 PARTS OF BATTLESPACE

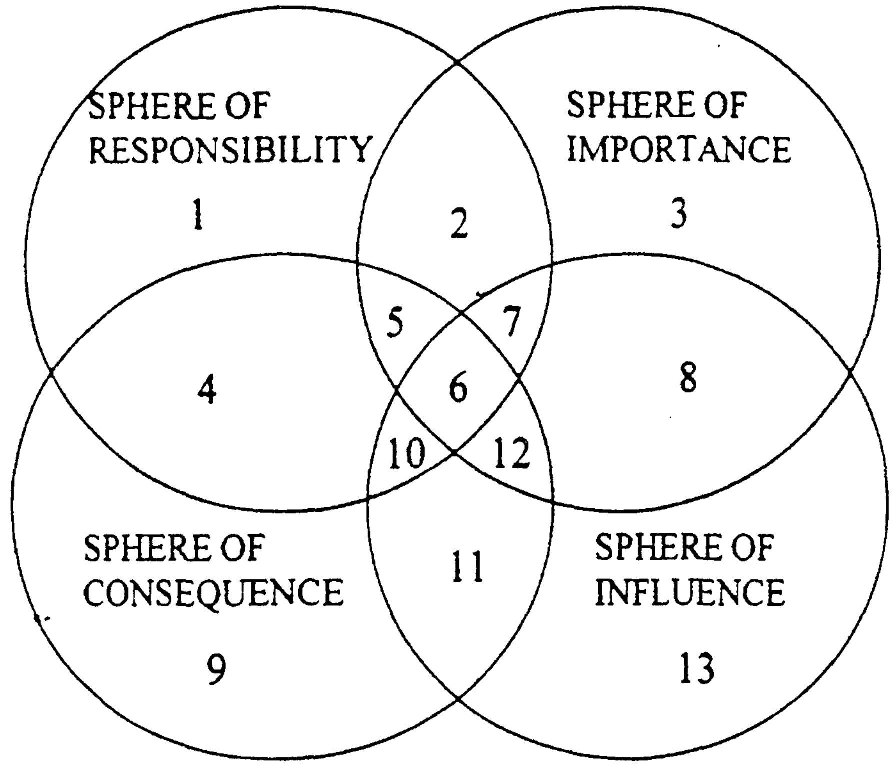


FIGURE 2

WHAT THE 13 PARTS MEAN

	SPHERES				SIGNIFICANCE
	RESP	IMP	INLF	CONS	
1	X	0	0	0	NO INTEREST/NO RISK, BUT ON OUR TURF
2	X	X	0	0	ESSENTIAL, BUT BEYOND OUR CAPABILITIES
3	0	X	0	0	ESSENTIAL, BUT CAN + MAY NOT TOUCH
4	X	0	0	X	NO INTEREST... WE CAN ONLY REACT ANYWAY
5	X	X	0	X	ESSENTIAL/AT RISK, BUT NEED ASSISTANCE
6	X	X	X	X	ESSENTIAL AND WE CAN DEAL WITH RISK
7	X	X	X	0	ESSENTIAL AND WE CAN HANDLE WITH OUT RISK
8	0	X	X	0	ESSENTIAL, NOT OURS, BUT WE CAN HANDLE
9	0	0	0	X	NO INTEREST WHATSOEVER
10	X	0	X	X	NOT IMPORTANT/ OURS/ HANDLE IF WE WANT
11	0	0	X	X	NOT IMPORTANT/ CAN HANDLE O/O WITH RISK
12	0	X	X	X	ESSENTIAL, BUT CAN ONLY HANDLE O/O
13	0	0	X	0	NOT IMPORTANT, BUT CAN HANDLE O/O WITH OUT RISK

BATTLE FOCUS = 2,3,5,6,7,8,12 POTENTIAL OPS W/IN "REACH" = 11,12,13
TIME/RESOURCES WASTERS = 1,4,9

FIGURE 3

- Part 12 - Operating *beyond* what should have been the *U.S. responsibility*

- Part 11 - A combination of Parts 10 and 12

This experience of "mission creep" in complex battlespace reveals two enduring lessons for Force XXI: First, the fine distinctions in battlespace *exist* and *matter a great deal.* Second, the "dark side" of battlespace is deadly and is distinguished by three types of knowledge deficiencies:

Uncertainty - The information a commander is conscious that he doesn't know

Ignorance - The information a commander is unconscious that he doesn't know

Stupidity - The beliefs a commander persists in that are not true

Whether it is the *tactical uncertainty* of RPGs in the anti-helicopter role, the *operational ignorance* of working in the constrained UN arena, or the *strategic stupidity* of not having well-defined end-states--the "dark side" can subject brave men unnecessarily to deadly battleground.[16]

It is no longer possible, prudent nor productive for commanders to confine their battle focus exclusively within a physical area of responsibility, because the immediate strategic and diplomatic implications of tactical operations demand broader focus. It is further critical that declining U.S. military forces be husbanded and finely focused in the face of the U.S. National Security Strategy of Engagement and Enlargement.

> "Our engagement must be selective, focusing on the challenges that are most relevant to our own in interests and focusing our resources where we can make the most difference. We must also use the right tools."[17]

To this end it is important for commanders and staffs to be able to divide battlespace intellectually into distinguishable parts that can aid analysis and planning by sorting information into categories that lead to deductions, conclusions and decisions--decisions to "use the right tools" for the mission at hand. FM 100-5's limited concept of AOR is unequal to this demand.

B. RETOOLING METT-T

> "Using the analytical framework of mission, enemy, troops, terrain and time available (METT-T), commanders designate *physical objectives*. . . these become the basis for all subordinate plans."[18]
>
> FM 100-5
> Operations
> June 1993

The METT-T analysis model and FM 100-5's strong reliance on it as the foundation of military planning, predispose the "man in the middle" to short-sighted and flawed analysis of full dimension operations. What is "enemy" supposed to mean in a disaster relief scenario? What relevance does "terrain" have when the ground to be negotiated on a United Nations peacekeeping mission consists principally of political, procedural and psychological obstacles? These questions hint that use of the time-honored METT-T may require extraordinary leaps of association in analysis to be meaningful in full-dimension operations. The lack of comprehensiveness of this combat construct is revealed by the face of a changing world and by the United States decision to employ its military arm more broadly than ever before. As evidence of this the Army has adopted four fundamental roles in its strategy for the 21st Century:

> ". . . to compel those who fight U.S. to accede to our will."

". . . deter those who might oppose us."

". . . reassure our allies. . ."

". . . support at home."[19]

It is then this broad charter that compels the military mind to "come out of the turret" and behold the tenets that define battlespace--tenets that defy a purely combat mentality and demand well more than FM 100-5's "physical objectives."

Mission

"To accept battle in haste is to fight without being sure of victory."[20]

Mao Tse Tung

The aggressive mind-set that makes the military achiever "jump on" his mission and "do it!" has brought the United States not only stunning victory, but stinging defeat as well. Wading into tactical fights, without first weighing the situation's full strategic or diplomatic import, has placed commanders and soldiers in dilemmas in which both the *problem* and the military's *purpose* were misunderstood. Long years of war in Vietnam with near absolute dominance at tactical and operational levels nonetheless left the U.S. in defeat and retreat. The general consensus that the U.S. did not really understand the situation within Vietnam and consequently came to question its real purpose there reflects the issue of not "doing one's homework" and then applying the wrong formula to the problem--bombs and bullets apparently not able to "fix" what needed to be "fixed."[21]

The U.S. approach to regional challenges and threats in following years, such as the Soviet invasion of Afghanistan, the insurgency in El Salvador and the hostility of communist Nicaragua, have all reflected a finer situation analysis and measured U.S.

response. The recent U.S. relief effort in Rwanda further demonstrated the Vietnam lessons learned of first *assessing* the nature of the problem and then defining the specific, accomplishable purpose of U.S. forces. Instead of plunging into the mission, JTF Commander, LTG Schroeder, a Vietnam veteran, assessed the "turf," defined realistic, limited objectives, and tailored the force accordingly before commencing the relief mission proper.[22] The old Army saying that "The mission comes first," thus gave way to the reality that "*Understanding the problem* comes first." Mission is thus subordinated to the broader analytical dictates of defining **PROBLEM** and **PURPOSE**.

Enemy

The "us versus them" mentality spawned by U.S. history and mythology reflects a black-white view of reality. The Army's 5-paragraph field order--the doctrinal format for military orders--juxtaposes "enemy forces" and "friendly forces" in depicting the military situation. The world today, however, is increasingly characterized by many shades of gray; what threatens friendly forces may not be an enemy force per se. The simplistic view of friend vs foe may hold true in scenarios where one monolithic force faces an opposing symmetrical force or a well-defined opponent on an isolated battlefield. The U.S. National Security Strategy, however, reflects a grander perspective on the challenges to national security. It confounds "us vs them" rationales and compels the military mind to re-think exactly who and what is of concern to a commander in his battlespace in the context of U.S. engagement and enlargement.[23]

The word "enemy" invites narrow interpretation suggesting a person, people, unit or force. Recent world events suggest the case can be to the contrary. The U.S.

humanitarian relief to Rwanda was faced with arguably its largest threat in the form of disease--with chaos a close "second."[24] In Operation Safe Passage, the transfer of Cuban migrants from Panama to Guantanamo, the most significant threat to success was a potentially hostile and misinformed media that could damage U.S. legitimacy in the eyes of the world. The other potential threat consisted of "friendly" migrants, who for personal or psychological reasons, might unexpectedly attempt a desperate act in front of the media.[25] The fickle nature of the enemy was further demonstrated in the U.S. intervention in Haiti on OPERATION RESTORE DEMOCRACY, where the relationship between friend and foe ended up not being one of "attack and defend," but instead one of "cooperate." In fact, some feel the real threat to success in Haiti may turn out to be something as abstract as the lack of the population's ability to manage basic societal processes.[26] Threats to U.S. forces in certain situations may consist of such things as restrictive ROE, cumbersome and inefficient international or inter-agency procedures, the lack of unity of effort in combined operations, or even environmental pollution. The common threat in these examples is not "enemy," but is reflected in the larger concept of "threat"--a reality with many faces in the Army's business of COMPEL - DETER - ASSURE - SUPPORT.

"Threat" is not merely a re-naming of "enemy," but rather has far greater implications. It is subordinate to larger analytical constructs critical to comprehensive situation analysis--defining the *problem*, identifying all the *players* in battlespace and understanding all possible planning *parameters*. That is to say "threat" finds its true relevance within larger contexts. An example from the UNPROFOR mission in Bosnia-

Herzogovina is instructive on this point. A commander's mere knowledge of mercenary activity in his region is of little use to him unless it is analyzed in context. How do mercenary agendas, capabilities, and connections inside and outside the region define the current problem or potential problems for UNPROFOR? What are the range of relationships between the mercenaries and all other *players* in the region and what activities are therefore certain, probable, possible, uncertain, unlikely, and impossible? What planning *parameters* arise as a result of analyzing the implications of mercenary presence and activity? The point here is that threat analysis is but one factor of many needed in computing the larger building blocks of PROBLEM, PLAYERS and PARAMETERS. The deductions and implications of these can then drive the commander to action. At issue here is a fundamentally different approach to integrating threat into situation analysis in a way that logically progresses toward decision. "Threat" or "enemy" are therefore not analytical building blocks themselves, they instead find their importance within the context of larger constructs.

Troops

The "troops" part of the METT-T formula is intended to compel the commander to assess his *manpower resource* in the context of this situation. This narrow measure of unit capabilities and power is hardly a broad enough construct to properly assess the *total resources* necessary for tactical, operational, strategic and diplomatic success. In Vietnam the U.S. had over 500,000 troops on the ground at the height of conflict, while in El Salvador the manpower cap was set by Congress at 55--yet successful outcome bore no relationship to manpower per se. What emerges from this reality are larger questions in the generation of "force" necessary for success:

Who are the PLAYERS?

What constitutes real POWER?

What PRINCIPLES work in applying power?

The participants present in battlespace span the spectrum from enemy to hostile to unaligned to neutral to friendly to unknown. One has but to consider the well-known images of Navy SEALS under media floodlights "infiltrating" Somalia, of medecins sans frontieres and U.S. Special Forces working together to save Kurds, or of a former U.S. president in a dictator's den in Haiti at D-3 hours with the 82d Airborne Division "in bound," in order to see that the cast of *players* now knows few bounds. While it once may have seemed simple--"command troops and kill the enemy,"--the verbs that now typify a commander's interaction with the broad array of players in his battlespace include not only "commanding" and "killing," but also "caring for," "convincing," "coercing," "compromising," and "co-opting." In view of this, and keeping in mind that the commander's duty is ultimately to *influence a desired outcome or end-state*, the intellectual challenge for him becomes one of knowing what kind of power to use effectively under the diverse circumstances of full dimension operations. Whereas a commander conducting counterinsurgent operations may have to resort to precise lethal power, his arsenal of power in a foreign internal defense (FID) setting may be completely different. COL James Roach, Commander 7th Special Forces Group (ABN), tells of a special forces warrant officer who subdued a high ranking corrupt commander, who was in his day-to-day counterpart. A "lost" generator, destined for a schoolhouse built as a civic action project, mysteriously reappeared at the school when the local military commander was "advised" that his nation's "big brass" were coming to the school's official opening ceremony.[27] The warrant officer's situation analysis exceeded the capabilities of METT-T and reflected not only an analysis of *power* and the *principles* of its precise application, but also a keen appreciation of **PRIORITIES**.

Whether one is launching a precision Hellfire missile or placing a well-aimed phone call, the decision to do so transcends the intellectual skill of knowing *how to do it right* and enters the realm of wisdom--that is, knowing *why doing it this way now is right.* The implications of killing an insurgent or alienating an important and powerful counterpart underscores the importance of deducing well-defined *priorities* in situation analysis, as well as being cognizant of all the **POSSIBILITIES** associated with the situation in terms of techniques, options, contingencies and consequences. Without the wisdom born of a keen awareness of *priorities* and *possibilities*, analytical conclusions can produce decisions to "throw troops" heavy handedly at situations requiring finesse in the application of power. It is thus that METT-T's "troops"--seen in its broader essence as the *force* for accomplishing aims and ends--points to larger "force"-related building blocks:

- **PLAYERS**
- **POWER**
- **PRINCIPLES**
- **PRIORITIES**

- POSSIBILITIES

The detailed analysis of these larger constructs (as opposed to "enemy" and "troops") stands a greater likelihood of enabling success in full-dimension operations at both the macro and micro levels. The recent U.S. intervention in Haiti is evidence of this evolution in analysis. At the national level a diverse cast of *players* was orchestrated to create a synergy of *power* using the *principles* of overwhelming force and diplomacy, based on well-defined *priorities* focused first on removing corrupt authorities in an operation designed for the *possibilities* of "fighting" or "fixing" what ailed Haiti. This same type of analysis was reflected down to tactical levels, where analysis of "enemy" and "troops" was inadequate in generating the conclusions necessary for dealing with vengeance, voodoo and violence.[28]

<u>Terrain</u>

FM 100-5's description of this construct is confined exclusively to a *physical* view of a conventional battlefield which includes climatic impacts.[29] While physical domain is key in the terrain equation, it is only part of it. As previously discussed the concept of "turf" in full-dimension operations extends into political, psychological and other realms. Another war in the Persian Gulf, for example, could conceivably include wide-spread terrorism against the U.S.--clearly reaching beyond Middle East terrain into psychological and political "terrain." We routinely talk of "political minefields," "diplomatic obstacles," "emotional climate," and "psychological barriers."--these along with the rise and fall of topography and temperature combine to define the features of the "terrain" to be negotiated in the Army's missions of *compelling, deterring, assuring* and *supporting.*

They essentially constitute the *parameters* that define the operational environment in terms of constraints, restraints, limitations and enablers that can facilitate or impede progress through battlespace. PARAMETERS therefore emerge as the essence of what "terrain association" seeks to define.

The "turf" in the complex battlespace reflected in Vietnam, Bosnia-Herezegovina, Somalia and Haiti embraces a wide range of "terrain features" that can make operations easy, hard or impossible. Physical terrain was as perplexing in Vietnam as it was enabling in Desert Storm, but it was the lack of definition of Vietnam's "turf" in terms of clear and attainable objectives to move toward that eventually bogged the U.S. down.[30] While Bosnia offers particularly inhospitable and rugged topography, the UNPROFOR is supremely challenged to navigate in and across invisible cultural and ethnic boundaries, as well as within the perplexing jungle and jumble of UN, NATO and factional policies, procedures and practices.[31] Restrictive ROE, force structure limitations, imperfect inter-operability procedures and "mission creep" combined to spoil U.S. operations in Somalia, just as certainly as the avoidance of these obstacles enabled the initial U.S. success in Haiti. It therefore is apparent that the FM 100-5's version of terrain needs broadening if it is to help "the man in the middle" map out and navigate his difficult trek through dynamic terrain with insight and foresight for understanding all the defining *parameters* of battlespace.

Time Available

Taking the vast dimension of time and shrinking its scope down to a mere matter of "time available" reflects the persistent short-sightedness of the military mind used to a battle focus of "taking the next hill on schedule." The implications of "the temporal" far exceed the limited perspective of *time as an available resource of finite quantity* for mission accomplishment. What Force XXI Operations require is radical reconsideration of what time means in terms of its major divisions--past, present, and future. These have no intrinsic value, but instead constitute the *continuum of processes* that produce successful operations--that enable the transformation of concept into action and finally into ultimate endstate. It is therefore *process*, not time, that emerges as the important construct to be analyzed.

"Time availability" is of itself a concept as worthless to the modern commander as the whiteman's concept of snow is to the Eskimo. The native has no single word for snow, but rather some fifty words for the "white stuff"--each with special significance according to time, place and circumstance. Finer distinctions of "the temporal" are also of relevance to "the man in the middle"--timeliness, time-killers, time lag, timing, NET and NLT, timetable, time consuming, perishability over time, synchronization, time duration, time sensitivity. These, in turn, have no relevance unless considered in regard to their importance in accomplishing processes. Likewise, an analysis of past, present and future reveals the linkage of the past (knowledge) to the future (envisioned end-states) by means of the present (process). It is thus again that the "things of time" point to the larger issue of **PROCESS**. Time-availability has its proper place subordinate to *parameters,* just as "time sensitivity" may apply to certain aspects of *power*, or "time killer" may have significance in defining the *problem*. In the final analysis it is *process*, that keeps one off "the road to disaster" and "on track."

Time management was not enough to assure U.S. success in Vietnam. It is now apparent that beneath the triple canopy jungle there were on-going processes that were not fully appreciated in the U.S. analysis of the situation. The processes of corruption within South Vietnamese government and society, the indirect and direct processes by which the communists worked on the will of Vietnamese villagers and the U.S. public, the processes of colonialism and conquest by outside aggressors that had forged communist resolve--these low-tech processes combined to overmatch the highly efficient hi-tech processes by which the U.S. sought victory.[32] The refinement of these hi-tech processes, by contrast, enabled U.S. dominance in Desert Storm, just as a refined appreciation of on-going processes in Bosnia has precluded the U.S. from unwisely wading into an unwinnable situation. The specific processes to be understood in situation analysis and the ones regarded as critical to success are not to be generically listed, but rather are situation-dependent. Better knowledge of the past, objectivity in assessing the present situation and clear articulation of future end-states will reveal those processes to beware of and those to be mastered. A full appreciation of these processes enables the commander and his staff to proceed beyond analysis to mission planning.

The review of METT-T in the face of the on-going, anticipated and uncertain challenges of a multi-polar world compel the need for a broader analytical construct for situation analysis. The nine building blocks below deduced from METT-T's shortcomings, constitute a more comprehensive and logically linked progression of analysis capable of driving commanders systematically to conclusions:

PROBLEM

PURPOSE

PLAYERS

POWER

PARAMETERS

PRINCIPLES

PRIORITIES

POSSIBILITIES

PROCESS

Together these constitute an umbrella under which METT-T finds its place within broader situation analysis that reveals "essentials" to the commander facing full-dimension operations. Using this framework the commander will be able to identify not only FM 100-5's "physical objectives," but also the other critical objectives in multi-spectral battlespace. This supports Force XXI's aim of "enhanced situational awareness."[33]

C. THE ESSENCE OF THE BATTLEFIELD OPERATING SYSTEMS (BOS)

> "Army leaders examine large complex operations in terms of functional operating systems that exist at each level of war."[34]

The logic of FM 100-5 on the matter of *functional operating systems* has two faces: one which has well served past commanders at tactical, operational and strategic levels and one which is not structured to serve the tactical commander, who now is *not* able to plan and operate neatly within just one level of conflict. Complex battlespace, which compresses diplomatic, strategic and operational realities on top of the tactical commander, is a phenomenon to be faced by commanders at all levels for the foreseeable future. Given the modern commander's challenge to handle unanticipated threats worldwide on short-notice, it follows that he could benefit from a single, but versatile construct for organizing full-dimension operations. The BOS itself is unequal to this challenge, as indicated by the example of the total lack of relevance of the Air Defense BOS in humanitarian relief operations--just one of many examples of BOS shortcomings. It is, however, in examining the *essence* of the BOS that more dynamic constructs are revealed--ones that better enable the commander and staff to think, plan and organize in broader contexts.

Battlefield Operating Systems	versus	"Full-Dimension" Operations Constructs (Essence of BOS)
Intelligence		Battle Space
Maneuver		Operations
Fire Support		Power
Air Defense		Protection
Mobility-Survivability		Operations Enablers
Logistics		Resources
Battle Command		Battle Command

The following discussion is thus aimed at illustrating the need for more dynamic functional operating constructs for Force XXI.

Intelligence vs Battlespace

The problem with this BOS is in the word "intelligence" itself. *Intelligence* is fundamentally but a single enabling tool, which assists the commander in the overarching task of formulating an accurate picture of dynamic battlespace. TRADOC Pam 525-5's statement that Force XXI operations start with "information operations," reflects the recognition that success in murky battlespace has its "first steps" in attaining adequate knowledge of that battlespace.[35] This challenge transcends FM 100-5's focus on intelligence operations principally in terms of "enemy" on "battlefields."[36] At issue here is the definition of the major building blocks that together constitute the environment of operations--the appreciation of which will enable a commander to attain his tactical, operational, strategic, if necessary, diplomatic endstates. This is the essence of intelligence.

The Army's traditional form of "appreciating the enemy" falls short of the knowledge of commander needs about such very real *threats* as adverse media coverage or the sometimes incompatible agendas of "allies." In Somalia, for example, an unconstrained media placed U.S. forces not only in tactical danger, but also in strategic and political danger. First, the initial positive image of the U.S. humanitarian relief effort thrust the military in the limelight as "saviors of humanity." The threat here for the military is reflected in the public perception that the military can "do it all." Second, the military's inability to tell its story first in the wake of the aborted raid to seize Ahdid, enabled the media to graphically depict its version of "ground truth," immediately putting the military on the defensive. The military thus found it had to manage not only the local battlefield, but political and psychological battlegrounds as well. "Knowing the battlefield" therefore includes not only an appreciation of topographic and climatic realities, but of realities ranging from restrictive ROE to political climate--realities which are part of defining battlespace well beyond the aspect of "enemy." The U.S. intervention in Rwanda was not shaped simply by "intelligence on the enemy," but instead by EUCOM's JTF first assessing a variety of inter-related aspects of "ground truth" that comprised a clearer vision of battlespace. It was this larger awareness of the total picture (to include friendly and neutral aspects) that enabled the JTF to determine realistic and feasible objectives. The existence of a long-established infrastructure in the region limited the U.S. focus largely to establishing an air bridge and logistical transload sites.[37]

In this light it becomes apparent that *intelligence* is too narrow a construct to give the modern commander full appreciation of all the aspects of battlespace that constitute the *threat* and *environment* he must face. The following subsets of battlespace provide better definition of the fog of war (and of OOTW) and provide the basis for developing military options and plans:

The Dimensions
The Problems
The Players
The Threats
The Powers
The Climate
The Parameters
The Temporal

The interrelationship of these gives further definition to the landscape of battlespace. It is the conclusions deduced from these relationships that can drive the commander to specific action. For example, in SOUTHCOM's movement of Cuban migrants to Guantanomo the implications of maintaining U.S. legitimacy in the eyes of others, the problem of migrant frustration over not reaching the U.S.A., the presence of the media and special interest groups, the threat of violence "staged" for the media, and the climate of anticipation generated by all on-lookers, combined to drive the commander to specific action. The CINC staged a "pre-emptive strike" by inviting the press to a tell-all, show-all media day, which defused a potentially dangerous situation and paved the way to successful operations.[38] This success was enabled by a broader appreciation of things not "targetable" by SOUTHCOM's intelligence apparatus.

What then distinguishes the BATTLESPACE construct is first, its *breadth of focus* on all relevant aspects beyond "enemy" and "battlefield," and second, the *synthesis of the relationships of these aspects into conclusions* that drive the commander to decision and action. It is here that the 13-part battlespace model (Figure 2) has its purpose in aiding planners to categorize conclusions according to their importance in unit battle focus.

Maneuver vs Operations

While the Maneuver BOS is popularly associated with the *movement and positioning* of forces, the essence of maneuver is seen in its ultimate aim--"to gain positional advantage."[39] The question is then logically--*where* in battlespace must the commander gain and maintain positional advantage? The dynamic nature of modern battlespace dictates a relook at traditional divisions of the battlefield. Each of these, however, seen in their broadest essence, point to more suitable divisions of battlespace to be dominated in full dimension operations.

The Maneuver BOS	versus	Operations
Deep		Beyond the Assigned AOR
Security Zone		Transition Areas and Seams
Main Battle Area		AOR
Reserve		Contingencies, Opportunities, Areas for Exploitation
Rear		Vulnerabilities

The commander in humanitarian assistance operations may have no *deep battle* per se, but may have *areas of interest, influence and consequence* that exceed his authorized AOR. The commander of a NEO force does not have a *security zone* in the traditional battlefield sense, but must be keenly aware of the many *important seams and transitions* that exist in the intricate business of extracting non-combatants in a chaotic and hostile multi-national environment. The unit supporting counter-drug operations may not have a physical *main battle area*, but instead may have *functional areas of responsibility* that cause its soldiers to be spread across several countries. The FID trainer does not have a *reserve*, but must be ever on the lookout for *opportunities* to exploit or *contingencies* to execute within his broader mission of nation-building. The commander supporting combat search and rescue operations is not concerned about his *rear*, but is instead focused on the issue for force *vulnerabilities*. Even the maneuver term "positional advantage" begs broader interpretation, since in OOTW and in combined and inter-agency arenas it can be the intangible "moral authority", "psychological advantage," "U.S. legitimacy," or "personal credibility" that puts the commander in positions of ultimate advantage. For example, British peacekeepers in Northern Ireland, as well as U.S. peacekeepers in both Beruit and Somalia found that they lost "positional advantage" once they were "perceived" as not being neutral. This had nothing to do with physical "maneuver." This broader essence of "maneuver" is not intended to preclude commanders from taking a traditional focus of the battlefield, it is rather aimed at compelling him to "think out of the box" in terms that will better assure him "advantage" in all dimensions of battlespace.

Mobility and Survivability vs Operations Enablers

The combat engineer tasks one normally associates with this BOS are ill-equipped to deal with the diverse obstacles, "minefields" and force vulnerabilities in Force XXI's battlespace. Here the impediments to forward progress take on non-traditional, as well as traditional form--"red tape," ambiguous measures of success and poor coordination are just as sure to bog down operational momentum, as will a well-constructed obstacle belt with covering direct fire.[40] It is thus in discerning this BOS's intended endstate--the enabling of operations momentum and continuity--that a viable planning construct for full-dimensional operations is revealed.

TRADOC Pam 525-5's emphasis on the important role of operational tempo control in Force XXI Operations is predicated on the stated intent that a commander must be able to "pulse" operations at the right place and time.[41] The demands of complex battlespace place a premium of tempo control as never before. Of greater concern now to the commander, than his narrow list of important engineer tasks is the larger issue of identifying and accomplishing the major enabling tasks that keep his operations alive, responsive and focused.

A commander conducting peacekeeping and humanitarian assistance operations in Bosnia-Herzegovina, for example, faces even in the simplest tasks, complexities born of politics and UN procedures that confound his attempts to translate commander's intent into action and then into desired endstates.[42] Just as a NATO jet, flying a retaliatory strike in support of UNPROFOR, must be carefully guided all the way from planning concept to target strike and back, so also is the launching of an Army mission into complex battlespace equally demanding. The successful progression of an operation along its "critical path" has historically been based on the following linked building blocks, which ultimately ensure the *mobility* and *survivability* of the operation:

<u>OPERATIONS ENABLERS</u>

- Vision
- Plans
- Process
- Means
- Awareness
- Flexibility
- Recuperability
- Durability

These are what have traditionally give the commander "freedom to maneuver" and the ability to control optempo and "pulse" at will.

In the same way a minefield breach must be linked by routes and river crossings to an objective, so also must *operations enablers* be linked and oriented on end-states. Modern history offers convincing examples of getting "bogged down" as a result of failures in understanding what was ultimately essential for "mobility" and "survivability." The disastrous Nazi invasion of Russia resulted from vague end-states and inadequate means to ensure continuous operations.[43] The U.S. approach to Vietnam revealed poor linkage between means and end-states--B52 "Arc Lights" and other forms of lethality proving to be poorly linked to the goal of gaining Vietnamese support.[44] The UN predicament in Bosnia-Herzegovina again shows the inescapable consequences of ambiguous endstates, ill-defined supporting objectives, restrictive procedures and inadequate means to actually correct what is wrong in the region.[45] While each of these environments contain no shortage of mobility and survivability tasks for combat engineers, the reasons for getting "bogged down" clearly exceed the capabilities of bulldozers and Bailey bridges.

The commander and staff who concentrate on the larger criteria for *enabling operations continuity* will logically deduce the practical steps to be taken in breaching, bridging and negotiating whatever might impede, impair or kill the operation and the ability to "pulse." Freedom of maneuver is thus not so much the result of engineer tasks well done, as it is the end-product of a more dynamic "engineering" effort. . . . well thought-out and linked to clear end-states.

Logistics vs Resources

The logical follow-on to the intellectual engineering of operations continuity is then the organization and orchestration of all concrete *means* that make operations possible. These, however, transcend the realm of the logistics BOS, which would delegate this dynamic task to J4s, G4s, and S4s. FM 100-5's concept of logistics (in its traditional sense) stands in contrast to the larger issue of *resources*--the total resources necessary to accomplish operations.

The existence of logistical service, support and materiel is critical, but is merely part of a larger equation. This equation demands that the commander integrate all his resources in synergistic effect to create the power and to enable the processes essential for successful operations. For example, successful U.S. intervention in Haiti was not so much a matter of logistics, as it was based on the orchestration of a wide-range of resources. Two aspects of resources bear emphasis. First, *total resource visibility* (unlike total logistics visibility) gives the commander a complete menu of available means to handle challenges which span the spectrum from killing tanks to training third-world forces to supporting disaster relief. Second, it is the *combination of various means* at his disposal that actually enable the commander to meet these challenges. For example, the availability of a linguist (critical to a commander in counter-insurgency, foreign internal defense or peacekeeping operations) is almost meaningless to him, unless it is linked to other resources--transportation to move him to the right place, protective forces to cover him as required, knowledge about his target audience, subject-matter expertise requisite for the missions assigned, time available to accomplish tasks. For this reason the narrow focus of the Logistics BOS is ill-prepared to give the commander the "total asset visibility" he needs to create a synergy of effects.

Full dimension operations require efficient integration and orchestration of finite resources--these constitute a commander's "basic load" for battle. A broader view of "basic load" includes the following:

- Forces
- Materiel
- Support
- Services
- Information
- Skills
- Capabilities
- Time

Given a commander's grasp of *battlespace, power, protection* and *operations enablers*, he can then orchestrate *resources* for employment in any chosen area of operations. It is this integrated "packaging" of resources at the right place and time that closely reflects and supports Force XXI's concepts of "pulsing" operations and creating "synergistic efforts" to "overmatch" opponents.[46] The resource package used to leverage the Haitian Dictator Cedras was a mix of military might and mental manipulation. The orchestration or PSYOP leaflet drops on the tail of B52 strikes in Desert Storm similarly reflects *resource packaging* delivered at the right place and time. By contrast, the commander who fails to integrate his "basic load" can open the door to failure. A well equipped war-fighting infantry commander or similarly equipped peacekeeper can be hobbled by intelligence or informational shortfalls. A well-informed unit can be rendered ineffective through the lack of critical skills, such as linguistic or counter-sniper skills. For these types of reasons (and their broader implications in joint, combined and inter-agency operations) the logistical logic of *computing beans and bullets to kill bad guys* must stand aside to the broader concept of total *resource visibility and integration*. The commander can then apply his resources in concert appropriate for the given situation. These resources extend well beyond the logistician's focus.

Battle Command (FM 100-5) vs Battle Command for Full-Dimension Operation

Today's commanders still are in want of a comprehensive concept of battle command capable of serving them in full-dimension operations. FM 100-5's concept has been supplemented with an OOTW perspective in the form of FM 100-20 (Draft).[47] This patchwork method of defining what is arguably the most important BOS, leaves commanders with a less-than-comprehensive vision of battle command. The practitioners of command who face diverse environments around the world are in need of a coherent and systematic battle command architecture that is flexible enough to cross-walk from one situation to the next. The mere description of command in battle and of the peculiarities of command in OOTW together do not properly capture nor convey the practical building blocks of battle command. These are essential to "the man in the middle," if he is to wage the diverse "battles" that go with the army missions of COMPEL, DETER, ASSURE and SUPPORT.

FM 100-5's concept of battle command is a combat-oriented narrative using truisms that few can contest--"decision making is knowing if to decide, then when and wait to decide... to command is to direct... leadership is taking responsibility... "[48] The problem with this descriptive narrative is that it is largely battlefield oriented, and does not address command vis a vis the broader *battles* as defined by Department of the Army. There is no mistaking that FM 100-5's battle command concepts can cross-walk into non-combat settings, but FM 100-5's concept does not explore this. This reflects the U.S. National Military Strategy's insistence that "the fundamental purpose of the Armed Forces must remain to fight and win our nation's wars... "[49] The U.S. National Security Strategy, however, clearly states: "First, the primary mission of our Armed Forces... is to deter and, if necessary, win conflicts... "[50] The difference in verbiage is striking, because it is clear that the National Command Authority is stressing *deterrence* as the "first strike" and *winning conflicts* (not just wars) as the contingency. "Thus, balanced U.S. forces are needed in order to provide a wide range of complementary capabilities and to cope with the unpredictable and unexpected."[51] A "balanced" perspective on battle command is similarly appropriate in not only *coping with* the "unpredictable and unexpected," but in *dominating* them when they challenge the commander..

It is the Joint Universal Task List (JUTL) that provides the basic architecture for command and control at all levels in terms of five dominant tasks:[52]

- Acquire
- Assess
- Determine
- Direct/Lead
- Employ C2W

FM 100-5's architecture, by contrast, is based on three tasks:[53]

- Assimilating thousands of bits of information
- Assessing the situation
- Directing military action

Two distinctions between these architectures are important: First, FM 100-5's list does not address the cornerstone command task of *acquiring both knowledge and information prior to operations*. Second, "directing military action" in FM 100-5's authoritarian rendering of command and control, does not address the broader implications of JUTL's "employ C2W" in joint, combined and inter-agency environments. Here strategies, operations and tactics may not be accomplished by *authoritative* command and control methods, but instead by more indirect or non-traditional means that, nonetheless, can enable a commander to ultimately "command the situation" and "control outcomes" through *influence*.

Acquire. This JUTL first step to command and control has broad implications for "the man in the middle." The wide array of potential threats, missions and environments today put greater emphasis on the personal knowledge, experience, expertise and wisdom of the commander.

> "Leaders will have a keen awareness of the world and the role of military force in that world. . . be skilled in synchronizing and harmonizing all aspects of combat and non-combat operations. . . will be called upon to make rapid, doctrinally sound decisions. . . in more diverse, high-pressure operational environments."[54]

This Force XXI dictate places clear priority on the *pre-battle preparation* of commanders. A commander who doesn't know where or how to access critical compartmentalized intelligence, does not understand the difference between a defense attache' and a MILGROUP commander, does not know what medecins sans frontieres can and cannot accomplish, does not know the extent of SOF capabilities and limitations, and who thinks the principle of overwhelming combat power wins hearts and minds, is little more than a well-intentioned leader, who will have difficulty "commanding the situation." The alert to deploy on short-notice is no time for one-who-would-command to try to establish his foundation of knowledge. When he is told "You will be OPCON to a British-led CJTF conducting rear area humanitarian assistance in the "Near Abroads," working closely with MSF, Red Crescent and Deutshcer Bergwacht. . ."--these words, acronyms and concepts need to have meaningful implications to him--not be sources of bewilderment. Given the commander's pre-battle acquisition of knowledge and expertise, the subsequent acquisition of battlefield information can then be accurately assessed by him and turned into wisdom of action.

Command and Control. Despite U.S. commanders' in-bred desire to directly command and control at will, complex battlespace can challenge and confound this instinct. The reality today is that a commander may not legally be authorized to dictate anything to a faction, give direct orders to an NGO or PVO, or command an ally. He may instead have to coerce, co-opt, negotiate, arbitrate, compromise or cooperate *as an equal* with assorted players in his battlespace--the end-state being "to influence desired outcomes." This itself can constitute "battle" of complex proportions for even a well-prepared commander. It also underscores the vital role a commander plays in multi-national and inter-agency operations or in sensitive situations with severe strategic and diplomatic consequences--situations where a heavy-handed commander can unwittingly sabotage his unit's potential success. It is thus the commander's foreknowledge of the situation he would command and the players he seeks to control, that can aid him in selecting direct or indirect approaches to command and control. This principle applies to attacking fortified positions as certainly as it applies to dislodging obstructionists to progress.

The widening of the battle command spectrum to encompass LIC and OOTW places a premium on foreknowledge and the "indirect approach" in a commander's battle mathematics. Modern battle command, thus, is not merely a matter of knowing "what to do" once deployed on battleground, but more importantly a matter of knowing "the right things" *before* the deployment takes place. In this light FM 100-5's concept needs only to incorporate a broader sense of battlespace and an emphasis on indirectly influencing the situation and desired outcomes.

The relationship between the Battlefield Operating Systems and the broader constructs derived from their essence clearly indicate the BOS's solid foundation as a bridge to planning full-dimension operations. The BOS logically retains its utility in certain situations, but is not properly developed to meet all the needs of the commander at the nexus of diverse spheres. The unit that can tactically dominate an enemy with the synergy of lethal and non-lethal power, negotiate the operational obstacles and minefields of the inter-agency and combined operations, and leverage various players to act according to U.S. strategic interests--all without diplomatic embarrassment--is a force that grasps the grander essence of the BOS. This is also a force that more closely represents TRADOC PAM 525-5's vision of Force XXI.

IV. CONCLUSION

> "The abiding theme in 20th Century military history is that the changing character of modern war long ago turned the corner on conventional military practice. . ."[55]

The limitations of old intellectual constructs in U.S. Army operations planning stand bare before today's military challenges. Readiness for war, combined with rising U.S. military involvement in OOTW illustrate the demand for more dynamic analytical tools. The Army's vision of the 21st Century further underscores the inadequacies of the tactical commander's current intellectual tools for planning full-dimension operations. The historical and hypothetical examples presented, as well as the discussion of shortfalls and short-sightedness in conventionally approaching complex battlespace, repeatedly indicate that tactical and operational intellect alone are not sufficient for commanders at the nexus of diverse spheres of operations. The "flattening" of the military hierarchy is a trend which increasingly pushes sensitive decisionmaking to the lowest levels. No longer can the commander on the ground view his environment in purely tactical or operational terms, because his decisions and his soldiers action or inaction potentially carry strategic and diplomatic consequences. The scattered wreckage of a Pan Am jumbo jet across the Scottish countryside of Lockerbie, potentially linked to the tactical decision of USS Vincennes to unwittingly shoot down an Iranian airliner, stands as a testament to this evolution of battleground. This change in reality for the military commander dictates a corresponding change in how he views battlespace, analyzes complex situations and organizes for full-dimension operations.

In contrasting the paper's two sets of planning constructs it is important to first distinguish which one better serves as an overarching architecture for full-dimension operations planning, and then which one is properly subordinate to that architecture. In this light, the evidence of the tactical/operational constructs of area of operations, METT-T and BOS indicates they belong subordinate to larger constructs. They thus emerge as functional enablers within a broader planning architecture. These solid tactical and operational constructs not only continue to serve ground commanders as before, they also serve as intellectual bridges to understanding this broader architecture which encompasses the strategic and the diplomatic. The intellectual leap to be taken lies in rethinking the old familiar constructs in terms of their essence--essence to be weighed in the broadest context of battlespace's potentially diverse dimensions.

Force XXI's vision of multi-spectral dominance of a wide-range of lethal and non-lethal battleground reflects a logical evolution in power protection and force application in consonance with the present U.S. national security strategy. Similarly three new planning constructs for full-dimension operations evolve from the essence of old constructs:

Spheres of Operation

The 9 P's of situation analysis

Full-dimension operations constructs

These reflect an evolution from a tactical/operational battle focus to a more mature, multi-spectral focus--one that can handle the rigors of complex battlespace. These evolutionary constructs are linked building blocks, each with distinct functions, but which together constitute a seamless intellectual process--a process that can rapidly, efficiently and effectively transform raw information into vision, conclusion, decision and action. This intellectual ordering of information and ideas in situational analysis and operations planning supports Force XXI's stated intent to "orchestrate apparent chaos on the battlefield--with patterns understood by the US commander and coalition partners."[56] This ability to see clearly amid chaos is a function of intellectually being able to discern the fundamental nature and critical detail of the concept of modern battlespace, grasp the broad implications of multi-spectral situation analysis, and organize and orchestrate operations at one level according to simultaneous tactical, operational, strategic and diplomatic dictates. Without such a common vision and commonly understood means for sorting massive information into meaningful, manageable knowledge, a command would logically be intellectually predisposed to disunity and loss of battle focus.

The nation's high expectation for military success is reflected in the following statement from TRADOC Pam 525-5: "Failure in early entry operations will have major strategic consequences for follow-on military action or prevent action altogether."[57] It is the emphasis on early tactical and operation success that compels the Army to seek every advantage in the pre-deployment preparation of its forces. Given the proven tactical and technical proficiency of soldiers, it is then the commander and his staff that are critical in complex battlespace. While the Revolution in Military Affairs focuses largely on hi-tech tools of war, it is rather the mental manipulators and orchestrators of those tools who need attention. In turn, it is their intellectual analytic tools that ultimately will empower them to do the right thing at the right time with the right technology on short-notice around the world in order to *compel, deter, assure* and *support.* To this end the Army's intellectual approach to situation analysis and operations planning for full-dimension operations needs to evolve beyond Cold War mindsets, if Force XXI is to succeed in an uncertain and challenging 21st Century.

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DOCUMENT 4

Command and Control in the 21st Century
A Construct of the Future

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By
Lieutenant Colonel Le'Ellen Kubow
U.S. Marine Corps
April 1995

U.S. Army War College, Carlisle Barracks, PA

STRATEGY RESEARCH PROJECT

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BY

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Abstract

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New technologies and changes in organizational hierarchies are being touted as the keys to the future. But we approach the future with short, incremental steps - using today's paradigms. In an attempt to move beyond this gradualism, this paper proposes a 30-year hypothetical leap into a future military environment to anticipate its command operations and structure. This "fast-forward" projection reveals major issues in decision-making and leadership. It allows us to analyze the effects of flattened organizations and to re-assess the role of the commander. Finally, assuming we transition to an organization similar to this 30-year model, it identifies possible near-term actions required to effect such long-term changes.

Increased horizontal and vertical awareness will enhance commanders' coordination and decision-making, but the role of senior commanders and their relationship to subordinate commanders and their troops will change. To gain the full benefit of a flattened organization, commanders will rely more on intuitive decision-making abilities, which in turn will redefine the path to command and foster new relationships between levels of war. Reflecting on the questions raised by this projection will help us determine a future that will best serve our national and global interests.

List of Illustrations

Command and Control in the 21st Century
A Construct of the Future

Our military Services continue to grapple with issues pertaining to the shape, content and functions of the military in the 21st century. We hear every day such buzz words as downsizing, fighting smarter, digitizing, flattening, and empowering. But few have described the command operation and structure that will successfully lead these downsized, digitized organizations. With the increased capabilities provided by information age technology, we can flatten the command and control function of our military organizations, empowering commanders at all levels. But, is this the best way to operate? How will these newly empowered forces function on a degraded battlefield?

To study the ways a redesigned force will change the command function, this paper first hypothesizes a concept of operation and propose a command structure for 2025.[1] This model then raises implications of the changes and provides the basis for proposed near-term transitions. We need a model of how we plan to fight in the future in order to recruit, train and educate the force while building or buying the technology to support it.

The military inherited the concept of flattened organizations and empowered workers from industry, where the advantages of efficient information management are tied to profits. A modern, sophisticated, demanding public forced industry to develop new methods to ensure customer satisfaction through greater flexibility in customer relations and increased adaptability of products. As a result, the Industrial Age work model is no longer valid. In this model each worker gained expertise in just one facet of the process. As systems or products became more complex, management added many layers of control to facilitate supervision and coordination of these specialists. The management layers created their own replicated hierarchies of specialized tasks resulting in added work with no added value. Business innovators found that information age technology enabled management to increase their span of control and use generalized rather than specialized workers. This resulted in flatter corporate organization and reduced duplication. Decreasing or eliminating middle management has allowed front-line employees to make timely decisions and provide valuable feedback for product updates. This entire transformation has lowered costs, speeded up production, and finally, generated greater profits.[2]

Our military leadership has been greatly influenced by this new command and control concept. Even so, our current command and control system consists of multiple, unrelated, vertical hierarchies. This is not surprising, since it mirrors organizations established on the antiquated model used in business. Multiple levels of command each maintain a set of functional staffs, often performing the same processes, separated only by command or functional boundaries. But, information technology gives us the ability to build command and control systems that share data between functional areas and commands.

However, we are currently using cutting-edge technology to automate the support structure created for a 19th century commander. Instead we should develop new concepts of command and control incorporating the tools of the information age. The future command and control support structure must provide an environment that enhances the capabilities of its users and optimizes information value. Once we identify a concept of future operations and organizational structure, training and education and doctrine can follow.

Most current discussions of command and control are based on technical descriptions of computers and communications equipment. However, Joint Publication 1-02 defines command and control as the exercise of authority and direction by the commander over designated forces in order to accomplish the mission.[3] The principal elements of the system providing command and control are people and information. People interact with each other and utilize the equipment, and the information is acquired or used to make and disseminate decisions. The final element of the command and control system is the support structure, which includes the organization, procedures, equipment, facilities, training, education, and doctrine. So the computer and communications equipment is simply a small, but necessary part of the system.[4]

Joint Publication 3-0, Doctrine for Joint Operations, details the functions of command and control required by Joint Force Commanders.[5] Service doctrine amplifies these functions by specifying more fully the qualities needed to command warfighters. Field Manual 100-5, Operations, probably describes them best as "two vital components - decision making and leadership." The commander must position himself so he can best assess and influence the battle, poised to make the right decisions at the right times, and providing the leadership to inspire action and to take responsibility for the decisions.[6]

Any long-range concept of the future builds upon the present. The Services have started down the path formulating the next doctrine, generating viable concepts for the next 5-15 years. While service-unique differences remain, many similarities in approach and goals appear when examining Service concepts.

The Training and Doctrine Command Pamphlet 525-5, Force XXI Operations, suggests that the Army's definition of

Battle Command may need to emphasize art more than science because of the unpredictability of future scenarios. The Pamphlet also proposes the need for rapid adjustments because of changing "temporal and spatial variations" of the battlefield. It anticipates a flexible command structure that can share information in both the traditional hierarchical and throughout a new networked non-hierarchical structure. A networked structure promotes the concept of a flexible chain of command. Technology will shorten the decision-making-to-action time, thus blurring the distinctions of the strategic, operational, and tactical levels of war. Commanders must be able to act upon their intuitive sense of the battlefield; they must communicate their intent to the individual soldiers, who then may act independently if necessary.[7]

The Air Force hopes to better align the responsibility and authority of its commanders. Through decentralization, the Air Force will reduce large headquarters staffs and grant field commands more authority. The emerging command structure will push control of decisions to the lowest levels possible. Resource consolidation leading to mergers in tactical air commands is the subject of a second focus. This is consistent with the Air Force's promotion of central control of air forces under the combatant commander.[8] The consolidation effort also recommends that commanders control all logistic and administrative processes supporting their units' operation.[9] The Air Force appears to be consolidating command and control in order to service its need for technological solutions and to strengthen the tie to its logistics train.

Naval forces are traditionally decentralized commands. In preparing for the 21st century, the Navy will move to a more tailored force of ships assigned to a task group based on mission requirements.[10] The Navy proposes the least change in preparation for the information age. While command and control support systems will provide a more consistent view of naval battlespace, the Navy's mission and tools to accomplish that mission are not changing.[11] Well-adapted to decentralized command, Navy commanders are becoming more aware of centralized control capabilities.

The Marine Corps believes that the concepts of command described in maneuver warfare doctrine will hold true in information age war as well. Mission-type orders and decentralized control are the hallmarks of the doctrine, which requires subordinate commanders to understand the intent of their orders and allows them the opportunity to pursue their mission with minimal guidance.[12] Developing concepts predict an increased tempo, task-organized missions, and changing force and command structures requiring flexibility and intuitive decision-making by the commander. While most of the internal command and control commander. While most of the internal command and control structure will remain, relations with commands external to the Marine Corps' combat structure may change radically.[13]

The greatest impact of the information age on the function of command and control will be felt in the Army and Marine Corps, primarily because they are both people intensive services. Their concepts of command are very similar. In the near-term, both acknowledge a requirement for increased flexibility, continued use of decentralized control, and an emphasis on intuitive decision-making. However, these emergent concepts reflect current capabilities and structure resulting in incremental changes. Perhaps that is justified, but will it lead to our desired future? We must attempt to conceptualize future doctrine beyond existing capabilities in order to examine unexplored possibilities and validate long-range goals.

The foregoing review of current concepts provides the jumping off point for discussing future concepts.[14] Depicting a hypothetical future will provide a foundation to facilitate discussion beyond current long-range plans. It begins with some assumptions about the environment and, within that setting, projects a concept of operation and the command structure of the force. While many debatable positions are stated as fact, the proposed future is presented to study the model's effect on the commander's decision-making and leadership role.

In 2025, niche wars continue to arise in various regions of the world. In addition, a peer competitor equaling the United States in economic strength and/or technology shares in world power. The United States continues to pursue a National Security Strategy similar to one of Engagement and Enlargement, requiring a warfighting military capable of overseas presence, peacekeeping, and peacemaking operations. Because of real threats to United States industry and acts of terrorism, the military often operates separately or in conjunction with civil authorities for internal defense.

Technology continues to advance, providing commanders with unlimited access to information and equipment configured and sized to the unit's requirements. Precision strike weapons are available on command and include those weapons capable of defeating or neutralizing 1st wave competitors.[15] Tanks and aircraft carriers, no longer considered the focal point of operations, are mostly things of the past, along with large logistics bases and command centers. All of these present too rich a target in a precision strike era. Manned aircraft, deemed too expensive and inefficient, are no longer the primary focus of aviation. Weapons and their platforms exploit smaller, faster, lighter technologies with an emphasis on personal precision weapons.[16] Command and control support systems provide seamless audio and visual information and decision support systems to commanders at all levels.

Although the force structure is small, military capabilities greatly exceed those of 1995. A division with 4000 personnel has greater combat effectiveness than one of 15,000 in the past. A platoon-sized unit controls an area comparable to that of a Desert Storm era battalion.[17] The military of 2025 is a small, light, but well armed force, capable of responding to a myriad of tasks or missions.

Based on the continuing National Security Strategy, the missions of our 2025 armed forces continue to be ones of deterrence, warfighting, peacekeeping, and humanitarian relief. Performing these missions with 1st through 3rd wave allies and foes necessitates a cohesive force with one overriding doctrine, prepared for varied fast-paced and changing operations, supported in accord with their mission needs.

Strategic implications of operational and tactical actions and tactical implications of strategic actions require simultaneous conduct of all three levels of war. The pace and visibility of events emphasize the direct relation of the military element of national power to economic and political power. Effective operational and tactical as well as strategic commanders must be attuned to the interrelations of the elements of national power.

Operating forces conduct two basic types of missions - those requiring temporary use of force for peacemaking or those requiring continued presence, bridged by peacekeeping missions. Wars or other temporary operations require a force trained and prepared to fight major conflicts, where the emphasis is on winning and terminating a specific cause of conflict or instability. Continuing missions generally require a smaller force, capable of flexible but limited response, operating primarily as a part of a diplomatic solution. While these forces are structured similarly, their different view of missions require different training and doctrine.

Operations, both temporary and continuing, are executed under the auspices of a single Strategic Combat Commander. Since the battlespace has grown in size and dimension, dividing possible theaters by geography is no longer useful. This single commander has the global awareness required to coordinate effectively the use of force in compliance with the National Command Authority requirements. Task commanders assigned by the Strategic Combat Commander conduct operations using land, sea, air, and space forces as the mission requires. A mission such as "Defeat enemy's ability to command and control forces" may employ primarily strategic precision strike aviation and data systems neutralization forces. One requiring "Neutralize an adversary's logistics capabilities" may employ a combination of general and special forces.[18] Some of these forces assigned to a commander will not be physically present in theater. For example, operators of long-range precision strike weapons and information warfare weapons generally fight from their continental United States locations.

The concept of chain of command must continue, because accountability must be retained. But the chain of command for a unit may change by the mission. A Fighting Unit reports to a division commander in one mission; in the next, it reports to the theater commander. Although the hierarchy of command changes there must always be a definite chain of command, even though it appears abstract. Because of the availability of strategic precision strike weapons to tactical commands and to meet all demands for fires, fire support control is centralized by necessity.[19]

With the commander's normal span of control considered to be 1 to 10, the notional hierarchy of command is much flatter than in 1995. The mission commander's operating forces consist of Fighting Units selected by projected mission requirements. These Fighting Units are used in a "plug and play" mode, rotating in and out of theater when supplies and/or personnel are expended. They are then replaced by fresh units. When mobilized, reservists, formed in their own Fighting Units, blend easily with active duty units. The increased span of control absorbs them seamlessly into the mission task structure.

A commander's staff consists primarily of intelligence gatherers, tacticians, and planners. Some of the staff operate from locations out of theater; tacticians, simulating the next operation, generally locate in the continental United States. Warfighting commanders do not have the luxury of time for logistics and administrative considerations. Therefore, the Support Command provides all combat service support.[20] Commanders' questions or requirements in these areas are resolved by the appropriate support unit or staff agency in the support command.

When not participating in actual operations, all forces are attached to commands within the Department of National Security (see Figure 1). The civilian staff provides policy guidance to the department. Warfighting Preparation Command includes all military forces that could ultimately be employed to defeat an enemy, ground combat forces to computer infiltration units. Support Command consists of all combat service support military forces and commercially contracted forces.

The Warfighting Preparation Command is tasked with training, war gaming and simulations, long-range planning, and doctrine development. Within the Command, the only permanently structured units are formed at the lowest tactical level. The Fighting Units generally contain not

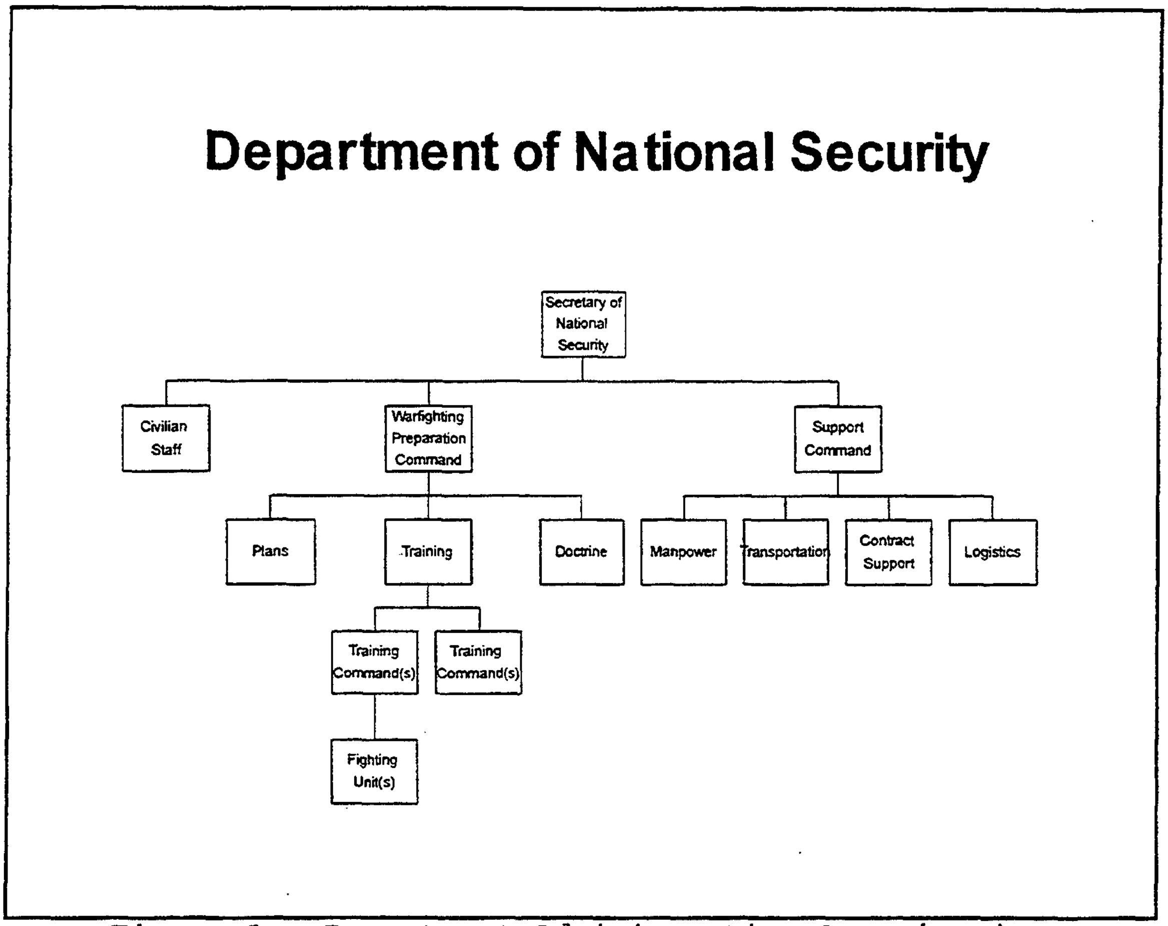

Figure 1: Department Administrative Organization

more than 100 personnel, comparable to platoon size. They comprise the basic tactical unit. Some Fighting Units have specialized tasks such as missile defense, long-range precision strike, or information disruption, but most consist of combined-arms, multi-mission forces. A ship and her crew constitute a Fighting Unit. Another type of Fighting Unit is the commander and staff, ensuring they train together for a variety of missions. Organized and trained in their Fighting Unit, warfighters deploy in these units when assigned an operation. Thus the basic organization retains unit integrity and long-term relationships with commanders.

The Support Command provides the forces for planning, procuring, and providing administrative, transportation, logistic, and medical support to the warfighters. With a separate structure and career pattern, support personnel organize similarly to the warfighters into small Support Units capable of being combined to meet mission requirements. They generally support the warfighters while remaining under control of the Support Command. Command and specialized Support Units lead peacekeeping operations focusing on combat service capabilities. The Strategic Combat Commander, as the single combat commander, reports directly to the National Command Authority (see Figure 2). Permanent regional commands of military representatives, with a small operations and intelligence staff, coordinate United States action with allies, provide expertise in regional matters and advise the Strategic Combat Commander. As possible operational theaters develop, the Strategic Combat Commander assigns a Theater Task Commander, with battle staff, who determines mission requirements and defines the mission commands required. Small Fighting Units are drawn from the Warfighting Preparation Command as required and Mission Commanders assigned as needed. The presence mission requires a permanent commander controlling all forward deployed units not participating in a designated theater. The Strategic Combat Commander and permanent staff coordinate the activities of theater and presence commands thereby ensuring all actions complement each other.

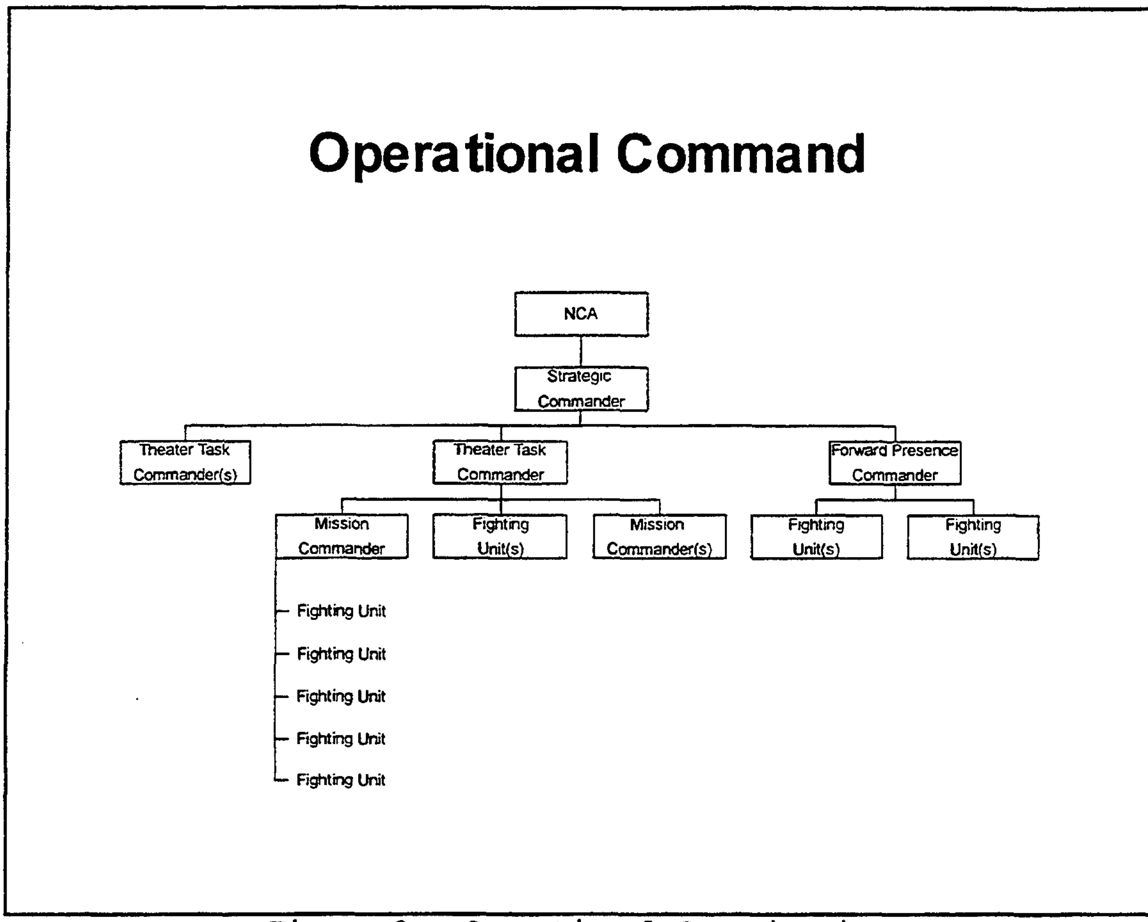

Figure 2: Operational Organization

While there are many implications concerning weapons systems, delivery platforms, and technology advances that emerge from this scenario, the following discussion will be limited to the impact of flattened organizations and quickly composited major commands on command and control. How will the commander effect the decision-making and leadership aspects of command in order to assess and influence the battle?

Flattening structure applies to all levels of command. Transitioning to a Strategic Combat Commander commanding multiple theater commanders administratively reduces the number of permanent staffs required. More importantly this transition simplifies the organization and provides greater flexibility in establishing areas of responsibility based on situational need. The requirement exists for regional experts to provide the link to allies, but these should not be tied to arbitrary geographic areas. As alliances and conflict between countries change, experts can move, without the need to redraw permanent command lines. Contingency commands also permit the theater commander to focus completely on the assigned mission.

A flattened organization with its increased span of control expands horizontal as well as vertical situational awareness. Commanders' access to a common picture enhances cohesion between units and enables more flexible response.[21] The relationship of tactical to strategic levels of war demands that tactical commanders maintain a thorough understanding of operational and strategic goals and objectives. They must also be able to visualize how their tactical goals complement or detract from the strategic goal. Increased vertical awareness enables both tactical and strategic leaders to fight or at least observe and advise on the other's war. Strategic leaders now have the capability to direct tactics.

Flattening the organization, in conjunction with improved command and control technology, drive the changes in our concepts of levels of war. In fact, as strategic and tactical levels grow closer the concept of an operational level of war, needed to transition between strategic and tactical levels, may cease to have meaning.

Because major commands are quickly composited and disbanded, commanders find their view of leadership roles changed. Little allegiance develops between senior commanders and personnel in the Fighting Units. Mission and theater commanders have minimal personal contact and rely on the Fighting Unit commanders to provide that contact. Staffs are well acquainted with their commander, but have little personal knowledge of the units assigned. The Fighting Unit commanders must gain and mold the loyalty and trust of their troops and communicate a sense of their physical and emotional state to senior commanders. Strategic leaders must focus on information. With all information available and with the impracticality of physically walking the battlespace, some theaters are best served by the senior commanders operating from a location physically remote from the theater.

Decision-making also has changed. The simultaneity of strategic and tactical levels of war requires short decision cycles. To succeed in the environment that created this type of command structure, commanders must be adaptable, versatile, and flexible. They must be able to manipulate many concepts at once and to plan intuitively. This versatile commander must adeptly use all forces available. Employing ground forces, remotely piloted vehicles for close air support, and space assets as precision strike weapons, the Fighting Unit commander must clearly understanding a three-dimensional war. Flexibility is needed in an ever-changing hierarchy of command, of training and taskings to multiple types of missions and rules of engagement. Traditional staff planning, while sufficient for long-range plans, is too time-consuming in actual operations. Therefore commanders and staffs rely heavily on their well-developed intuitive decision-making skills.

Let us now assume that the foregoing projection indicates roughly where the military should be in 2025. If so, then what kinds of interim changes should be effected in 2000-2010 in order to transition to that future? The generals and colonels of 2025 start their training as lieutenants soon. We must ensure they are prepared to lead effectively in the future. This historical snapshot of the near-term future shows the beginning actions taken to transition to the proposed 2025 concept.

We continue to rely on major weapons platforms such as tanks and carriers in 2010, but their vulnerability is becoming apparent. Precision strike weapons are available, but not for use by individual ground fighters. Information technology provides commanders at all levels with broadcast strategic, operational, and tactical data, and command and control support systems have the ability to filter the information and thereby provide the commander with intelligence tailored to his needs. Command and control systems are now sufficiently fast and detailed such that the National Command Authority could control the tactical battle. Media news coverage of all international events is transmitted to unit commanders, enabling them to be well-versed in strategic issues.

We maintain four services, but they rarely operate independently. Regional combatant commanders effect National Military Strategy, with operational area theater commanders assigned as the situation requires. Theater commanders assign missions to subordinate commanders and provide them with a suitable joint force. As a result of technological improvements, the commander's span of control is increasing, thus enabling direction of a more diversified force with fewer intermediate commands. Because of the availability of information and its ease of manipulation, command staffs have ceased to grow. Rather, they are beginning to decline. Staff serving as researchers, messengers, processors of information and technicians are disappearing. Principal staff officers have become familiar with automated tools and provide the commander with needed assessments and plans. Control measures are disseminated and monitored through the automated systems as well. Increased span of control and reduced staff size are the first steps in eliminating some levels of command. They are no longer needed, and in fact, can hamper timely operations.

Establishment of a centralized logistics command providing supporting logistics operations relieved the strategic and operational level commanders of some of their logistics burden. At the tactical level, logistics remains a primary concern in planning and conducting operations.

Separate land/air/sea component commanders were replaced within the theater commands by task or mission commanders. They are provided with forces to operate in all required mediums. The regional commanders retain service component commanders as an advisory crutch until such time as senior officers are confident in their use of all forces.

Recognizing the need to move to smaller, task-organized units, the Army and Marine Corps have begun to reduce the number of levels in the hierarchy of command. With the division as its principal tactical element, the Army eliminated the staffs between it and the theater task commanders. Within the division brigade staffs are being eliminated and division commanders operate directly with their battalions. The Marines continued their focus on Marine Expeditionary Units as their basic task-organized organization, with Marine Expeditionary Forces reserved primarily for major contingencies. The Marines also have started eliminating mid-level structure within their ground and aviation organizations, regiments and groups, reflecting their usage in combined-arms task organizations.

While technology has improved their ability to communicate the battle picture across commands, Navy and Air Force command changes have been minimal, probably due to the nature of their environment. The Air Force completed its restructuring of major commands in the early 1990's, which enhanced its ability to provide the appropriate mix of air power to the battle. Shipboard command has always required mission-type orders; therefore few naval changes were needed, mainly because of the physical separation of naval forces.

The consequences of the transition to this new command and control structure are becoming apparent. Senior commanders dislike their separation from the personalities of the tactical units, but are finding themselves better prepared. Small unit cohesion is vital and we must ensure individuals have a long-term relationship with one unit.

The evolving flattened command structure requires changes in commander development. Thinkers, planners, and commanders do not necessarily exhibit the same qualifications. Also a tactician is not necessarily a commander. With a flatter organization, there are many commands at the low end and very few at the top. If we want to ensure we have only the best commanders, then perhaps we should begin to treat command as a specialty field. A majority of the career of a commander should be spent in command or command preparation. Flattening the organization has also revealed a need for grade restructure. With command opportunities at three levels, the traditional seven steps to general officer seem excessive.[22]

Commanders must be able execute mission-type orders and act intuitively. Without forgetting the benefits of the past focus on deductive analysis, intuitive decision-making is now a primary concern. Intuitive decision-making is cultivated from the earliest schools through simulation, war-games, and exercises. These begin as individual computer games during which lieutenants pit themselves against the computer. Staffs are taught to plan in conjunction with the commander's intuitive decisions. Instead of a rigid cycle and format for decision-making, which generates a cost/benefit analysis of a finite set of actions, proposals become a stimulus and challenge for arriving at an optimal solution.

Providing a common picture of the battlefield to all commanders, while enlightening, also causes unwanted changes in outlook. Many examples exist of small unit effort winning a battle thought lost by senior commanders. Or the alternative, commanders not withdrawing or committing reserves early because they were unaware of battle casualties, to the overall benefit of the campaign. Commanders will have to consider carefully the composite view in relation to their focused view, and maintain that focus.

Given their Roles and Missions and budget concerns, the Services are planning for the next 5-7 years. Recent and current acquisition projects must be supported to validate their purchase. Having been institutionalized, we find it difficult to get outside the box and think of a future operating on different principles. Any agreement to cede functions to another Service could lead to role and funding cuts. Certainly no Service wants to give the impression of no longer being needed.

In fact, the National Security Strategy needs all the functions, and will need them. We must study functional vice service unique capabilities. The future missions require all four mediums (land, air, sea, and space) to effect the military arm of national strategy. The nation deserves the best direction possible of its military forces. We must consider and evaluate changes in service structure and command relationships, if for no other reason then to ensure we chose the correct path.

Some of these suggested changes will occur because present day issues are driving them. First, the American population does not want to pay for a costly military force, but they do want a well-trained, capable force when it is needed. Because of on-going reductions in force, the manpower requirements to staff this structure will not change significantly. This is not a plan for force reduction. Secondly, the new technologies are relatively inexpensive, and becoming cheaper. They offer an easy way for a small power to have a large influence.[23] The best way to combat a similar force is to be an expert in the use of new technology. We know the next wars will be fast-paced and complex. In addition to giving us a new medium of war, information age technology provides a way to satisfy the public's wishes.

This future structure for an information age military force relies heavily on technology. What happens when it doesn't work? As warfare proponents adopt technological solutions to fight better, there is always some probability that something will go wrong. Operating in a degraded mode is not new to the battlefield; something always breaks. Work-around solutions must suffice until repairs are made.

We must guard against possible system failure by reducing the chance of failure through redundant systems and plug-in parts. But if the automated command and control systems fail, how does it affect command? The changes to command structure, education, and prior access to the command and control systems before their failure will enhance the commander's ability to cope within a degraded battlespace. The commanders at each level have been acquainted with the strategic and operational goals. They have their mission and understand the commander's intent. As done in the past, commanders trained to operate with mission-type orders and aware of the general situation, continue to operate without external control until communications are reestablished.

Finally, can we get there from here? And do we want to? We must! The 2025 target is a fictional future that will never totally materialize. But some portions of it will. We need to act now to begin the transition to this or other worthwhile long-range restructuring. There will be a reduction in force. Technology will continue to be smaller, cheaper, and faster. There will be a need for a well-equipped, well-led military. We must actively consider creating a new command structure that anticipates future missions and attempts to remove service parochialism from discussions of future doctrine. We must immediately start realigning our educational institutions to develop a truly joint environment. We must develop and teach intuitive approaches to decision-making and crisis action planning.

We must start acting on the near-term solutions. Otherwise we will remain a Desert Storm attrition based armed force in a century of information maneuvering. We are by nature tradition-bound and slow to accept change. The revolution in military affairs dictates that the military mind can no longer be static, rather we must be continually evolutionary.

Endnotes

1. With a bibliography including several science fiction works, this must be a work of fiction. The application of military power proposed by Heinlein and Card have been stimulating and provocative. Gene Roddenberry's *Star Trek* and Anne McCaffrey and Elizabeth Moon's Sassinak (New York, Baen Publishing, 1989) also shaped my thoughts.

2. Michael Hammer and James Champy, Reengineering the Corporation: A Manifesto for Business Revolution, (New York: HarperBusiness, HarperCollinsPublishers, 1993), chap 1, 2, and 4 passim.

3. Joint Chiefs of Staff, Dictionary of Military and Associated Terms, Joint Publication 1-02, (Washington: Government Printing Office, 1989).

4. U.S. Marine Corps, A Concept of Command and Control, Fleet Marine Force Reference Publication 15-3 (Washington: U.S. Marine Corps, 3 August 1994), 16-18.

5. Joint Chiefs of Staff, Doctrine for Joint Operations, Joint Publication 3-0 (Washington: Joint Staff, 9 Sep 1993), II-19 - II-21.

6. Department of the Army, Operations, Field Manual 100-5 (Washington: U.S. Department of the Army, 14 Jun 1993), 2-14.

7. Department of the Army, Force XXI Operations: A Concept for the Evolution of Full-Dimensional Operations for the Strategic Army of the Early Twenty-First Century, TRADOC Pamphlet 525-5 (Fort Monroe, Virginia: U.S. Department of the Army, 1 Aug 1994), 2-8 - 2-10,3-3 - 3-8.

8. Department of the Air Force, Global Reach-Global Power, Air Force White Paper (Washington: U.S. Department of the Air Force, December 1992), 5,13.

9. Department of the Air Force, Air Force Restructure, Air Force White Paper (Washington: U.S. Department of the Air Force, September 1991).

10. U.S. Navy, Force 2001, A Program Guide to the U.S. Navy (Washington: Chief of Naval Operations, 1994).

11. It is not surprising that fictional space militaries are modeled after the terrestrial navy. The concept of traveling between planets or star systems is more like an ocean-going vessel making short port visits, rather than an aircraft flight between bases.

12. U.S. Marine Corps, Command and Control, Fleet Marine Force Manual 3 (Washington: U.S. Marine Corps, 16 Jun 1993), 7,13.

13. U.S. Marine Corps, A Concept for Command and Control of the MAGTF, Fleet Marine Force Reference Publication 14-33 (COORDINATING DRAFT) (Washington: U.S. Marine Corps, 23 Jan 95), 14.

14. Some of these ideas surfaced through work on an Army War College class project on the Revolution in Military Affairs, Operation and Organization Concepts. Project members were Col James O. Newhouse, USAFR, LTC Robert H. Reardon, Jr., USA and the author.

15. Alvin Toffler and Heidi Toffler, War and Anti-War: Survival at the Dawn of the 21st Century (Boston: Little, Brown and Co., 1993). 1st wave societies are agrarian-based. 2nd wave are of the industrial age and we are moving into the 3rd wave, information.

16. Heinlein's "bounce suits" are not available, but personal exoskeletons replace heavy, cumbersome body armor.

17. Col Doug Williams, USA, Faculty Instructor, U.S. Army War College. Concept presented during the course, "Revolution in Military Affairs," Feb 1995.

18. Another consideration is the use of remotely piloted vehicles. If RPV's are capable of providing close air support, they could be controlled/operated by the ground units they are supporting.

19. The ultimate form of fire support is a warfighter carrying a weapon that can be pointed at a target and the target eliminated by the most suitable means. Centralizing fire support without limiting a commander's options will require virtually unlimited resources. Fire support like logistics will need to be negotiated prior to conduct of the battle.

20. Just as private industry is contracting out much of its warehousing, transportation and supply needs, warfighters will identify their requirements and the supporters will provide. Supporters monitoring the command networks will be aware of the general nature of requirements. If the mission calls for Unit 1 to displace to Location B, then, like a rental car company, the appropriate transportation will arrive at Unit 1's location. During campaign mission formulation, the support commander will agree with the strategic combat commander on the supportability of the campaign.

21. Office of the Secretary of Defense (Net Assessment), Report on the Proceedings of the Workshop on Dominating Maneuver 16-18 Aug 94, US Army War College, Carlisle Barracks, PA (Strategic Assessment Center, Science Applications International Corporation, October 1994), Group A report.

22. Perhaps slower promotions, but greater step pay increases. Should there be three grades, with the first five years in each serving as learning periods prior to command? The problem with small unit commanders deciding strategic issues is generally a lack of experience. How can an officer gain these skills? Are junior officers assigned to teams within the unit, taking what is traditionally a senior enlisted billet? With the push to increase understanding of the battlefield to the lowest level, it could be carried to the point of eliminating all enlisted ranks or requiring privates to have college degrees. If junior officers are not given command, how do they learn?

23.Toffler, 179-189.

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INTERNET LOCATIONS

Note: The following URLs are current as of the date of publication.

New World Vistas Study - URL: http://web.fie.com/htdoc/fed/afr/sab/edu/txt/any/afrtnwv.htm
You will also find a hard copy of this report within the body of this issue of *The DTIC Review.*
The URL is included as an additional resource.

AspireSpace: Advanced Enabling Technologies - URL: http://www.gbnet.net/orgs/aspire/advance_link.html
Aspire Space Rocket Programme - URL: http://www.gbnet.net/orgs/aspire
Mind expanding pages addressing new technologies including nanotechnology and space rockets.

DoD-TECNET: The Test and Evaluation Community Network - URL: http://tecnet1.jcte.jcs.mil:8000/
Test & Evaluation home page.

Year 2000 Issue - URL: http://tecnet1.jcte.jcs.mil:8000/htdocs/teinfo/y2000.html
Includes links to the Army Year 2000, Navy Year 2000, DISA Year 2000, Air Force Year 2000 as well as other interesting sites and locations.

The Year 2000 Information Center - URL://www.year2000.com/cgi-bin/clock.cgi
Check out the project 21st century link.

Other links for Year 2000 problem - URL: http://www.year2000.com/link.html
Links to other military projects.

Battlefield of the Future - URL: http://www.cdsar.af.mil/battle/bftoc.html
Military view of the future.

Millennium Institute home page - URL: http://www.igc.apc.org/millennium/
The state of the world and other resources and observances for the 21st century.

MITRE Year 2000 Homepage - URL: http://www.mitre.org:80/research/y2k
C4I applications and other links to Army, Navy and Marine projects for the 21st century.

Undersecretary (A&T) Publications - URL: http://www.acq.osd.mil/ousda/documents.html
Documents published by USD A&T, press briefings, speeches, congressional testimony many dealing with topics regarding the 21st century.

The Defense Airborne Reconnaissance Office - URL: http://www.acq.osd.mil/daro/uav.aav.html
Executive overview of the DoD UAV program transitions into the 21st century.

Additional References

Note: Refer to the order form following the bibliographies for ordering information.

✦AD-A307 010

ARMY WAR COLL STRATEGIC STUDIES INST CARLISLE BARRACKS PA

(U) The Future of American Landpower: Strategic Challenges for the 21st Century Army.

MAR 95 39P

PERSONAL AUTHORS: Metz, Steven; Johnson, William T.; Johnsen, Douglas V., II; Kievit, James 0.; Lovelace, Douglas C., Jr.

UNCLASSIFIED REPORT

ABSTRACT: (U) The authors explore the premises which will shape thinking about the 'Army After Next.' In an era characterized by a volatile international security environment accelerating technological advances (particularly in acquiring, processing, and disseminating information), the emergence of what some are calling a 'revolution in military affairs,' and forecasts of increasingly constrained fiscal resources, it seems ill-advised to plan only for the 'next Army.' The authors challenge convictions that provide much of the basis for the 'current Army,' as well as some of the assumptions that under-gird planning for the 'next Army.' They discuss outlines of future security conditions and the Army's role in that environment. The ensuing exchange of ideas, they hope, will help create a force that can continue to be called upon to serve the interests of the Nation in an as yet uncertain future.

DESCRIPTORS: (U) *LAND WARFARE, *MILITARY STRATEGY, *ARMY PLANNING, NATIONAL SECURITY, ENVIRONMENTS, INFORMATION TRANSFER, COLD WAR, VOLATILITY, ARMY OPERATIONS, WESTERN SECURITY (INTERNATIONAL), INTERNATIONAL RELATIONS, NORTH AFRICA, WESTERN EUROPE.

IDENTIFIERS: (U) ARMY AFTER NEXT PROJECT, ARMY BEYOND FORCE 21, AANP (ARMY AFTER NEXT PROJECT), PACIFIC RIM.

AD-A306 719

JET PROPULSION LAB PASADENA CA

(U) Spaceborne Synthetic Aperture Radar: Current Status and Future Directions. A Report to the Committee on Earth Sciences.

APR 95 183P
PERSONAL AUTHORS: Evans, D. L.; Apel, J.; Arvidson, R.; Bindschadler, R.; Carsey, F.

UNCLASSIFIED REPORT

ABSTRACT: (U) This report provides a context in which questions put forth by NASA's Office of Mission to Planet Earth (OMPTE) regarding the next steps in spaceborne synthetic aperture radar (SAR) science and technology can be addressed. It summarizes the state-of-the-art in theory, experimental design, technology, data analysis, and utilization of SAR data for studies of the Earth, and describes potential new applications. The report is divided into five science chapters and a technology assessment. The chapters summarize the value of existing SAR data and currently planned SAR systems, and identity gaps in observational capabilities needing to be filled to address the scientific questions. Cases where SAR provides complementary data to other (non-SAR) measurement techniques are also described. The chapter on technology assessment outlines SAR technology development which is critical not only to NASA's providing societally relevant geophysical parameters but to maintaining competitiveness in SAR technology and promoting economic development.

DESCRIPTORS: (U) *SYNTHETIC APERTURE RADAR, DATA PROCESSING, TERRAIN, ROCK, MOISTURE CONTENT, HYDROLOGY, OCEANOGRAPHIC DATA, SOILS, SNOW, ICE, MELTING, MAPPING, GEOPHYSICS, OIL POLLUTION, VEGETATION, EARTH (PLANET), RADAR ANTENNAS, AIR WATER INTERACTIONS, TOPOGRAPHIC MAPS, RADIOFREQUENCY, FORESTS, ECOLOGY, GLACIERS, RECONNAISSANCE SATELLITES, TERRAIN ANALYSIS RADAR, SPACEBORNE, BIOMASS CONVERSION, ICE BREAKUP.

IDENTIFIERS: (U) STRAWMAN PROJECT.

✦ Included in *The DTIC Review*, July 1996

AD-A306 640

AIR UNIV MAXWELL AFB AL

(U) Future War: An Assessment of Aerospace Campaigns in 2010.

JAN 95 186P
PERSONAL AUTHORS: Barnett, Jeffery R.

UNCLASSIFIED REPORT

ABSTRACT: (U) The purpose of this book is to outline the aerospace aspects of future war. Because future war is an exceptionally broad subject, three caveats are in order. This book outlines only future state versus state warfare. Its theories are applicable only to future wars between sovereign states and alliances of sovereign states. States have organized militaries, infrastructures, production bases, capitals, and populations. These components enable unique capabilities and vulnerabilities which dictate the scope and character of war. Because states alone have these attributes, theories of state versus state war are unique. The book is not intended to provide a template for wars with nonstates such as future versions of Somali clans, Bosnian Serbs, or Vietcong. Nonstate warfare is certainly important; its future deserves serious treatment. However, because nonstates differ fundamentally from states, an examination of future nonstate warfare requires a wholly separate treatment. Nonstates, by definition, exist without infrastructures, production bases, and capitals. Nonstates usually have neither organized militaries nor any responsibility for populations. In essence, nonstates have completely different makeups relative to states. Because of these gross differences, nonstates require their own theories of war. It is impossible to reconcile both state and nonstate conflict into one theory. Future aerospace operations in wars with nonstates must remain for others to address. This particular book views future aerospace operations through only one prism, that of state versus state conflict. This book reviews only the aerospace aspects of future war. This limited focus is not meant to slight land and naval campaigns-they will remain crucial to future war, forming fundamental components of joint campaigns.

DESCRIPTORS: (U) *AERIAL WARFARE, *AEROSPACE ENVIRONMENTS, *MILITARY PLANNING, *TECHNOLOGY FORECASTING, COMPUTERIZED SIMULATION, COMMAND CONTROL COMMUNICATIONS, MILITARY OPERATIONS, MILITARY HISTORY, MILITARY STRATEGY, COMPETITION, IMPACT, OPERATIONAL READINESS, BATTLEFIELDS THEORY, PENETRATION, INTEGRATION, LIMITATIONS, MILITARY CAPABILITIES, PRECISION, MILITARY APPLICATIONS, MASS DESTRUCTION WEAPONS, TIMELINESS, SURVEILLANCE, INFORMATION SCIENCES, MILITARY ART.

IDENTIFIERS: (U) NICHE COMPETITOR, PEER COMPETITOR.

AD-A306 556

NAVAL POSTGRADUATE SCHOOL MONTEREY CA

(U) Modeling and Experimental Testing for Future Development of Night Vision Electro-Optic (NVEO) FLIR92 Model.

DEC 95 129P
PERSONAL AUTHORS: Koc, Clem

UNCLASSIFIED REPORT

ABSTRACT: (U) Recent advances in thermal imaging technology have resulted in the fielding of two-dimensional array detector based imaging systems. These designs have been labeled second-generation, and are rapidly replacing first generation systems having linear detector arrays with a parallel scan type architecture. It has been postulated that first generation prediction models are not applicable to second generation systems. In particular, the minimum resolvable temperature difference (MRTD) modeling needs refinement in the areas of sampling, quantization noise, and array nonuniformities in order for it to be applied to second generatlon systens. The present industry standard for MRTD is the Night Vision FLIR92 Model. Results from the FLIR92 Model and the two well known first generation models will be presented and compared with experimental measurements made on two thermal imaging systems available at the Naval Postgraduate School.

DESCRIPTORS: (U) *IMAGE PROCESSING, *FORWARD LOOKING INFRARED SYSTEMS, *ELECTROOPTICS, *INFRARED IMAGES, *INFRARED SCANNING, *THERMAL IMAGES, COMPUTER PROGRAMS, MATHEMATICAL MODELS TRANSFER FUNCTIONS, TARGET RECOGNITION, THESES PARALLEL PROCESSING, NIGHT VISION DEVICES, PIXELS, NOISE (ELECTRICAL AND ELECTROMAGNETIC).

IDENTIFIERS: (U) FLIR92 COMPUTER PROGRAM.

AD-A306 119

NAVAL POSTGRADUATE SCHOOL MONTEREY CA

(U) The Future of the Swedish Defense Industry: Strategies for Competiveness and Support.

DEC 95 112P
PERSONAL AUTHORS: Sjoberg, Staffan H.

UNCLASSIFIED REPORT

ABSTRACT: (U) In the light of the new geopolitical developments and the end of the cold war, the Swedish government is downsizing the Armed Forces. The proposed organization and spending level will not be able to sustain a domestic defense industry of current size. In an attempt to overcome this, there are different industry initiated strategies available. This thesis evaluates three of them: International Cooperation, Concentration and Consolidation, Integration and/or Conversion, by using evaluation colteria derived from the future needs of the Swedish Armed Forces. The criteria are: Produce competitive systems, Maintain a broad defense industrial base for growth, Support build-up and mobilization, Provide technology unavailable from abroad, Support and modify systems in inventory and Limit foreign dependence. The evaluation shows no single strategy fulfills all needs. International cooperation is the strategy that best meets the needs. The Swedish Defense Industry must choose its own strategy to adapt to the new environment. It may include elements of all three strategies, but given forseeable spending levels, it is impossible to pursue all three simultaneously. It is therefore necessary for the government and the Armed Forces to clearly communicate future priorities and requirements in order to facilitate the process.

DESCRIPTORS: (U) *STRATEGY, *DEFENSE INDUSTRY, *SWEDEN, *MILITARY DOWNSIZING, FOREIGN POLICY, COMPETITION, GOVERNMENT(FOREIGN), MILITARY FORCES (FOREIGN), TECHNOLOGY TRANSFER, MOBILIZATION, MODIFICATION, GROWTH (GENERAL), THESES, GEOPOLITICS, COLD WAR, INVENTORY, PLANNING PROGRAMMING BUDGETING, INTERNATIONAL RELATIONS, INDUSTRIAL RELATIONS, FOREIGN AID.

AD-A305 713

AIR UNV MAXWELL AFB AL SCHOOL OF ADVANCED AIRPOWER STUDIES

(U) Global Reach - Global Power, Air Force Strategic Vision, Past and Future.

PERSONAL AUTHORS: Faulkenberry, Barbara J.

UNCLASSIFIED REPORT

ABSTRACT: (U) The analysis presented in this thesis evaluates the contents of past Air Force strategic vision documents and studies the process used to create such documents. The thesis argument is that strategic vision documents can fulfill important functions for an organization, and that greater attention to the process of creating these documents can result in a more effective final product. The author defines a strategic vision document as a formal, written product endorsed by the organization's senior leader that provides broad and motivational guidance for the organization in the present while providing sage direction for the future. Based on current literature addressing the subject, the author proposes a framework of three attributes and two functions for strategic vision statements. The attributes of such statements are a declaration of organizational identity, a disclosure of future goals, and a view of the methods by which goals will be met. The two functions of strategic vision are to unify internally and advocate externally. Within this framework the author examines three past Air Force strategic vision documents for content and details the known processes behind their creation and distribution: General Arnold's 1945 report Air Power and the Future, the 1990 white paper The Air Force and US National Security: Global Reach Global Power and the 1992 white paper Global Reach Global Power: The Evolving Air Force Contribution to National Security. Additionally, the author discusses the processes involved in two other official works, Global Presence and the ongoing efforts aimed at creating a new Air Force strategic vision. Based on analysis of both content and process, the author develops and proposes a standard developmental process for vision documents including specific recommendations for content based on required attributes and functions.

DESCRIPTORS: (U) *STRATEGIC ANALYSIS, *AIR POWER, *AIR FORCE PLANNING, GLOBAL, NATIONAL SECURITY, LEADERSHIP, THESES, DOCUMENTS, GUIDANCE, MOTIVATION.

IDENTIFIERS: (U) *STRATEGIC VISION.

AD-A304 644

NATIONAL AIR INTELLIGENCE CENTER WRIGHT-PATTERSON AFB OH

(U) Trends of Microwave Weapon Development.

PERSONAL AUTHORS: Zhihao, Zhu
REPORT NO: NAIC-ID(RS)T-0632-95

UNCLASSIFIED REPORT

SUPPLEMENTARY NOTE: Trans. of an unidentified Chinese language article, 11p.

ABSTRACT: (U) Microwave weapons, which depend on electric power and are based on electromagnetic pulse technology, will replace weapon systems that depend on chemical energy. It is estimated that by the twenty-first century, the many directed-energy weapons that will appear, including microwave weapons, will have a profound effect on warfare. Thus, microwave weapon technology should be given sufficient emphasis. This article describes the importance of microwave weapon development, gives a general description of microwave weapons and development trends, and gives some conclusions and suggestions concerning microwave weapons. This article particularly emphasizes the unique role of microwave weapons in countering stealth technology.

DESCRIPTORS: (U) *WEAPON SYSTEMS, *MICROWAVE EQUIPMENT, *DIRECTED ENERGY WEAPONS, *RADIATION WEAPONS, WEAPONS, WARFARE, ELECTROOPTICS, ENERGY, MICROWAVES, CHEMICAL REACTIONS, PATTERNS, ELECTRIC POWER, ELECTROMAGNETIC PULSES.

AD-A304 170

BATTELLE MEMORIAL INST COLUMBUS OH

(U) Identification of Emerging Research Trends and Issues in Maritime Human Factors.

JUN 95 47P
PERSONAL AUTHORS: Jackson, James L.; Tijerina, Louis
CONTRACT NO. DAAL03-91-C-0034

UNCLASSIFIED REPORT

ABSTRACT: (U) The Naval Biodynamics Laboratory (NBDL) has a rich history as the principal U. S. Navy enterprise for conducting biomedical research on the effects of mechanical forces, both motion and impact, encountered aboard ships or aircraft on naval personnel. This biomedical research has included investigations of biomechanical, physiological, perceptual, and cognitive dimentions of naval personnel. The University of New Orleans (UNO), located near NBDL and a long-time research partner, has recently established an Advanced Marine Technology Center (AMTC) to perform research, development testing, and evaluation projects in support of U.S. Navy and commercial maritime interests. Both UNO and NBDL have the objective of collaborating on research projects of mutual interest. To facilitate this collaboration, Battelle has been contracted to identify research capabilities, current research and development (R&D) programs, and anticipated research needs for commercial and defense interests that might be supported by the to-be-developed NBDL/AMTC.

DESCRIPTORS: (U) *MOTION, *HUMAN FACTORS ENGINEERING, *FORCE (MECHANICS), SHIPS, COMMERCE, AIRCRAFT, DEFENSE SYSTEMS, NAVAL PERSONNEL, SHIP MOTION, LONG RANGE (TIME), SHIP PERSONNEL, PATTERNS, NAVAL RESEARCH LABORATORIES, MEDICAL RESEARCH, BIOMEDICINE, BIODYNAMICS.

AD-A303 059

RCI LTD MINNEAPOLIS IN

(U) Parallel Software Engineering Technology Forecast, Blue Ribbon Panel Conclusions. Volume 1.

OCT 95 24P
PERSONAL AUTHORS: Murphy, Carl
CONTRACT NO: F306002-94-C-0108

UNCLASSIFIED REPORT

ABSTRACT:(U) Rome Laboratory developed a 'Parallel Software Technology Forecast' to identify the parallel software engineering technology that will be required to meet Air Force needs for mission-critical software in a High Performance Computing environment for the next decade. It concentrated on the quality and cost issues of software development for Command, Control, and Communications (C3I) applications and addressed the following, goals: (1) anticipate technology directions of the parallel computer industry and forecast parallel software technology capabilities; (2) identify key C3I factors in the Air Force and show what the implications of HPC might be on the Air Force's ability to develop productive and efficient C3I applications software; and (3) compare and contrast Air Force needs for parallel software technology to that in the commercial sector. Rome Laboratory assembled a distinguished Blue Ribbon Panel consisting of seven technical experts, and solicited position papers from a broader range of position makers from academia, government, and industry.

DESCRIPTORS: (U) *SOFTWARE ENGINEERING, *PARALLEL PROCESSING, COMPUTER PROGRAMS, AIR FORCE, CONTRAST, MILITARY REQUIREMENTS, INDUSTRIES, COMMERCE, ENVIRONMENTS, PANELS, ORIENTATION (DIRECTION), PARALLEL PROCESSORS, COSTS, QUALITY, MISSIONS, TECHNOLOGY FORECASTING.

✦AD-A303 728

SCIENTIFIC ADVISORY BOARD (AIR FORCE) WASHINGTON DC

(U) New World Vistas: Air and Space Power for the 21st Century.

UNCLASSIFIED REPORT

ABSTRACT: (U) New World Vistas is a study about the Air Force. New World Vistas is documented in detail in over 2000 pages of monographs collected in 15 volumes. The study participants are listed, and abstracts of their work are contained in Appendix B.

DESCRIPTORS: (U) *AIR FORCE RESEARCH, *AIR POWER, COMPUTER PROGRAMS, DATA BASES, MOBILITY, GLOBAL, SPACE TECHNOLOGY, EDUCATION, ABSTRACTS, AIR FORCE TRAINING, WEAPON SYSTEM EFFECTIVENESS, MILITARY CAPABILITIES, LETHALITY, MAN MACHINE SYSTEMS, DIGITAL COMMUNICATIONS, FLIGHT SIMULATION, MILITARY SATELLITES, AWARENESS.

IDENTIFIERS: (U) *SPACE POWER.

✦ Included in *The DTIC Review*, July 1996

AD-A303 054

RCI LTD MINNEAPOLIS MN

(U) Parallel Software Engineering Technology Forecast, Assessment, Trends, Vision, and Strategy. Volume 2.

OCT 95 130P
PERSONAL AUTHORS: Murphy, Carl
CONTRACT NO. F30602-94-C-0108
PROJECT NO. 5581

UNCLASSIFIED REPORT

ABSTRACT: (U) Rome Laboratory developed a "Parallel Software Technology Forecast" to identify the parallel software engineering technology that will be required to meet Air Force needs for mission-critical software in a High Performance Computing environment for the next decade. It concentrated on the quality and cost issues of software development for Command, Control, and Communications (C3I) applications and addressed the following goals: (1) anticipate technology directions of the parallel computer industry and forecast parallel software technology capabilities; (2) identify key C3I factors in the Air Force and show what the implications of HPC might be on the Air Force's ability to develop productive and efficient C3I applications software; and (3) compare and contrast Air Force needs for parallel software technology to that in the commercial sector. Rome Laboratory assembled a distinguished Blue Ribbon Panel consisting of seven technical experts, and solicited position papers from a broader range of position makers from academia, government, and industry.

DESCRIPTORS: (U) *SOFTWARE ENGINEERING *PARALLEL PROCESSING, COMPUTER PROGRAMS, AIR FORCE, CONTRAST, MILITARY REQUIREMENTS INDUSTRIES, COMMERCE, ENVIRONMENTS, PANELS, ORIENTATION (DIRECTION), PARALLEL PROCESSORS, COSTS, QUALITY, MISSIONS.

AD-A302 589

ARMY ENGINEER INST FOR WATER RESOURCES FORT BELVOIR VA

(U) Infrastructure in the 21st Century Economy. Volume 2. Three Conceptual Papers Exploring the Link Between Public Capital and Productivity.

PERSONAL AUTHORS: Hulten, Charles R.; Aschauer, David; Nadiri, M. I.
REPORT NO. IWR-94-FIS-8-VOL-2

UNCLASSIFIED REPORT

ABSTRACT: (U) This interim report is a follow-up to a July 1993 publication entitled "Infrastructure in the 21st Century Economy: A Review of the Issues and Outline of A Study of the Impacts of Federal Infrastructure Investments" (Report 93-FIS-4). That first report described the beginning of the effort in which the Corps presented a "strawman" scope of work to three different panels composed of professional economists and other staff from other Federal agencies, Congress and academia, and solicited participation in devising a concrete research plan. This report describes developments since that initial workplan was articulated and is printed in three volumes. This volume (Volume 2) contains the three technical papers which developed and documented the the research approaches which form this study. The three papers discuss respectively: a Computable General Equilibrium (CGE) approach; an econometric cost function/ productivity approach; and an endogenous dynamic growth approach.

DESCRIPTORS: (U) *FINANCIAL MANAGEMENT, *PRODUCTIVITY, *RESEARCH MANAGEMENT, *PUBLIC ADMINISTRATION, CONGRESS IMPACT, ECONOMICS, COST ANALYSIS, GROWTH (GENERAL), EQUILIBRIUM (GENERAL), PLANNING, MACROECONOMICS, PROFITS.

AD-A301 857

ARMY WAR COLL STRATEGIC STUDIES INST CARLISLE BARRACKS PA

(U) Strategic Art: The New Discipline for 21st Century Leaders.

OCT 95 34P
PERSONAL AUTHORS: Chilcoat, Richard A.
REPORT NO. ACN-95033

UNCLASSIFIED REPORT

DESCRIPTORS: (U) *LEADERSHIP, *STRATEGIC ANALYSIS, NATIONAL SECURITY, SECURITY, YIELD, RELEASE, POWER, VALUE, PROMOTION (ADVANCEMENT).

AD-A301 166

ARMY COMMAND AND GENERAL STAFF COLL FORT LEAVENWORTH KS SCHOOL OF ADVANCED MILITARY STUDIES.

(U) Rethinking the Bottom-Up Review: Flawed Assumptions of Future Warfighting?

MAY 95 60P
PERSONAL AUTHORS: Mayes, Robert L.

UNCLASSIFIED REPORT

ABSTRACT: (U) The change in the strategic environment and the emerging priorities within the American society are causing major shifts in the size, structure, and focus of the U.S. Armed Forces for the 21st Century. The results have been a change in our force projection strategy that is based on a study called the Bottom-Up Review. This study, attempts to realign the focus of the U.S. Armed Forces, and do so within the ever increasing budget constraints. Although drastically needed, the Bottom-Up Review recommends shifts in our force projection strategy that appear to be based on faulty assumptions and incomplete analysis of the impacts on future warfighting abilities. This monograph analyzes the background and significance of force projection and its relationship to the emerging strategy as outlined in the Bottom-Up Review. It reviews history and analyzes some of the key assumptions on which the Bottom-Up Review is based, linking the historical issues with possible flaws in the Bottom-Up Review assumptions. This monograph concludes there is much work to be done on the underpinnings of changing a force projection strategy. This includes further study of the assumptions on which the Bottom-Up review is based, a clear definition of what our force projection capabilities should be in 2001 and beyond, and recommendations that will reduce near-term issues with our force projection strategy. Should the Department of Defense continue to use the Bottom-Up Review and its flawed assumptions as a base for our future force projection strategy, it may be the nation's future is currently being mortgaged rather than being protected. This study further concludes that the Bottom-Up Review is not a sufficient study from which to base a new force projection strategy.

DESCRIPTORS: (U) *STRATEGIC ANALYSIS, *MILITARY PLANNING MILITARY HISTORY, DEPARTMENT OF DEFENSE, MILITARY.

IDENTIFIERS: (U) WARFIGHTING.

✦AD-A300 728

AD-ARMY COMMAND AMD GENERAL STAFF COLL FORT LEAVENWORTH KS

(U) Full-Dimension Operations Planning Constructs: Thinking 'Out of the Box' for the 21st Century.

MAY 95 52P
PERSONAL AUTHORS: Heinemann, Timothy S.

UNCLASSIFIED REPORT

ABSTRACT: (U) The Revolution of Military Affairs (RMA), occasioned by technological advances and the shift-drift-rift of paradigms born of multipolar world realities, is rich with vision, but hobbled by lingering Cold War mentalities. Nowhere is this more apparent today than in the way the U.S. Army approaches situation analysis and operations planning. Certain time-honored constructs, long ingrained in the Army's psyche from foot soldier to war-fighting four star, continue to survive as "inviolates"-- somehow eternal despite compelling evidence to the contrary. Three such "inviolates" are firmly entrenched as the critical 'first steps' to successful operations. First is the inclination to perceive battlespace largely in terms of PHYSICAL AREA. Second is the instinctive tendency to analyze situations according to METT-T. Last is the nearly unqualified adoption of the seven BATTLEFIELD OPERATING SYSTEMS (BOS) as a universal planning and analysis construct.

DESCRIPTORS: (U) *MILITARY OPERATIONS, *LOGISTICS SUPPORT, *MILITARY STRATEGY, *MILITARY PLANNING, MILITARY INTELLIGENCE, AIR DEFENSE, MOBILITY, MILITARY PERSONNEL, DECISION MAKING, LEADERSHIP, SURVIVABILITY, MILITARY DOCTRINE, BATTLEFIELDS, TERRAIN, COMMAND AND CONTROL SYSTEMS, COLD WAR, INFANTRY PERSONNEL, ARMY.

AD-A299 300

ARMY COMMAND AND GENERAL STAFF COLL FORT LEAVENWORTH KS

(U) Special Forces Missions: A Return to the Roots for a Vision of the Future.

JUN 95 145p

PERSONAL AUTHORS: Maxwell, David S.

UNCLASSIFIED REPORT

ABSTRACT: (U) This study traces the development of Special Forces (SF) missions from the OSS in 1944 to the present to determine how the doctrinal missions evolved. Five specific operations/events are examined; including the Jedburghs and Operational Groups in France, Unconventional Warfare during the Korean War, Operation White Star in Laos, Special Forces conduct of the CIDG program and its participation in MACV-SOG during the Vietnam War, and SF operations in the Dominican Republic. The possible characteristics of conflict in the Post Cold War World are established. These characteristics are compared with the five specific operations examined to determine the likenesses and differences among them, as well as lessons learned that will have application for future Special Forces training. The study concludes that because the Post Cold War World will be characterized by chaos and uncertainty, SF requires the broadest training possible. It should focus on two missions and all others should become collateral activities. The wartime mission should be Unconventional Warfare and the peacetime mission should be Unconventional Operations. Training for these missions provides flexible, language capable, culturally aware, highly skilled, and disciplined soldiers that will meet the requirements across the spectrum of conflict.

DESCRIPTORS: (U) *SPECIAL FORCES, *DEFENSE PLANNING, MILITARY FORCES (UNITED STATES), GLOBAL, LESSONS LEARNED, PEACETIME, ARMY PERSONNEL, MILITARY DOCTRINE, THESES, MISSIONS, FRANCE, COLD WAR, CONFLICT, MILITARY TRAINING, KOREA, UNCONVENTIONAL WARFARE, POSTWAR OPERATIONS, VIETNAM, EVOLUTION (DEVELOPMENT), DOMINICAN REPUBLIC, LAOS.

IDENTIFIERS: (U) WHITE STAR OPERATION, CIDG (CIVILIAN IRREGULAR DEFENSE GROUP), OOTW (OPERATIONS OTHER THAN WAR).

✦ Included in *The DTIC Review*, July 1996

AD-A298 784

NAVAL POSTGRADUATE SCHOOL MONTEREY CA

(U) NATO's 21st Century Mission - Expansion to the East to Include Poland: Incentives and Obstacles.

DEC 94 226P
PERSONAL AUTHORS: Kershaw, Justin F.

UNCLASSIFIED REPORT

ABSTRACT: (U) The central issue defining the European security debate concerns the future of Central and Eastern European countries currently outside of any durable military or political security arrangement. Since 1989, the North Atlantic Treaty Organization has begun to reexamine its historic role within the context of maintaining the Alliance's historic role. Based upon the 1949 Washington Treaty and the 1967 Harmel Report, members have agreed to "safeguard the freedom, common heritage and civilization...founded on the principles of democracy, individual liberty and the rule of law." NATO has accomplished this goal by adhering to the dual approaches of attempting to settle disputes by political means while maintaining a strong military deterrent. The Atlantic Alliance's raison d'etre into the twenty-first century will hinge upon its ability to take on new missions and new members. There now exists a necessity to "export" NATO's core principles eastward in an attempt to secure the progress of democratic and market reforms. Moreover, security guarantees must be offered to Central and Eastern European states (the Visegrad Four and particularly Poland) because there still exists tangible Eastern risks.

DESCRIPTORS (U) *NATO, *EXPANSION, *WESTERN SECURITY (INTERNATIONAL), *POLAND, POLITICAL SCIENCE, MARKETING, THESES, MISSIONS, HISTORY, MILITARY APPLICATIONS, EASTERN EUROPE, DETERRENCE, DEMOCRACY.

AD-A298 602

ARMY WAR COLL STRATEGIC STUDIES INST CARLISLE BARRACKS PA

(U) The Principles of War in the 21st Century. Strategic Considerations.

PERSONAL AUTHORS: Johnson, William T.; Johnson II, Douglas V.; Kievit, James 0.; Lovelace, Couglas C., Jr.; Metz, Steven K.

UNCLASSIFIED REPORT

ABSTRACT: (U) The authors examine the concepts, philosophy and theory of strategy, as well as the nature of land warfare. They analyze how the principles of war may apply at the strategic level of warfare under the conditions of the 21st century. The authors conclude that there is considerable utility in maintaining a set of principles to act as a guide--but not a prescription--for the creative process of strategy formulation and execution. Then they offer a revision of the existing principale of war to conform to the strategic level of warfare and to bring them in line with the anticipated conditions of the so-called "Information Age".

DESCRIPTORS: (U) *STRATEGIC WARFARE, LAND WARFARE, MILITARY STRATEGY, THEATER LEVEL OPERATIONS, POLICIES, NATIONAL SECURITY, LESSONS LEARNED, DECISION MAKING, LEADERSHIP, STRATEGIC ANALYSIS, MOBILIZATION, COMMAND AND CONTROL SYSTEMS, JOINT MILITARY ACTIVITIES, TACTICAL ANALYSIS, MILITARY PLANNING.

IDENTIFIERS: (U) *OPERATIONAL ART, MILITARY ART.

AD-A298 538

NAVAL COMMAND CONTROL AND OCEAN SURVEILLANCE CENTER RDT&E DIV SAN DIEGO CA

(U) Command and Control Warfare Multi-Level Security: Infosec for the C4I Warrior.

AUG 95 8P
PERSONAL AUTHORS: Deichman, S. D.; Mattoon, T.

UNCLASSIFIED REPORT

Availability: Pub. in Proceedings, Information Security Concepts and Technologies, Session 2 p64-68, May 94. Available only to DTIC users. No copies furnished by NTIS.

ABSTRACT: (U) This paper discusses security engineerlng for structured military systems. INFOSEC for the C4I Warrior is a broad framework that integrates trust into the structure and function of naval operations. The design uses applied INFOSEC engineering from a system engineering perspective to describe how users should be served and how system components should operate to support the user's need for both service and assured operation. This framework is readily extensible to joint and combined interpretability. The special issues associated with the mobile user are central considerations to assure that their operational and communications needs are met. Present and near-term technologies and methods (2-4 years out) are assessed and projected to provide the technology base with which longterm security for military systems can be achieved. Three key technologies are identified that will provide the cornerstones of support to achieve this view of the future, these technologies are: (1) Multi-Level Secure (MLS) operating systems software with trusted window displays. (2) MLS database resources. (3) Encryption peripheral support for the trusted workstations.

DESCRIPTORS: (U) *COMMAND CONTROL COMMUNICATIONS, *DATA PROCESSING SECURITY, COMPUTER PROGRAMS, SYMPOSIA, SYSTEMS ENGINEERING, LONG RANGE (TIME), DISPLAY SYSTEMS, ENGINEERING, MOBILE, COMMAND AND CONTROL SYSTEMS, WINDOWS USER NEEDS, WORK STATIONS, NAVAL OPERATIONS, COMMUNICATION AND RADIO SYSTEMS.

IDENTIFIERS: (U) C4I (COMMAND CONTROL COMMUNICATIONS COMPUTERS AND INTELLIGENCE), SECURITY ENGINEERING.

AD-A298 321

NAVAL WAR COLL NEWPORT RI

(U) The Revolution in Miltary Affairs and Operational Maneuver from the Sea.

JUN 95 24P
PERSONAL AUTHORS: Huston, James V.

UNCLASSIFIED REPORT

ABSTRACT: (U) RMAs consist of technological advances, operational innovation, and organizational adaptation which combine to transition to a new form of warfare. OMFTS is a new concept which applies the principles of maneuver warfare to maritime power protection. This paper asks whether OMFTS is an appropriate concept for exploiting new technology, what changes need to be made, organizational implications, and recommendations for implementation. With a few changes, ONFTS can leverage the new technology associated with RMA for Naval operations. Combined with CWC and Battlespace Dominance, OMFTS can provide a compelling vision for employment of Naval Forces.

DESCRIPTORS: (U) *NAVAL OPERATIONS, *MANEUVERS, MILITARY FORCES (UNITED STATES), THESES, COMMAND AND CONTROL SYSTEMS, JOINT MILITARY ACTIVITIES.

IDENTIFIERS: (U) RMA (REVOLUTION IN MILITARY AFFAIRS) OMFTS (OPERATIONAL MANEUVER FROM THE SEA).

AD-A297 835

NAVAL WAR COLL NEWPORT RI JOINT MILITARY OPERATIONS DEPT

(U) Operational Fires: Past, Present and Future.

MAY 95 25P

PERSONAL AUTHORS: Kelly, Thomas R.

UNCLASSIFIED REPORT

ABSTRACT: (U) This paper provides an analysis of operational fires and certain key elements that are required for the effective employment of operational fires. The paper focuses on the purposes of operational fires, and how they are employed on the battlefield. First, the paper provides background information on the evolution of operational art during World War II. It discusses how Vietnam experiences and the Goldwater-Nichols Act influenced senior military leaders operational thinking prior to the Persian Gulf War. Second, it identifies how operational fires were employed during the Battle of Okinawa, Operation Iceberg. Third, the paper evaluates how battlefield dynamics, technology, political objectives, and constraints influenced the employment of operational fires during the Persian Gulf War, Operation Desert Storm. Fourth, the paper focuses on the future battlefield, and how operational fires may contribute in shaping future battlespace. The paper illustrates how battlefield dynamics, technology, availability of assets and constraints placed on military operations affected the exployment of operation fires. The paper highlights the importance of incorporating operational fires into the operational design in order to synchronize them with operational maneuver, deception, and intelligence. The paper predicts that the commander's ability to shape the future battlespace with operational fires will be limited only by the commander's ability to think operationally.

DESCRIPTORS: (U) *MILITARY DOCTRINE, *BATTLEFIELDS, MILITARY OPERATIONS, MILITARY HISTORY, MILITARY PERSONNEL, WARFARE, GLOBAL, IRAQ, LEADERSHIP, PERSIAN GULF, DYNAMICS, MANEUVERS, MILITARY COMMANDERS, BATTLES, DECEPTION, VIETNAM, EVOLUTION (DEVELOPMENT), OKINAWA.

IDENTIFIERS: (U) *OPERATIONAL FIRES, OPERATIONAL ART, ICEBERG OPERATION, DESERT STORM OPERATION, WORLD WAR 2.

AD-A297 810

ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MS GEOTECHNICAL LAB

(U) Stochastic Vehicle Mobility Forecasts Using the NATO Reference Mobility Model. Report 3. Database Development for Statistical Analysis of the NRMM II Cross-Country Traction Empirical Relationships.

JUN 95 218P
PERSONAL AUTHORS: Priddy, Jody D.
REPORT NO. WES/TR/GL-95-8

UNCLASSIFIED REPORT

ABSTRACT: (U) This report is the third in a series that documents the progression of a research effort aimed at developing stochastic vehicle mobility forecasting capabilities using the NATO Reference Mobility Model Edition II (NRMM II) . The first report introduced the basic concepts and procedures. The second report described extensions of the procedures and demonstrated the application of these procedures to two historical mobility assessments that were influential in the procurement of some current U.S. Arm vehicles. The procedures described in these first two reports characterized the variability of the NRMM II empirical relationships using small-scale data sets and/or judgement. The intent was only to demonstrate the viability of the stochastic forecasting concepts. The effort reported in this third report was conducted to facilitate a more accurate characterization of the variability in the cross-country traction empirical relationships. The approach was to: (1) thoroughly examine the empirical relationships in terms of fundamental origins and implemented use, and (2) economically develop a database that will accurately characterize the variability of each relationship. As a result, databases were developed for 65 of the 70 NRMM II empirical relationships for vehicle traction on soil covered terrain, and these databases will facilitate at least a conjectural evaluation of the variability in all 70. When variability characterizations based on these new databases are implemented into the stochastic forecasting procedures, more accurate risk assessments will result. Another result of this research was the observation that some of the NRMM II traction relationships are in need of attention for model improvements.

DESCRIPTORS: (U) *DATA BASES, *SYSTEMS ENGINEERING *STOCHASTIC PROCESSES, * MILITARY VEHICLES, *TRACTION *DECISION AIDS, *TERRAIN MODELS, TEST AND EVALUATION NATO, MOBILITY, RISK, BATTLEFIELDS, FORECASTING, ACCURACY, HISTORY, PROCUREMENT, TACTICAL ANALYSIS, STATISTICAL ANALYSIS, ADAPTERS, JUDGEMENT (PSYCHOLOGY), OFFROAD TRAFFIC.

IDENTIFIERS: (U) NRMM 2 (NATO REFERENCE MOBILITY MODEL 2).

AD-A297 080

RAND CORP SANTA MONICA CA

(U) China's Air Force Enters the 21st Century.

95 266P

PERSONAL AUTHORS: Allen, Kenneth W.; Krumel, Glenn; Pollack, Jonathan D.

CONTRACT NO. F49620-91-C-0003

UNCLASSIFIED REPORT

ABSTRACT: (U) In light of the Gulf War, in which airpower played a more dominant, effective, and visible role than in past military conflicts, many nations in the world seem likely to increase their emphasis on airpower. To better understand the potential implications of such a shift in military strategy, Project AIR FORCE at RAND has launched a multiyear effort that addresses the emergent role of airpower. The analysis is divided into two main efforts. The first portion explores the probable future position of the United States in the global balance of airpower. The second portion of the research analyzes the air forces of various major powers to see how these nations and their air force leaderships think about the past, current, and future role of airpower in support of their national security objectives. This report, written in support of the second element of this research effort, provides an overview and assessment of China's large and diverse air army the People's Liberation Army Air Force (PLAAF). Analysis of the PLAAF has traditionally focused on air order of battle enumerations and projections about equipment procurement. Until the past few years there were very few available primary source materials about the PLAAF. Virtually nothing was written in China to give the air force or other Chinese military institutions-a detailed identity. As a result, only two books have been published in the West devoted to the PLAAF (Bueschel, 1968; Allen, 1991). This study, which draws extensively upon newly disseminated Chinese language sources, should help to fill this gap in our knowledge.

DESCRIPTORS: (U) *AIR FORCE, *MILITARY FORCES (FOREIGN), *MILITARY PLANNING, *CHINA, WARFARE, GLOBAL, UNITED STATES, MILITARY AIRCRAFT, PROCUREMENT, SURFACE TO AIR MISSILES, AIR POWER.

IDENTIFIERS: (U) PLAAF (PEOPLE'S LIBERATION ARMY AIR FORCE), ANTIAIRCRAFT ARTILLERY.

AD-A297 008

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE (ACQUISITION AND LOGISTICS) WASHINGTON DC

(U) World-Wide Conventional Arms Trade (1994-2000): A Forecast and Analysis.

DEC 94 75P

PERSONAL AUTHORS: Flamm, Kenneth

UNCLASSIFIED REPORT

ABSTRACT: (U) The end of the Cold War has had a major impact on global trade in conventional armaments, just as it has on most facets of national security and defense. The nature of global demand for arms has shifted from the context of rivalry between superpowers and their associated client states to providing for national defense within the context of regional security needs. While these changes have led to a decline in total global demand for arms, countries continue to seek to acquire substantial amounts of increasingly sophisticated weapons. Ironically, in many respects, the post Cold War world is more unstable than the Cold War era, and is characterized by increased violence, by increased proliferation of military technology, and by the potential for these trends to continue. In this context, while the nature of the political-military issues that the U.S. and friendly nations now confront has changed, arms exports will continue to be a means of advancing U.S. national security and foreign policy objectives. In addition to these political-military changes, the post Cold War era has witnessed significant economic changes for the U.S. defense industry, as DoD purchases have sharply declined. Many U.S. defense companies have found that arms exports are an increasingly important component of their total sales and overall financial health. Therefore, some have suggested that arms transfer policy decisions should also take into account the possible impacts of export sales on the ability of industry to support national defense requirements. This has led to various proposals to increase the level and kinds of support that the U.S. government provides to U.S. companies when competing for approved international arms sales.

DESCRIPTORS: (U) *WEAPONS, *FORECASTING, *CONVENTIONAL WARFARE, *INTERNATIONAL TRADE, *NATIONAL DEFENSE, FOREIGN POLICY, GLOBAL, INDUSTRIES, POLICIES, POLITICAL SCIENCE, NATIONAL SECURITY, COMMERCE, MARKETING, DECISION MAKING, EXPORTS, IMPACT, ECONOMICS, HEALTH, COLD WAR, INTERNATIONAL, DEFENSE INDUSTRY, MILITARY ORGANIZATIONS, FINANCE.

IDENTIFIERS: (U) *CONVENTIONAL WEAPONS.

AD-A296 631

ADVISORY GROUP FOR AEROSPACE RESEARCH AND DEVELOPMENT NEUILLY-SUR-SEINE (FRANCE)

(U) Dual Usage in Military and Commercial Technology in Guidance and Control (Technologies duales militaires et civiles de guidage/pilotage).

MAR 95 182P
REPORT NO. AGARD-CP-556

UNCLASSIFIED REPORT

SUPPLEMENTARY NOTE: Preface in English and French.

ABSTRACT: (U) In the past decade, the development of components, techniques, and tools in the commercial world has had a significant impact upon the aerospace community. Such things as the personal computer, highly sophisticated operating environments, commercial computer chip developments, optical disks and fiber optics are examples. Alternatively, in cases where developmental costs are high for a limited production base, or in which commercial spin-offs are not imediately evident, the military has developed technologies which have had, or will have, a significant impact on the commercial sector. Examples are GPS, Fly-by-wire flight control systems, integrated avionics, and automatic landing systems. Major reductions in military procurements within NATO countries has led to concern over the long-term viability of the military industrial base. Dual-use technologies provide new markets for the military industrial base. Future military options are retained by the commercial market development of products which address important military needs. Commercial volumes are often higher for these products resulting in enhanced affordability for the military. Guidance and control is a natural dual-use technology because of the rich applications to commercial as well as military aircraft in areas such as navigation, control systems, flight management, automated vehicle operations and space C, N, and C. This Symposium will focus on commercial and military system producers throughout NATO countries who can create cooperative international products and markets. In a new spirit of international cooperation, technologists from former Warsaw Pact countries have been invited to participate.

DESCRIPTORS: (U) *NAVIGATION, *GUIDANCE, AVIONICS, FIBER OPTICS, NATO VOLUME, MILITARY REQUIREMENTS, INTEGRATED SYSTEMS, SYMPOSIA, CONTROL SYSTEMS, INDUSTRIES, COMMERCE, MARKET RESEARCH, AUTOMATION, DETECTORS, MARKETING, MANAGEMENT, MILITARY AIRCRAFT, PROTECTION, FLIGHT CONTROL SYSTEMS, COMPUTERS, CHIPS (ELECTRONICS), LONG RANGE (TIME), COSTS, AEROSPACE SYSTEMS, FLIGHT, AIR TO SURFACE, GLOBAL POSITIONING SYSTEM, VIABILITY, MILITARY APPLICATIONS, PROCUREMENT, LANDING AIDS, INTERNATIONAL, WARSAW PACT COUNTRIES, VEHICLES, DISKS, MICROCOMPUTERS, OPTICAL STORAGE, DUAL MODE, AUTOMATIC PILOTS, MULTISENSORS, MULTIPURPOSE, COOPERATION, FLY BY WIRE CONTROL, GYROSCOPES.

AD-A296 701

NAVAL COMMAND CONTROL AND OCEAN SURVEILLANCE CENTER RDT AND E DIV SAN DIEGO CA

(U) New Tactical Applications of HF Technology Hold Promise for Future Warfighters.

APR 95 11P
PERSONAL AUTHORS: Olson, Irving C.; Wallace, Laird E.

UNCLASSIFIED REPORT

Availability: Pub. in AFCEA C41 Symposium Proceedings, 20 Apr 94. Available only to DTIC users. No copies furnished by NTIS.

ABSTRACT: (U) Application of available technology to the High Frequency (HF) communications system offers increased utility for this frequency spectrum to meet warfighting requirements. The use of HF communications to support Navy and Marine Corps operations has fallen into disfavor as more sophisticated satellite systems have become available. HF radio systems that presently support Navy and Marine Corps operations consist primarily of 1950/1960 vintage equipment fielded without an overall integrated architecture. The equipment is large, heavy, unreliable, and difficult to maintain. Also, the system is prone to electromagnetic interference (FMI) problems due to poor overall design, and low throughput due to slow data rate transmission capability. From the warfighting perspective, it is easily detectable, easily tracked and/or interfered with, easily jammed, manpower intensive to operate, and has limited throughput. Despite the equipment shortcomings, and the reluctance of some planners to rely on HF communications, HF remains a primary frequency spectrum for interforce tactical connectivity and NATO/Allied interoperability. Indeed, in a typical Battle Group/ Amphibious Ready Group's Communication Plan, approximately 30 to 40 percent of the specified circuits are either an HF primary circuit, an HF secondary circuit, or an HF orderwire. To meet warfighting requirements, HF systems must incorporate many of the technical state-of-the-art advances that have occurred in the field of communications in the past 20-30 years. A number of initiatives have been undertaken and significant improvements in HF system performance have been or will be demonstrated.

DESCRIPTORS: (U) *HIGH FREQUENCY, *SATELLITE COMMUNICATIONS, *TACTICAL COMMUNICATIONS, FREQUENCY, NATO, INTEGRATED SYSTEMS, STATE OF THE ART, INTEROPERABILITY, NAVY, SPECTRA, MANPOWER, ARTIFICIAL SATELLITES ELECTROMAGNETIC INTERFERENCE, THROUGHPUT, COMMUNICATION AND RADIO SYSTEMS, TACTICAL WARFARE, RADIOFREQUENCY, BATTLE GROUP LEVEL, ORGANIZATIONS, FIELD EQUIPMENT, MARINE CORPS OPERATIONS.

IDENTIFIERS: (U) *HIGH FREQUENCY COMMUNICATIONS, C4I (COMMAND CONTROL COMMUNICATIONS COMPUTERS AND INTELLIGENCE).

AD-A295 927

ARMY ENGINEER INST FOR WATER RESOURCES
FORT BELVOIR VA

(U) Infrastructure in the 21st Century Economy: Volume 3. Data on Federal Capital Stocks and Investment Flows.

FEB 94 140P
REPORT NO. IWR-94-FIS-9

UNCLASSIFIED REPORT

SUPPLEMENTARY NOTE: Federal Infrastructure Strategy Program.

ABSTRACT: (U) The Federal Infrastructure Strategy (FIS) Program is a collaborative interagency study facilitated by the U.S. Army Corps of Engineers Institute for Water Resources designed to develop and stimulate implementation of an effective policy for managing and maintaining the nation's public works. This report presents developments in one element of that study, namely an effort to delineate and understand the effects of Federal infrastructure investments on the structure and functioning of the U.S. economy and the overall quality of life. This interim report is a follow-up to a July 1993 publication entitled Infrastructure in the 21st Century Economy: A Review of the Issues and Outline of a Study of the Impacts of Federal Infrastructure Investments (IWR Report 93-FIS-4). That first report described the beginning of the effort in which the Corps presented a "strawman" scope of work to three different panels composed of professional economists and other staff from Federal agencies, Congress and academia, and solicited participation in devising a concrete research plan.

DESCRIPTORS: (U) *ECONOMIC ANALYSIS, *INVESTMENTS, *FEDERAL BUDGETS, DATA BASES, TRANSPORTATION, CONGRESS, CONCRETE, QUALITY, PLANNING, ARMY CORPS OF ENGINEERS, FLOW, RESEARCH MANAGEMENT, WASTE MANAGEMENT, WATER RESOURCES, COLLECTION, LIVING STANDARDS, APOGEE.

AD-A295 912

ARMY ENGINEER INST FOR WATER RESOURCES
FORT BELVOIR VA

(U) Infrastructure in the 21st Century Economy. Volume 1. The Dimensions of Public Works Effects on Growth and Industry.

FEB 94 84p
PERSONAL AUTHORS: Gordon, Cameron
REPORT NO. IWR-94-FIS-7

UNCLASSIFIED REPORT

ABSTRACT: (U) This interim report is a follow-up to a July 1993 publication entitled "Infrastructure in the 21st Century Economy: A Review of the Issues and Outline of a Study of the Impacts of Federal Infrastructure Investments" (IWR Report 93-FIS-4). That first report described the beginning of the effort in which the Corps presented a "strawman" scope of work to three different panels composed of professional economists and other staff from Federal Agencies, Congress and academia, and solicited participation in devising a concrete research plan. This report describes developments since that initial workplan was articulated and is printed in three volumes. This volume (Volume 1) contains an overview of the research effort as it is now being implemented, namely three related research tracks to capture the different dimensions of infrastructure's effects on the economy. These tracts are: a Computable General Equilibrium (CGE) approach; an econometric cost function/productivity approach; and an endogenous dynamic growth approach.

DESCRIPTORS: (U) *ECONOMIC ANALYSIS, *INDUSTRIES, *ECONOMIC IMPACT, CONGRESS, INVESTMENTS, IMPACT, DYNAMICS, GROWTH (GENERAL), CONCRETE, EQUILIBRIUM (GENERAL), PLANNING, RESEARCH MANAGEMENT.

✦AD-A295 373

ARMY WAR COLL CARLISLE BARRACKS PA

(U) Command and Control in the 21st Century: A Construct of the Future.

APR 95 34P
PERSONAL AUTHORS: Kubow, LeEllen

UNCLASSIFIED REPORT

ABSTRACT: (U) New technologies and changes in organizational hierarchies are being touted as the keys to the future. But we approach the future with short, incremental steps - using today's paradigms. In an attempt to move beyond this gradualism, this paper proposes a 30-year hypothetical leap into a future military environment to anticipate its command operations and structure. This "fast-forward" projection reveals major issues in decision-making and leadership. It allows us to analyze the effects of flattened organizations and to re-assess the role of the commander. Finally, assuming we transition to an organization similar to this 30-year model, it identifies possible near-term actions required to effect such long-term changes.

DESCRIPTORS: (U) *LONG RANGE (TIME), *COMMAND AND CONTROL SYSTEMS, *MILITARY PLANNING, ENVIRONMENTS, ORGANIZATIONS, DECISION MAKING, LEADERSHIP, DEGRADATION, MODELS, BATTLEFIELDS, OPERATIONAL EFFECTIVENESS, MILITARY APPLICATIONS, HIERARCHIES.

AD-A295 147

SANTA MONICA CA

(U) Long-Term Research Plan and FY 95 Research Agenda.

APR 95 41P

REPORT NO. RAND/AR-5934-OSD
CONTRACT NO. MDA903-90-C-0004

UNCLASSIFIED REPORT

ABSTRACT: (U) The research plan of the National Defense Research Institute is a means for RAND and DoD to agree and document how this particular FFRDC (Federally Funded Research and Development Center) is to be used in the future. In the plan, NDRI hopes to capture the long-term research priorities DoD wishes to emphasize, recognizing that these priorities could change as events unfold. The plan also addresses the most pressing concerns of DoD policymakers. Setting research directions will help NDRI invest in capabilities for the future, while also fostering the kind of continuity expected of an FFRDC. The document explicitly sets forth the FFRDC resources required to carry out the desired research, thus providing a baseline for stable annual funding and for staff planning. We solicit DoD's comments and concurrence on our long-term research strategy. The NDRI Long-Term Research Plan has two parts: The first describes a long-term research strategy that is based on interactions with our DoD sponsors, our own assessment of major national security issues and our ideas about how RAND's analytical capability can best serve our sponsors in the years to come. The second part describes the research agenda for FY 1995 as of March 1995. This research plan takes into account the adjustments that the Department of Defense has already made since the end of the Cold War. However, the plan does not assume that a steady state has been achieved or that current policies are immutable. Thus it identifies research to be done within the current framework as well as research not confined by today's policies, as should be expected of an FFRDC that has both independence and a long-range perspective.

DESCRIPTORS: (U) *INTERNATIONAL POLITICS, *RESEARCH MANAGEMENT, SETTING (ADJUSTING), STEADY STATE, DEPARTMENT OF DEFENSE, MILITARY STRATEGY, POLICIES, NATIONAL SECURITY, MILITARY DOCTRINE, INTERACTIONS, LONG RANGE (TIME), PLANNING, LONG RANGE (DISTANCE), COLD WAR, NATIONAL DEFENSE.

✦ Included in *The DTIC Review*, July 1996

AD-A295 053

ARMY WAR COLL CARLISLE BARRACKS PA

(U) U.S. Army Logistics in the 21st Century and the Challenge of Change.

MAY 95 47P
PERSONAL AUTHORS: Geehan, Brian I.

UNCLASSIFIED REPORT

ABSTRACT: (U) The ongoing doctrinal and conceptual debates over Force XXI, will profoundly impact not only on how the U.S. Army of the 21st Century will fight but also how it will be logistically supported and sustained. The purpose of this paper is to examine logistics lessons learned from Operation Desert Shield/Storm (ODS) in the context of emerging Force XXI logistical concepts and to provide recommendations concerning logistics doctrine organizations and materiel requirements for the U.S. Army of the 21st Century. When ODS logistics lessons learned concerning strategic sealift, deployment planning host nation support, coalition responsibility sharing, transportation vehicle shortages and support of high tempo mechanized operations are overlaid on the emerging Force XXI logistics assumptions, threats and required capabilities then the resulting recommendations are far more evolutionary than revolutionary.

DESCRIPTORS: (U) *ARMY PLANNING, *LOGISTICS PLANNING, MILITARY OPERATIONS, TRANSPORTATION, DEPLOYMENT, IRAQ MATERIEL, MILITARY REQUIREMENTS, MILITARY STRATEGY, LESSONS LEARNED, MILITARY DOCTRINE, MARINE TRANSPORTATION, SHORTAGES, MECHANIZATION.

IDENTEFIERS: (U) DESERT STORM OPERATION, DESERT SHIELD OPERATION.

AD-A294 740

NAVAL POSTGRADUATE SCHOOL MONTEREY CA

(U) Defense Policy of Japan Maritime Self-Defense Force (JMSDF) in the Early 21st Century.

PERSONAL AUTHORS: Mashiko, Mitsuhisa

UNCLASSIFIED REPORT

ABSTRACT: (U) This thesis analyzes the defense policy of the Japan Maritime Self-Defense Force (UMSDF) in the early 21st century. The primary research question is 'Should the defense force structure of the DMSDF in the early 21st century remain the same as it has been in the last 10 years?' To answer this question, I made a brief analysis of current and future prospects for Japan and her neighboring countries in terms of their politics, diplomacy, economy and military. These countries included China, North and South Korea, Russia and the U.S. Finally, I evaluated the cost of baseline and alternative force structure. The alternative force structure may require some revision of current legal limitations and increased defense expenditures. Japan, however, should undertake this correction not only for her own security needs, but also to make a more equitable contribution to ensure the Japan-U.S. security arrangement viable in the coming decade.

DESCRIPTORS: (U) *POLICIES, *JAPAN, *DEFENSE PLANNING, NORTH KOREA, USSR, POLITICAL SCIENCE, NATIONAL SECURITY, THESES, COSTS, BASE LINES, LIMITATIONS, MILITARY FORCE LEVELS, SOUTH KOREA, CHINA.

IDENTIFIERS: (U) *SELF DEFENSE, UMSDF (JAPAN MARITIME SELF DEFENSE FORCE), RUSSIA.

AD-A294 836

RAND CORP SANTA MONICA CA

(U) Strategic Futures. Evolving Missions for Traditional Strategic Delivery Vehicles.

95 121P

PERSONAL AUTHORS: Mesic, Richard; Molander, Roger; Wilson, Peter A.
REPORT NO. RAND-MR-375-DAG

UNCLASSIFIED REPORT

ABSTRACT: (U) This report addresses the post-Cold War role of traditional U.S. strategic nuclear forces (nuclear-armed long-range bombers, intercontinental ballistic missiles (ICBMs), and submarine-launched ballistic missiles (SLBMs) from three perspectives: (1) 'Top-down'/goal-driven: In the new and evolving strategic environment, what strategic missions may be needed to fulfill emerging national security objectives? (2) 'Bottom-up'/technology- and system-driven: What technological opportunities are afforded by existing and potential capabilities? (3) Policy issues: How will various policy choices affect research and development (R&D), acquisition, and counterproliferation strategy alternatives? The study's objective was to gain a long view of possible directions for future strategic forces and lay out the basis for supportable R&D and acquisition initiatives to be pursued by defense agencies and the Services.

DESCRIPTORS: (U) *NUCLEAR FORCES (MILITARY) *COMBAT SUPPORT, *STRATEGIC WARFARE, *MILITARY PROCUREMENT *DEFENSE PLANNING, GUIDED MISSILES, NATIONAL SECURITY, ACQUISITION, LONG RANGE (DISTANCE), MISSIONS, MILITARY RESEARCH, SURFACE TO SURFACE MISSILES, COMBAT FORCES, SUBMARINE LAUNCHED.

AD-A294 711

ARMY WAR COLL CARLISLE BARRACKS PA

(U) Lessons from the Past and a Vision of the Future: Tactical Headquarters Requirements in Force XXI.

PERSONAL AUTHORS: Terpeluk, William

UNCLASSIFIED REPORT

ABSTRACT: (U) With the advent of the full exploitation of Information Age technology in a contemporary battlefield environment, the need for change in the echelons of tactical command can be anticipated. As part of Division XXI, it can be envisioned that the current functions of the battalion can be absorbed by a Regimental Headquarters when the battalion as a tactical headquarters becomes redundant. In the Pentomic Infantry Division of the late 1950s, the infantry battalion headquarters were completely eliminated and companies were directly subordinate to the Battle Group. The pentomic concept did not succeed because of the limited capability of technology at the time but would succeed in the future with the advanced C4I technology. The idea of a Brigade (or Regiment) with direct control of subordinate companies is both viable and practical as an integral part of Force XXI. Battle Management of a brigade-sized Area of Operations would be within the capabilities of a single individual whereas a Division Commander would be unable to effectively control his organization without a brigade level headquarters.

DESCRIPTORS: (U) *MILITARY REQUIREMENTS, *COMMAND AND CONTROL SYSTEMS, * MILITARY COMMANDERS, *TACTICAL DATA SYSTEMS, MANAGEMENT, BATTALION LEVEL ORGANIZATIONS, INFANTRY, BATTLEFIELDS, BRIGADE LEVEL ORGANIZATIONS, DIVISION LEVEL ORGANIZATIONS, TACTICAL WARFARE, BATTLE GROUP LEVEL ORGANIZATIONS.

IDENTIFIERS: (U) BATTLE MANAGEMENT.

AD-A294 425

NORTHWESTERN UNIV EVANSTON IL DEPT OF ELECTRICAL ENGINEERING

FEB 95 9p

(U) Ultra-Violet Detectors for Astrophysics, Present and Future. Volume 2397.

PERSONAL AUTHORS: Razeghi, Manijeh; Park, Yoon-Soo; Witt, Gerald L.
CONTRACT NO. N00014-93-1-0235

UNCLASSIFIED REPORT

Availability: Optoelectronic Integrated Circuit Materials, Physics, and Devices, v2397 p210-217, 10 Feb 95. Available only to DTIC users. No copies furnished by NTIS.

ABSTRACT: (U) Astronomical instruments for the study of UV astronomy have been developed for NASA missions such as the Hubble Space Telescope (HST). The systems that are "blind to the visible" ("solar-blind") yet sensitive to the UV that have been flown in satellites have detective efficiencies of about 19 to 20%, although typically electron bombardment charge coupled devices are higher at 30-40% and ordinary CCDs achieve 1-5%. Therefore, there is a large payoff still to be gained by further improvements in the performance of solar blind UV detectors. We provide a brief review of some aspects of UV astronomy, UV detector development, and possible technologies for the future. We suggest that a particularly promising future technology is one based on the ability of investigators to produce high quality films made of wide bandgap III-V semiconductors.

DESCRIPTORS: (U) *ULTRAVIOLET RADIATION, *ASTRONOMY *TELESCOPES, *ASTRONOMICAL INSTRUMENTS, *ULTRAVIOLET DETECTORS, SPACE SYSTEMS, EFFICIENCY, ENERGY GAPS, SEMICONDUCTORS, BROADBAND, GROUP III COMPOUNDS, GROUP V COMPOUNDS, ASTROPHYSICS.

IDENTIFIERS: (U) *ULTRAVIOLET ASTRONOMY, HUBBLE TELESCOPE.

AD-A294 232

SOFTWARE TECHNOLOGY SUPPORT CENTER HILL AFB UT

(U) Software Engineering Environment Technology Report.

APR 94 140P
PERSONAL AUTHORS: Hanrahan, Robert; Daud, Charles; Meiser, Kenneth; Peterson, Judi

UNCLASSIFIED REPORT

ABSTRACT: (U) Software Engineering Environment (SEE) technology is one of several software product domains being investigated by the U. S. Air Force's Software Technology Support Center (STSC) at the Ogden Air Logistics Center, Hill Air Force Base, Utah. This report is produced by the STSC to increase awareness and understanding of SEE technology. The information in this report is aimed at Air Force managers and technical people who must make the decisions about acquiring SEE technology and who must prepare their organizations to employ it effectively; use of this report should be the first step in that process. This report examines the software challenges facing today's Air Force and the role of SEE technology in meeting these challenges. The concepts of SEE technology are introduced and explained. The report examines current SEE technology and provides information about specific products 1n the marketplace. Finally, the report addresses future directions in SEE technology as an aid in planning long-range strategies.

DESCRIPTORS (U) *SOFTWARE ENGINEERING, *AIR FORCE PLANNING, COMPUTER PROGRAMS, ENVIRONMENTS, MANAGEMENT PLANNING AND CONTROL, STRATEGY, PROBLEM SOLVING, LONG RANGE (DISTANCE), AWARENESS, UTAH.

IDENTIFIERS: (U) SEE (SOFTWARE ENGINEERING ENVIRONMENT).

AD-A293 456

ARMY COMMAND AND GENERAL STAFF COLL FORT LEAVENWORTH KS SCHOOL OF ADVANCED MILITARY STUDIES

(U) The Stronger Form of War: The Effects of Technical Change on the Balance Between Attack and Defense.

DEC 94 52P
PERSONNAL AUTHORS: King, David M.

UNCLASSIFIED REPORT

ABSTRACT: (U) Clausewitz's Model of war postulates that the attack has a positive aim but the defense is the stronger form of war. Armies past and present have generally accepted the superior strength of the defense, but the degree of superiority has varied with changes in technology. This study examines the sources of defensive strength in an attempt to develop tools for evaluating the effect of future technology on the balance of offense and defense. Defense has two key advantages over attack the defender has less need to move than the attacker and the defender controls the ground over which he must move. Most of the defender's advantages in firepower, protection and leadership derive from these two strengths. The attacker can attempt to overcome the advantages of the defense by employing new technology or methods. A new weapon or capability that helps both the attacker and the defender may help one more than the other. The First World War provides good examples of how technological change affects the balance between attack and defense. The Persian Gulf War demonstrated the effectiveness of modern military technology. The development of long-range precision weapons may not merely shift the balance between attack and defense, but may obscure the distinction between the two. The result is a dichotomy: The offense may be the stronger form of air and long-range missile war, while the defense is the stronger form of land war.

DESCRIPTORS: (U} *LAND WARFARE, *ARMY OPERATIONS, *TACTICAL WARFARE, GUIDED MISSILES, MILITARY HISTORY, COMBAT EFFECTIVENESS, GLOBAL, LESSONS LEARNED, LEADERSHIP, STRATEGIC ANALYSIS, TECHNOLOGY TRANSFER, PERSIAN GULF, MILITARY DOCTRINE, ATTACK, AERIAL WARFARE, LONG RANGE (DISTANCE), MANEUVERS, ARMY PLANNING, MILITARY TACTICS, FIREPOWER, BALANCE OF POWER.

AD-A293 870

INSTITUTE FOR DEFENSE ANALYSES ALEXANDRIA VA

(U) European Telecommunications: Pathways to the Future.

MAR 95 54P
PERSONAL AUTHORS: Ross, Brendan
REPORT NO. IDA-D-1582

UNCLASSIFIED REPORT

ABSTRACT: (U) Technological and infrastructural developments will make pan-European interconnectivity a reality in the coming decade. New fiber-optic, wireless, and satellite technology, as well as the burgeoning and much wanted information superhighway, will all contribute to the increasing sophistication and simplicity of voice, video, and data communication. Recent developments in Eastern Europe demonstrate the thesis that increased communication and increased stability spiral upwards together. Regulation is tied intimately to progress in telecommunications. Political wrangling and the directed actions of interested parties such as unions, regulators, legislators, and business executives have a tremendous effect on the implementation of new technology. Global technology standards will be determined largely by governments that act quickly to interconnect across large markets. Intellectual property rights regulation must provide a balance between establishing standards and providing incentives for continued innovation. Although market forces will largely determine future trends in telecommunications, effective regulation will be a prerequisite to interconnectivity, innovation, and growth.

DESCRIPTORS: (U) *EUROPE, *TELECOMMUNICATIONS, *REGULATIONS, FIBER OPTICS, GLOBAL, COMMERCE, MARKETING, DATA TRANSMISSION SYSTEMS, THESES, ARTIFICIAL SATELLITES, STANDARDS, EASTERN EUROPE.

IDENTIFIERS: (U) *INFRASTRUCTURE, WIRELESS COMMUNICATIONS, INFORMATION SUPERHIGHWAYS.

AD-A293 814

CENTER FOR NAVAL ANALYSES ALEXANDRIA VA

(U) Prospects for U.S.-Korean Naval Relations in the 21st Century.

PERSONAL AUTHORS: Wie, Sung H ; Kim, Chang S.; Wood, Perry; Carlson, David; Yung, Christopher

UNCLASSIFIED REPORT

SUPPLEMENTARY NOTE: Prepared in cooperation with Korea Insitute for Defense Analyses.

ABSTRACT: (U) In October 1994, the Korea Institute for Defense Analyses (KIDA) and the Center for Naval Analyses (CNA) cosponsored a workshop in Seoul, Republic of Korea (ROK), to examine the prospects for United States-Korean naval relations over the next ten to 15 years. Navy and Marine Corps specialists, Asia defense analysts, and scholars of Korea attended the meeting, as did government representatives from both countries. Although discussions were not for attribution, papers prepared for the conference are available from either KIDA or CNA. The purpose of the conference was a candid exchange of views on the potential significance and nature of naval cooperation between the two countries from the present to the early decades of the 21st century. Participants examined (1) the effect of three scenarios on regional perceptions of security (continued confrontation with North Korea peaceful coexistence between the two Koreas, and unification), and (2) South Korean and U.S. naval force structures, strategies, and types of cooperation. The participants also looked at possible measures for improving Navy and Marine Corps cooperation and at the role of multilateral security initiatives and organizations in promoting cooperation between the two navies.

DESCRIPTORS: (U) *NAVY, *INTERNATIONAL RELATIONS, NORTH KOREA, MILITARY STRATEGY, UNITED STATES, SYMPOSIA, NATIONAL SECURITY, ANTIMISSILE DEFENSE SYSTEMS, MILITARY DOCTRINE, ARMS CONTROL, NAVAL WARFARE, MILITARY FORCE LEVELS, COOPERATION, WORKSHOPS, ASIA, SOUTH KOREA, MARINE CORPS OPERATIONS.

IDENTIFIERS: (U) *FOREIGN RELATIONS, POST COLD WAR ERA.

AD-A293 706

NAVAL WAR COLL NEWPORT RI DEPT OF OPERATIONS

(U) Forward .... From Under the Sea Historical Perspective and Future Vision of Submarine Littoral Warfare.

JUN 95 21P
PERSONAL AUTHORS: DiOrio, David R.

UNCLASSIFIED REPORT

ABSTRACT (U) This paper addresses the role of submarine warfare in today's national strategy. Analysis of submarine coastal operations during the Pacific War, specifically during the final campaign to invade mainland Japan, provides insight into submarine littoral warfare today. Following the decline of the Soviet Union, U.S. forces have focused on the application of maneuver warfare against emerging regional threats. Undoubtedly, this means control of the littoral regions of the world, where Joint forces, including submarines, can influence events ashore. Included within the text is a historical perspective and future vision of submarine littoral warfare as it relates to operational maneuver from the sea.

DESCRIPTORS: (U) *MILITARY DOCTRINE, *UNDERSEA WARFARE, *JOINT MILITARY ACTIVITIES, *NAVAL WARFARE, *NAVAL PLANNING, MILITARY FORCES (UNITED STATES), USSR, MILITARY HISTORY, MILITARY STRATEGY, COASTAL REGIONS, LESSONS LEARNED, MILITARY FORCES (FOREIGN), THREATS, FORECASTING JAPAN, NAVAL OPERATIONS, MANEUVERS, PACIFIC OCEAN, SUBMARINES, LITTORAL ZONES, ANTISUBMARINE WARFARE.

IDENTIFIERS: (U) SUBMARINE WARFARE, LITTORAL WARFARE, POST COLD WAR ERA, WORLD WAR 2, NATIONAL SECURITY STRATEGY, FSU (FORMER SOVIET UNION), NEW WORLD ORDER, MANEUVER WARFARE, REGIONAL THREATS, REGIONAL SECURITY.

AD-A293 604

ARMY COMMAND AND GENERAL STAFF COLL FORT LEAVENWORTH KS SCHOOL OF ADVANCED MILITARY STUDIES

(U) Operational Battle Command: Lessons for the Future.

MAY 94 68P

PERSONAL AUTHORS: Morrison, Douglas J.

UNCLASSIFIED REPORT

ABSTRACT: (U) Future thinking, decisive decision-making, and leadership provide the foundation for the analysis of battle command in theory, doctrine and history. Classical and modern military theorists make the commander the central point for leadership and vision. The art of command, leadership, and generalship have long been subject to review and scrutiny. This has taken on additional emphasis with the publication of U.S. Army Field Manual (FM) 100-5, Operations, in 1993. FM 100-5 presented a discussion of command and leadership which is the subject of numerous articles in professional journals and presentations by senior Army leaders. This monograph provides a foundation for the discussion of battle command by first reviewing the theoretical underpinnings of command. Next follows a discussion of service, Army, and joint doctrine along with a discourse on U.S Army doctrine since World War II. The examination covers the concepts of command in both the 1941 and 1949 versions of FM 100-5, Field Service Regulations: Operations. Finally, current doctrine is considered so that lessons can be drawn from the actions of successful operational commanders and applied to today's military.

DESCRIPTORS: (U) *DECISION MAKING, *LEADERSHIP, *MILITARY COMMANDERS, MILITARY HISTORY, WARFARE, GLOBAL, LESSONS LEARNED, ARMY PERSONNEL, ARMY TRAINING, MILITARY DOCTRINE, VISION, BATTLES, REGULATIONS, MANUALS, FIELD ARMY.

AD-A293 499

ARMY COMMAND AND GENERAL STAFF COLL FORT LEAVENWORTH KS SCHOOL OF ADVANCED MILITARY STUDIES

(U) Innovation in the 21st Century: Reconciling Technological Expertise with Military Genius.

DEC 94 65P

PERSONAL AUTHORS: Guthrie, Samuel A.

UNCLASSIFIED REPORT

ABSTRACT: (U) As the United States Army prepares for the 21st Century, few things are as certain as the tremendous influence that emerging technologies will have on military capability. The purpose of this monograph is to establish how you reconcile technological expertise with military genius. To resolve this question, the monograph begins by examining definitions and theories for genius expertise, technology and innovation. This includes an investigation of the effects of technology on the battlefield, and a redefinition of tactical innovation. Next, the directed telescope innovations of Field Marshal Montgomery and General George S. Patton Jr. are analyzed. A comparative analysis examines the Army Battle Command System and the directed telescope. Finally, synthesis is achieved through formulation of a theoretical model that casts light on the innovative process of the battle commander in combat. The Battlefield 500 model parallels the battle commander in combat, exploiting opportunity through innovation.

DESCRIPTORS: (U) *MILITARY CAPABILITIES, *MILITARY COMMANDERS, *INTELLIGENCE (HUMANS), MILITARY OPERATIONS, MILITARY HISTORY, LEADERSHIP, TECHNOLOGY TRANSFER, BATTLEFIELDS, PROBLEM SOLVING, MILITARY APPLICATIONS, JUDGEMENT (PSYCHOLOGY), MILITARY TACTICS.

IDENTIFIERS: (U) MILITARY GENIUS, MILITARY TECHNOLOGY.

AD-A293 440

ARMY COMMAND AND GENERAL STAFF COLL FORT LEAVENWORTH KS SCHOOL OF ADVANCED MILITARY STUDIES

(U) The Evolution of the U.S. Army Infantry Squad: Where Do We Go From Here? Determining the Optimum Infantry Squad Organization for the Future.

DEC 94 54P
PERSONAL AUTHORS: Hughes, Stephen E.

UNCLASSIFIED REPORT

ABSTRACT: (U) An undeniable trend in modern warfare that has influenced how the infantry is organized and how it fights is the increasing dispersion of the battlefield. The primary source of this trend has been the evolution of technology which has resulted in increasingly decentralized operations. This led to the birth of the infantry squad as an independent maneuver element. This study traces the evolution of the infantry squad in the American Army from WW2 until the present. It analyzes the lessons from combat as well as numerous studies and tests that influenced how the Army changed the make-up of the squad and explain why the squad has its present organization. The study then turns from the past to examine the nature of future conflict and the role of the infantry in it. It examines the newest technologies and how they will likely be incorporated at the infantry squad level. Finally, the study examines the triangular infantry squad organization proposed by the United States Army Infantry School. The proposal is part of a plan to restructure the infantry force to take it into the next century. The study reveals that the proposed squad organization is not original but has been used successfully by the U.S. Marines as well as the armies of other nations in the recent past. The elements of combat power are used to compare the proposed organization with the present one. The study determines that the triangular squad is superior in all the criteria and should be tested in the field for validation.

DESCRIPTORS: (U) *INFANTRY, *SQUAD LEVEL ORGANIZATIONS, MILITARY HISTORY, COMBAT EFFECTIVENESS, LAND WARFARE, OPTIMIZATION, LESSONS LEARNED, DISPERSING, LEADERSHIP STRATEGIC ANALYSIS, VALIDATION, ARMY PERSONNEL, BATTLEFIELDS, TEAMS (PERSONNEL), MORALE, MANEUVERS, ARMY OPERATIONS, MILITARY TACTICS, ORGANIZATION THEORY, DECENTRALIZATION.

AD-A292 361

TRADOC ANALYSIS CENTER
FORT LEAVENWORTH KS

(U) Recommendations for the 21st Century Classroom Derived from Observations of the1994 Battle Command Elective and Advanced Warfighting Experiments.

SEP 94 8P
PERSONAL AUTHORS: Bomman, Louis G., Jr

UNCLASSIFIED REPORT

ABSTRACT: (U) This paper presents observations and recommendations for design of the 21st century classroom for the U.S. Army Command and General Staff College (CGSC). These observations and recommendations were derived from several advanced warfighting experiments (AWEs) conducted by the Battle Command Battle Laboratory (BCBL) at Fort Leavenworth, Kansas. The experiments were aimed at advancing the art of battle command, and were designed to complement two activities associated with the CGSC. These activities were the Battle Command Elective (BCE), a pilot course developed jointly by BCBL and CGSC, and the Prairie Warrior student exercise conducted by the college in May 1994. This paper was prepared by the Training and Doctrine Command (TRADOC) Analysis Center (TRAC) in support of BCBL.

DESCRIPTORS (U) *ARMY TRAINING, *COMPUTER AIDED INSTRUCTION, *BATTLES, SCHOOLS, COMMAND AND CONTROL SYSTEMS, LABORATORIES, ARMY OPERATIONS, KANSAS.

AD-A291 975

ADVISORY GROUP FOR AEROSPACE RESEARCH AND DEVELOPMENT NEUILLY-SUR-SEINE (FRANCE)

(U) Guidance and Control Techniques for Future Air-Defence Systems (Techniques de Guidage/Pilotage pour Les Systemes Futurs de Defence Anti-Aerienne).

JAN 95 203P
REPORT NO. AGARD-CP-555

UNCLASSIFIED REPORT

SUPPLEMENTARY NOTE: Presented at the Missions Systems Panel 1st Symposium, Copenhagen, Denmark 17-20 May 1994.

ABSTRACT: (U) This volume contains the Technical Evaluation Report and the 18 unclassified papers, presented at the Mission Systems Panel Symposium held in Copenhagen, Denmark from 17th to 20th May 1994. The papers presented covered the following headings: Ballistic Missile Defence Architecture and Air Defence Simulation; Advanced Sensors Technology and Techniques; Acquisition, Pointing, Fire Control and System Integration, Data Fusion, Tracking and Identification; Threat Detection, Suppression and Situation Assessment; Missile Guidance and Control; C3I Aspects.

DESCRIPTORS (U) *CONTROL SYSTEMS, TEST AND EVALUATION, AIR DEFENSE, GUIDED MISSILES, NATO, SIMULATION, INTEGRATED SYSTEMS, SYMPOSIA, DETECTION, DETECTORS, ACQUISITION, THREATS, TRACKING, DATA FUSION, FIRE CONTROL SYSTEMS, DENMARK, FIRE, *GUIDANCE.

IDENTIFIERS (U) NATO FURNISHED.

AD-A291 663

CALIFORNIA UNIV LOS ANGELES DEPT OF ELECTRICAL ENGINEERING

(U) New Trends and Ideas in the Fields of Microwave Technology.

SEP 94 5P

PERSONAL AUTHORS: Itoh, T.
CONTRACT NO. DAAH04-93-G-0068

UNCLASSIFIED REPORT

ABSTRACT: (U) This paper presents a subjective view toward new directions and some examples for changing microwave research. The paper is written primarily from the point of view of how the electromagnetic research must change and what kind of impact such a change can give rise to stimulation for the device and circuit research for microwave technology. it is emphasized that interdisciplinary treatment of electromagnetic research is vital for the future of microwave technology.

DESCRIPTORS: (U) *MICROWAVES, FABRICATION, ELECTROMAGNETIC WAVE PROPAGATION, ELECTROMAGNETIC RADIATION, ANTENNAS, PACKAGING, CIRCUITS, MICROWAVE. TRANSMISSION.

AD-A290 482

CIVIL ENGINEERING RESEARCH FOUNDATION WASHINGTON DC

(U) Geo Engineering: A Vision for the 21st Century.

SEP 94 54P
PERSONAL AUTHORS: Magnell, C. O.
REPORT NO. CERF-94-5020
CONTRACT NO. DAAH04-94-G-0071

UNCLASSIFIED REPORT

ABSTRACT: (U) This report, Geo-engineering: A Vision for the 21st Century, documents recent actions by acknowledged U.S. experts in the geo-engineering related disciplines of civil engineering to define the role of geo-engineering and geo-engineering in the 21st Century. Approximately 50 of the nation's industry, academic, and public sector leaders met for a two-day synthesis session held at the Xerox Document University in Leesburg, Virginia. There, they addressed issues such as: (1) who are geo-engineers; (2) where should geo-engineering be in the larger civil engineering achieve the desired goals. From these discussions, a geo-engineering action plan that focuses on identity education, research, contracting, procurement, and advancing the state of the art and improving the state of practice was developed. In addition, recommendations were made to expand the action plan so that it is international in nature. Participants debated information of an integrating organization to begin implementation of the geo-engineering action plan. The report recommendations include convening an expanded international workshop within the next 12 months.

DESCRIPTORS: (U) *CIVIL ENGINEERING, *GEOTECHNICAL ENGINEERING, *SOIL STRUCTURE INTERACTIONS, SYMPOSIA, SOIL MECHANICS, TUNNELS, MINING ENGINEERING, GEOLOGY, CONSTRUCTION, PUBLIC RELATIONS, FOUNDATIONS (STRUCTURES), EARTHQUAKES, SOIL STABILIZATION, SLOPE STABILITY, WORKSHOPS, UNDERGROUND STRUCTURES, DAMS.

AD-A289 746

NAVAL RESEARCH LAB WASHINGTON DC

(U) Proceedings on the Damage Control/Fire Fighting into the 21st Century. Workshop Held at Arlington, Virginia on 8-10 Jun 1994.

DEC 94 41P
PERSONAL AUTHORS: Tatem, Patricia A.

UNCLASSIFIED REPORT

ABSTRACT: (U) A workshop was held at the Naval Research Laboratory, 8-10 June 1994, to identify all technologies that could make an impact on innovative damage control concepts and systems, specifically fire fighting, so the Navy can move out smartly in its approach to damage control in the 21st century. The workshop was used to identify the critical component technologies and potential players that can support an Integrated science and technology program in fire protection and damage control. In this type of forum, the relevant science and technology issues were addressed, and related work in government, commercial and university environments was identified. The technology limitations, needs and integration issues were also identified.

DESCRIPTORS: (U) *NAVAL RESEARCH LABORATORIES, *FIRE FIGHTING, *THERMAL IMAGES, *SHIP FIRES, HEAT TRANSFER, DATA BASES, ALGORITHMS, COMPUTERIZED SIMULATION, INTEGRATED SYSTEMS, SYMPOSIA, SURVIVABILITY, TECHNOLOGY TRANSFER, PERFORMANCE TESTS, HUMAN FACTORS ENGINEERING, ENVIRONMENTAL IMPACT, PARTICULATES, INPUT OUTPUT DEVICES, TACTICAL ANALYSIS, FIRE PROTECTION, PLUMES, MAN COMPUTER INTERFACE, EXPOSURE (PHYSIOLOGY), COMPUTER AIDED DIAGNOSIS, FLOODING, COMBAT FORCES, IMMERSION, WORKSHOPS, SENSES (PHYSIOLOGY), HAZARDOUS MATERIALS, DAMAGE CONTROL, SMOKE ABATEMENT, MIST, GUIDED MISSILE SHIPS.

IDENTIFIERS: (U) VIRTUAL REALITY.

AD-A289 367

ARMY SCIENCE BOARD WASHINGTON DC

(U) Army Science Board Ad Hoc Study on Technology for the Future Land Warrior.

OCT 94 46P
PERSONAL AUTHORS: Montgomery, A. B.; Godden, Gerald D.; LaBerge, Walter B.; Wagner, Louis C., Jr

UNCLASSIFIED REPORT

ABSTRACT: (U) This report documents the results of a study to identify high payoff technologies programs to overcome technical and system barriers, and to recommend appropriate demonstration projects. Near term high payoff technologies identified include the squad radio, global positioning systems, a continuous, positive pressure NBC mask blower, the AIM light, and a leg brace for parachutists called LEAP (Lower Extremity Assistance for Parachutist). Longer term technology programs identified include location and target detection, combined arms integration, lightweight power, improved airdrop, NBC and individual equipment, and advanced medical/trauma care. A demonstration program is recommended for each of the longer term-programs as a means to evaluate trade-offs among various technical solution. The report concludes that technology for the Land Warrior is available. Recently completed programs demonstrated that the use of technology for the soldier profoundly improves individual and squad capabilities. Careful planning and testing is needed to procure the right mix of equipment for an adequate number of soldiers to enhance capabilities at a reasonable cost.

DESCRIPTORS: (U) *MILITARY PERSONNEL, *LAND WARFARE, *MILITARY EQUIPMENT, *PROTECTIVE EQUIPMENT, SQUAD LEVEL ORGANIZATIONS, COMBAT EFFECTIVENESS, COST EFFECTIVENESS, COMBAT READINESS, MILITARY RESEARCH, MILITARY PLANNING TECHNOLOGY FORECASTING, RADIO EQUIPMENT, TARGET DETECTION, PARACHUTISTS, MASKS, AIR DROP OPERATIONS.

IDENTIFIERS: (U) LAND WARRIOR MISSION, LEAP (Lower Extremity Assistance for Parachutist).

AD-A288 748

ARMY COMMAND AND GENERAL STAFF COLL FORT LEAVENWORTH KS
SCHOOL OF ADVANCED MILITARY STUDIES

(U) America's Middleweight Force: Enhancing the Versatility of the 82nd Airborne Division for the 21st Century.

JAN 94 61P
PERSONAL AUTHORS: Nicholson, John W., Jr

UNCLASSIFIED REPORT

ABSTRACT: (U) This study examines the Army's need for a middleweight force. Such a force must be rapidly deployable, opposed entry capable, lethal, tactically mobile and survivable against well armed 21st Century threats. Versatility is essential for the middleweight force, so that it can create force packages of combat power, (firepower, maneuver, protection, leadership), tailored for the unique conditions of each contingency. The 82nd Airborn Division, the Army's premier conventional early entry division, possesses many of these capabilities already, but needs greater tactical mobility, firepower and sustainment capability to become a middleweight force. This study explores the versatility of the Division Ready Brigade task force using the Wass de Czege Relative Combat Power Model. Prepositioning of force enhancement packages, called "DRB sets", around the world is an affordable way to address the shortcomings identified in the versatility analysis. These sets would be transported into an airhead using intratheater airlift, thus significantly upgrading DRE capability without requiring excessive intertheater airlift sorties. A feasibility study of the DRB set proposal in terms of airlift, training, money, and time concludes the monograph.

DESCRIPTORS: (U) *MILITARY FORCES (UNITED STATES), *COMBAT EFFECTIVENESS, *ARMY PLANNING, MOBILITY, THEATER LEVEL OPERATIONS, LEADERSHIP, SURVIVABILITY, MODELS, BRIGADE LEVEL ORGANIZATIONS, TASK FORCES, FEASIBILITY STUDIES, MISSIONS, LETHALITY, MANEUVERS, POWER, TACTICAL.

AD-A288 829

NAVAL WAR COLL NEWPORT RI CENTER FOR NAVAL WARFARE STUDIES

(U) The Evolutlon of Naval Power to the Year 2010.

AUG 94 16P
PERSONAL AUTHORS: Daniel, Donald C.

UNCLASSIFIED REPORT

ABSTRACT: (U) This report examines the characteristics of naval power, its comparative advantages in meeting national security requirements, and its future as the world enters the next millennium. It was originally prepared and presented in French at a conference sponsored by Le Centre d'Analysis Sur la Securite Europeene.

DESCRIPTORS: (U) *POWER, *NAVAL PLANNING, NUCLEAR FORCES (MILITARY), REQUIREMENTS, NATIONAL SECURITY, MILITARY FORCES (FOREIGN), NAVY, EVOLUTION (GENERAL).

AD-A288 207

INDUSTRIAL COLL OF THE ARMED FORCES WASHINGTON DC

(U) U.S. Army and Marine Corps Maritime Prepositioning: The Right Course For the 21st Century?

APR 94 34P
PERSONAL AUTHORS: Washington, Albert A.

UNCLASSIFIED REPORT

ABSTRACT: (U) Forty years before the United States participated in the Gulf War and experienced an enduring lesson in the value of forward prepositioning, Rear Admiral Henry E. Eccles championed the future utility of advance "floating bases" in 1950 to support forward deployed forces where "the supplies, services and replacment of equipment are provided from auxiliary ships and craft based within an anchorage" (Eccles, Operational Naval Logistics 87). Despite the fact that Admiral Eccles and other leading logisticians from the World War II era proclaimed the importance of strategic logistics reach through advance positioning and forward floating bases, the defense establishment paid little attention to such concepts until decades later. In support of the Gulf War, the U.S. Navy, Marine Corps and Air Force wrote a new chapter in the effective use of strategic logistics reach through the successful employment of advance "floating bases" in the form of Maritime Prepositioning Ships (MPS). This combined seabased and airlifted forward projected force provided an early, balanced air and ground combat capability that was fully interoperable with afloat Naval aviation as well as deploying Army and Air Force elements. The successes enjoyed by the employment of MPS during the rapid closure and initial buildup phases in Desert Shield served in stark contrast to the slower, " dribbling" theater delivery of other war materiel aboard Ready Reserve Fleet shipping. In the aftermath of the war, the rapid response of MPS moved Congress and the Department of Defense (DoD) to examine the future strategic mobility requirements of the nation's armed forces with particular emphasis on the value of maritime prepositioning.

DESCRIPTORS: (U) *MILITARY FORCES (UNITED STATES), MILITARY OPERATIONS, MOBILITY, LOGISTICS SUPPORT, MILITARY SUPPLIES, AIR FORCE, AUXILIARY, CLOSURES, COMBAT EFFECTIVENESS, CONGRESS, CONTRAST, DELIVERY, DEPARTMENT OF DEFENSE, DEPLOYMENT, FLOATING BASES, FORWARD AREAS, GLOBAL, GULFS, IRAQ, KUWAIT, LAND WARFARE, MARINE CORPS, MATERIEL, MILITARY FACILITIES, MILITARY REQUIREMENTS, MILITARY STRATEGY, NATIONS, NAVAL AVIATION, QUICK REACTION, SHIPS, THEATER LEVEL OPERATIONS, UNITED STATES.

IDENTIFIERS: (U) GULF WAR, MPS (MARITIME PREPOSITIONING SHIP), MARITIME PREPOSITIONING, DESERT SHIELD OPERATION.

AD-A286 744

ASSISTANT DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS FORCE DEVELOPMENT (ARMY) WASHINGTON DC

(U) The United States Army 1995 Modernization Plan. Force 21.

APR 95 667P

UNCLASSIFIED REPORT

ABSTRACT: (U) Modernization objectives: project and sustain; protect the force; win the information; conduct precision stroke, dominate the maneuver battle; and assure land force dominance into the 21st Century. (Author)

DESCRIPTORS: (U) *MILITARY MODERNIZATION, *ARMY PLANNING, *COMBAT READINESS, ARMY OPERATIONS, AIR DEFENSE, DEFENSE PLANNING, LONG RANGE (TIME), LOGISTICS PLANNING, LOGISTICS MANAGEMENT, QUICK REACTION, MILITARY FORCE LEVELS, TACTICAL INTELLIGENCE, FIRE SUPPORT, ELECTRONIC WARFARE, COMBAT VEHICLES, ARMY TRAINING, SPECIAL FORCES, ARMY PERSONNEL.

IDENTIFIERS: (U) Theater missile defense, *Army modernization plan, Special operations forces.

AD-A286 195

NATIONAL DEFENSE UNIV WASHINGTON DC INST FOR NATIONAL STRATEGIC STUDIES

(U) Strategic Forum, Number 11. The Revolution in Military Affairs.

NOV 94 4P

UNCLASSIFIED REPORT

ABSTRACT: (U) The Conference Conclusions were: The most fundamental strategic challenge to the U.S. military is to convert the Military-Technological Revolution, the impact of information technologies on warfare into a Revolution in Military Affairs the subsequent transformation of operations and organizations. Although the U.S. military's grasp of the MTR is unquestioned, optimism that the United States will lead others in converting the MTR to an RMA is premature. The core debate at the Conference was over the relative importance of today's small but irksome military tasks compared to potentially more critical but totally unknown tasks that may face the nation two decades from now. Although information technologies going into military systems have generally been no better and often less current, than those of commercial systems available for military use, converting data into information remains a highly sophisticated art at which the United States excels. Other nations with clearer strategic purpose and less sunk capital at risk from an RKA could be the leaders in this new race. The United States would be better off if those nations were to waste decades trying to copy what they thought we could do in the 1990's rather than seeking to leapfrog us by grasping the RKA before we do.

DESCRIPTORS: (U) *NATIONAL SECURITY, *DEFENSE PLANNING, *INFORMATION SYSTEMS, * ECONOMIC WARFARE, MILITARY FORCES (UNITED STATES), TECHNOLOGY FORECASTING, THREAT EVALUATION, WARFARE, MILITARY OPERATIONS, MILITARY ORGANIZATIONS, TRANSFORMATIONS, INFORMATION TRANSFER, TECHNOLOGY TRANSFER, STRATEGY, ASIA, NATIONS, COMPETITION, ECONOMICS, CHINA, ADVANCED WEAPONS, COMMAND AND CONTROL SYSTEMS, SYMPOSIA, MILITARY MODERNIZATION, STRATEGIC INTELLIGENCE, FORECASTING.

IDENTIFIERS: (U) Post Cold War Era, New world order, *MTR (Military Technological Revolution), *RMA (Revolution in Military Affairs), Advanced technology, Information technology, Global information Infrastructure, Strategic planning.

AD-A285 780

TRADOC ANALYSIS CENTER FORT LEAVENWORTH KS

(U) Mobile Strike Force 2010.

SEP 94 165P
PERSONAL AUTHORS: Bailey, Timothy J.; George, Sherrie R.; Groover, Roland R. Jr.; Sheehan, Brendan P.; Anderson, Michael R.

UNCLASSIFIED REPORT

ABSTRACT: (U) This paper describes the Mobile Strike Force (MSF) 2010 analysis. This analysis provided input to the TRADOC Commander and the Chief of Staff of the Army to support decisions regarding FORCE XXI development and to the Battle Laboratory Integration and Technology Directorate (BLITD), TRADOC, in support of their Louisiana Maneuver New Technology issue. The TRADOC Analysis Center (TRAC) conducted a workshop to assess the impact of future technological capabilities and organizational variations enabled by these new technologies. TRAC assembled a group of subject-matter experts from the new technologies' proponent schools and centers to role play the MSF 2010 staff. TRAC used the Computer Assisted Map Exercise (CAMEX) model to execute the Southwest Asia (SWA) Prairie Warrior 94 MSF scenario with the MSF force structure, systems, and threat updated to 2010. TRAC conducted after-action reviews after each staff planning session to collect qualitative observations from the workshop participants. There was a base case and six alternatives that were variations on the insertion of new technologies and changes in organizational structure and MSF employment based on those new technologies. New technologies, Prairie warrior, 2010 Mobile strike force, Computer assisted map exercise, CAMEX.

DESCRIPTORS: (U) *WAR GAMES, *MILITARY EXERCISES,*STRIKE WARFARE, *COMPUTER AIDED DESIGN, ARMY, ASIA, BATTLES, COMPUTERS, EMPLOYMENT, GRASSLANDS, INPACT, INPUT.

AD-A285 478

RAND CORP SANTA MONICA CA

(U) Future Technology-Driven Revolutions in Military Operations. Results of a Workshop.

94 113P
PERSONAL AUTHORS: Hundley, Richard O.; Gritton, Eugene C.
CONTRACT NO. MDA903-90-C-0004

UNCLASSIFIED REPORT

ABSTRACT: (U) Recent advances in technology have brought about dramatic changes in military operations, including the use of low-observable aircraft to negate air defenses, smart weapons for precision conventional-strike operations, and the employment of both ballistic missiles and antiballistic missiles in conventional warfare. Such technology breakthroughs will continue to occur in the future, just as they have in the past, and they will continue to bestow a military advantage on the first nation to develop and use them. It is important to the continued vitality and robustness of the U.S. defense posture for the Department of Defense (DoD) research and development (R&D) community, and in particular the Advanced Research Projects Agency (ARPA), to be on the leading edge of breakthrough technologies that could revolutionize future military operations. During October to December 1992, RAND conducted a workshop for ARPA on Future Technology-Driven Revolutions in Military Operations. This documented briefing summarizes the results of that workshop. Five promising program areas as candidates for new ARPA research initiatives were identified: very small systems (micro and nano technologies); biomolecular electronics; the use of techniques from molecular biology and biotechnology to develop new molecular electronic materials, components, and computational architectures; new technologies for military logistics; cyberspace Security and safety, and performance enhancers for the individual soldier. This documented briefing provides details on all five of these candidate program areas.

DESCRIPTORS: (U) *MILITARY OPERATIONS, *TECHNOLOGY FORECASTING, *ADVANCED WEAPONS, *MILITARY RESEARCH, *REPORTS, MILITARY FORCES (UNITED STATES), CONVENTIONAL WARFARE, BALANCE OF POWER, WORKSHOPS, WEAPON SYSTEMS, EVOLUTION (DEVELOPMENT), MICROMINIATURIZATION, MICROELECTRONICS, BIONICS, BIOTECHNOLOGY, LOGISTICS PLANNING, COMMUNICATIONS NETWORKS, SECURE COMMUNICATIONS, ELECTRONIC SECURITY, COMBAT FORCES, SURVIVABILITY, MOBILITY, MISSIONS, PERFORMANCE (HUMAN), MAN MACHINE SYSTEMS.

IDENTIFIERS: (U) Advanced technology, Research and development, Research initiatives, Briefings, ARPA (Advanced Research Project Agency), Breakthrough technologies, Revolutionary Developments, Nanotechnologies, Biomolecular electronics, Cyberspace security, Performance enhancement.

AD-A285 443

DEFENCE SCIENCE AND TECHNOLOGY ORGANIZATION MELBOURNE (AUSTRALIA)

(U) Trends in C3 System Technology.

JUL 94 112P
PERSONAL AUTHORS: Fairs, K.
REPORT NO. DSTO-TR-0002

UNCLASSIFIED REPORT

ABSTRACT: (U) This paper gives an overview of technologies considered pertinent to Command, Control and Communications (C3) systems within the next 15 years. The style of the document is tailored deliberately for the non-specialist community. The report draws primary from research being conducted within DSTO, and mentions significant world trends. The report discusses significant near-term issues influencing C3 system design. It proposes the functionality and architecture for a future C3 system, and then maps the technologies which could support migration to such a proposed future C3 system. Command and control, Communications Networks, C3 Architecture, CS Systems.

DESCRIPTORS: (U) *COMMAND CONTROL COMMUNICATIONS, ARCHITECTURE, COMMUNICATIONS NETWORKS, COMMUNITIES, CONTROL, DOCUMENTS, MAPS, MIGRATION, NETWORKS, PAPER, SPECIALISTS.

AD-A284 758

ARMY COMMAND AND GENERAL STAFF COLL FORT LEAVENWORTH KS SCHOOL OF ADVANCED MILITARY STUDIES

(U) Electromagnetic Spectrum Domination: 21st Century Center of Gravity or Achilles Heel?

MAY 94 65P
PERSONAL AUTHORS: Schneider, Michael W.

UNCLASSIFIED REPORT

ABSTRACT: (U) The Army is currently embarking on a major peacetime modernization program. As the drawdown comes to a close, the Army is about half its former size and is confronted with a far more complex strategic environment. Virtually any place the Army may be employed, it will be at the end of a long line of communication with its CONUS sustaining base. Furthermore, the Army will have to be wary of simultaneous challenges to United States interests in other theaters. As a result the Army must be capable of quick decisive victories with minimal casualties in spite of its smaller size. In order to ensure that the Army is able to meet this standard in its future wars, the Army's leadership has set in motion a modernization plan aimed at maximizing the potential power of a smaller but more lethal army. This modernization plan places a heavy premium on the integrative technologies, (computers and communications), to get more of its forces into the fight at the right time and place and at an ever increasing operational tempo. One by-product of this plan is an increasing dependence on the electromagnetic spectrun to collect and move information on the 21st century battlefield.

DESCRIPTORS: (U) *ARMY PLANNING, *MILITARY MODERNIZATION BATTLEFIELDS, CASUALTIES, LEADERSHIP, MOTION, PEACETIME, BALANCE OF POWER, STRATEGIC WARFARE, COMBAT READINESS ARMY OPERATIONS, MILITARY STANDARDS, COMMAND AND CONTROL SYSTEMS, ELECTRONIC WARFARE, MILITARY DOCTRINE, INFORMATION SYSTEMS, TACTICAL DATA SYSTEMS.

IDENTIFIERS: (U) *Information warfare.

AD-A284 721

ARMY COMMAND AND GENERAL STAFF COLL FORT LEAVENWORTH KS SCHOOL OF ADVANCED MILITARY STUDIES

(U) Pentomic Doctrine: A Model for Future War.

MAY 94 52P
PERSONAL AUTHORS: Smith, Jack F.

UNCLASSIFIED REPORT

ABSTRACT: (U) This monograph investigates Pentomic doctrine of the 1950's. The political and military factors that drove the Army to adopt a new vision of war, restructure and reorganize its major combat formations and to eventually abandon that change are very similar to forces driving today's Army. Although the primary focus of this monograph is the military aspects of the Pentomic doctrine, the doctrine was initially directed by political concerns, consequently, political factors are examined first. The monograph examines similarities between today's political environment and that of the Pentomic era. Today's Army is again turning to technology to provide answers to insufficient manpower to meet required defense force structure. As the Army adopts new technology, the vision of future warfare tends to change raising questions on how the Army plans to fight in the presence of such technology. By studying the past the Army may avoid mistakes in the future. The political and military factors that the 1950's Army had to consider provide a case study on what the Army planned to achieve and which operational problems drove modifications in force structure, technology and methods of execution. Pentomic, Doctrine, Future war, Force structure, Operational art.

DESCRIPTORS: (U) *MILITARY DOCTRINE, *NUCLEAR WARFARE, ARMY, CASE STUDIES, ERRORS, MANPOWER, MODIFICATION, WARFARE, POLITICAL SCIENCE.

IDENTIFIERS: (U) Pentomic Era, New World Order, Post Cold War Era.

AD-A284 613

ARMY COMMAND AND GENERAL STAFF COLL FORT LEAVENWORTH KS SCHOOL OF ADVANCED MILITARY STUDIES

(U) Blainey and the Bottom-Up Review: Increased Potential for Miscalculation and War in the 21st Century.

MAY 94 57P
PERSONAL AUTHORS: Nicholson, John W., Jr

UNCLASSIFIED REPORT

ABSTRACT: (U) On 1 September, 1993, Secretary of Defense Les Aspin and Chairman of the Joint Chiefs of Staff, General Colin Powell announced the results of the Clinton Administration's Bottom-up Review (BUR), to determine America's future defense needs. This analysis of the BUR identifies discrepancies with the methodology and underlying assumptions of the BUR. These flaws, in turn, resulted in serious deficiencies in the results of this important work. The BUR's point of departure for an examination of future defense needs was the 1991 demise of the Soviet Union. Rather than develop a comprehensive picture of the nature of war and peace in the 21st Century as a basis for force planning, the BUR assumes limited wars of the DESERT STORM variety are the model for future conflict. Contemporary scholars such as Samuel Huntington, John Keegan, and Alvin and Heidi Toffler disagree with this assumption. They point to a clash of civilizations in the next century and an increased potential for violent cultural conflict. Such conflicts tend to be protracted and costly, not limited. The BUR's assumption concerning peace fail the test of history as provided by Geoffery Blainey's exhaustive study of the causes of war and peace since 1700. The BUR's assumptions are that the best guarantors of peace are a thriving web of free trading relationships and an international partnership of democratic nations. As Blainey comments, free trade and democracy may have caused more international war than peace. The strategy, force structure and budget of the BUR actually increase the potential for international miscalculation and war.

DESCRIPTORS: (U) *DEFENSE PLANNING, *MILITARY PLANNING, *MILITARY BUDGETS, *NATIONAL SECURITY, ECONOMIC ANALYSIS, MILITARY FORCE LEVELS, FORECASTING, THREAT EVALUATION, MILITARY DOCTRINE, MILITARY STRATEGY, HISTORY, CATALYTIC CONFLICT (WARFARE), METHODOLOGY, ERRORS.

IDENTIFIERS: (U) *Bottom up review, Future wars, 21st Century, Post Cold War Era, National security strategy, Clinton William, Blainey Geoffrey, Downsizing, Military force structure.

AD-A284 384

NAVAL SURFACE WARFARE CENTER
DAHLGREN DIV VA

(U) Systems Engineering of Future Strategic Systems.

AUG 94 18P
PERSONAL AUTHORS: Gates, Robert V.
REPORT NO. NSWCDD/TR-94/183

UNCLASSIFIED REPORT

ABSTRACT: (U) Future strategic systems will be developed to meet new and different requirements. Among these are the changes imposed by the evolving world situation and by the realities of defense budgeting. System-engineering disciplines have been applied to the development of strategic weapon systems with the result that requirements have been identified and met. The capabilities of existing Navy strategic weapon systems and the fact that they were developed within both budget and schedule are proof of this. In the future, however, this will not be sufficient. The entire strategic system, of which the weapon system is only a part, must be subjected to the systems-engineering approach if both system effectiveness and cost effectiveness are to be ensured. Application of these disciplines will lead to identification of the proper distribution of functionality across the system and the areas of technology that must be addressed to have the greatest impact on total system effectiveness. Systems engineering, Strategic weapon systems.

DESCRIPTORS: (U) *STRATEGIC WEAPONS, *DEFENSE PLANNING *NAVAL PLANNING, APPROACH, COST EFFECTIVENESS, COSTS, ENGINEERING, IDENTIFICATION, IMPACT, NAVY, REQUIREMENTS, SYSTEMS ENGINEERING, WEAPON SYSTEMS, SUBMARINE LAUNCHED, DETERRENCE, NAVAL BUDGETS.

IDENTIFIERS: (U) STRATPLAN 2010, FDS (Future Deterrence Study).

AD-A283 513

NAVAL WAR COLL NEWPORT RI DEPT OF OPERATIONS

(U) Space Control: The Operational Commander's Future Dilemma.

NDV 94 32P
PERSONAL AUTHORS: Berg-Johnson, Jon F.

UNCLASSIFIED REPORT

ABSTRACT: (U) Space systems have rapidly become like breathing for today's warfare commander a necessity for survival. However, the proliferation of space technology has begun to crowd the space and top the balance once overwhelmingly in the United States favor. This paper outlines the current and projected commercial-based space systems that will likely become available to those nations that have limited capability today. Further, it proposes to US operational commanders what this potential offsetting situation means and how this will affect his control of space. It suggests that he may have little capability to control all scenarios, and if this is the case, suggests the options that best exploit his own assets and limit the effectiveness of the opposition. Space, Satellites, Launch platforms, Theater commander, Commercial satelliltes, Navigation, Communications, SPOT, GPS, Landsat.

DESCRIPTORS: (U) *SPACE SYSTEMS, *SPACE TECHNOLOGY, ARTIFICIAL SATELLITES, CONTROL, NAVIGATION, PLATFORMS, SCENARIOS, WARFARE, MILITARY COMMANDERS, COMMAND AND CONTROL SYSTEMS, MILITARY FORCES (FOREIGN), BALANCE OF POWER, MILITARY FORCES (UNITED STATES), THEATER LEVEL OPERATIONS, COMMAND CONTROL COMMUNICATIONS.

IDENTIFIERS: (U) Proliferation, Launch platforms, Commercial satellites, GPS (Global Positioning System), LandSat satellite, SPOT Satellite.

AD-A283 465

NAVAL POSTGRADUATE SCHOOL MONTEREY CA

(U) Personal Communications Services: Improving Theater Deployable Communications for the 21st Century.

JUN 94 80P
PERSONAL AUTHORS: Cournoyer, Ronald C., Jr

UNCLASSIFIED REPORT

ABSTRACT: (U) Personal Communications Services (PCS) may be the key ingredient for vastly improved military communications capabilities at the turn of the century. The Federal Communications Commission (FCC) defines PCS as a family of mobile or portable radio communications services which could provide services to individuals and businesses and be integrated with a variety of competing networks ... the primary focus of PCS will be to meet communications requirements of people on the move. Today's generation of Theater Deployable Communications, which provides joint tactical communications to deployed forces, is the Tri-Service Tactical Communications (TRITAC) system. A description of TRITAC's family of equipment, network topology, typical employment, and critical limitations is presented in this thesis. Five commercial Mobile Satellite Services (MSS) are described as viable candidates for augmenting existing communications systems. Cellular design principles such as frequency reuse, cell splitting, channel access methods, and propagation factors are also addressed. Finally, a framework for comparison of the candidate MSS systems is proposed as a baseline for further studies into the most beneficial implementation of PCS into theater deployable communications systems for the future. TRITAC Communications, Theater deployable communications, Cellular technology, Mobile satellite services.

DESCRIPTORS: (U) *TACTICAL COMMUNICATIONS, *MILITARY PLANNING, *RADIO TRANSMISSON, *DEPLOYMENT, *THEATER LEVEL OPERATIONS, ACCESS, ARTIFICIAL SATELLITES, CHANNELS, COMPARISON FREQUENCY, LIMITATIONS, MOBILE, PROPAGATION, RADIO EQUIPMENT, REQUIREMENTS, SPLITTING, THESES, TOPOLOGY, COMMUNICATIONS NETWORKS, INTEGRATION.

IDENTIFIERS: (U) PCS (Personal Communications Services), TRITAC (Tri Service Tactical Communications), MSS (Mobile Satellite Services)

AD-A283 441

NAVAL WAR COLL NEWPORT RI DEPT OF OPERATIONS

(U) Operational Logistics/Role for the Future?

JUN 94 37P
PERSONAL AUTHORS: Ralston, Robert W.

UNCLASSIFIED REPORT

ABSTRACT: (U) The Army is preparing to publish a first ever doctrine manual on operational logistics. The draft version of this manual does not provide a template for conducting operational logistics in the future. Instead it is a culmination of past experience. This analysis examines the question of what role operational logistics will play in the future. To accomplish this operational logistics is defined within the scope of military operations and developed into a conceptual frame work for planning and application. The historical and present application of operational logistics is analyzed by use of 19th and 20th century military operations with the focus on major land campaigns. Using this analysis three future revolutionary changes impacting operational logistics are identified. These changes involve restructuring from service oriented to joint logistics forces balancing the equation of effectiveness and efficiency as the result of microchip technology and driving technology to find a solution for revolutionizing theater ground-transportation Objective focused theater logistics doctrinal concepts Oriented toward 21st century.

DESCRIPTORS: (U) *LOGISTICS, ARMY, EFFICIENCY, MILITARY OPERATIONS OPERATIONAL, EFFECTIVENESS, HISTORY, LOGISTICS PLANNING, COMBAT SUPPORT THESES, MILITARY DOCTRINE.

IDENTIFIERS: (U) Operational logistics.

AD-A282 436

RAND CORP SANTA MONICA CA

(U) Theater Analysis and Modeling in an Era of Uncertainty: The Present and Future of Warfare.

94 118P
PERSONAL AUTHORS: Bennett, Bruce W. ; Gardiner, Sam; Fox, Daniel B. ; Whitney, Nicholas K.

UNCLASSIFIED REPORT

ABSTRACT (U) This monograph report describes work done as part of the development of the RAND Strategy Assesment System (RSAS), an initiative of the Director of Net Assessment in the Office of the Secretary of Defense to improve the procedures used for analysis and modeling of major regional contingencies and higher-level conflicts. Because many of the key aspects of warfare have changed significantly over the last few years, and likely will change even more significantly in the next decade, a major component of recent RSAS development has been research into the future of warfare. This report summarizes a part of that work, describing some of our vision of the future, and what we believe that vision implies about requirements for military analysis and modeling of major regional contingencies. The work included here has involved war gaming and analysis, has spanned the spectrum of major force operations, and has considered both the present and future of warfare.

DESCRIPTORS (U) *WAR GAMES, *THEATER LEVEL OPERATIONS, *MILITARY PLANNING, EVOLUTION (DEVELOPMENT), INTERNATIONAL POLITICS, MILITARY REQUIREMENTS, KOREA, NORTH KOREA, UNCERTAINTY.

AD-A282 377

RAND CORP SANTA MONICA CA

(U) U.S. Military Strategy and Force Posture for the 21st Century Capabilities and Requirements.

94 265P
PERSONAL AUTHORS: Kugler, Richard L.
CONTRACT NO MDA903-91-C-0006

UNCLASSIFIED REPORT

ABSTRACT (U) The onset of an entirely new era of international affairs raises profound issues about future U.S. military strategy and forces. Clearly, the old Cold War strategy is defunct, but far less clear is the strategy that should replace it. With so many changes unfolding so rapidly, the act of designing a coherent strategy for the years immediately ahead alone is difficult, the difficulties are compounded when the distant future, and its far greater uncertainties, is addressed. What kind of world will we be dealing with ten or twenty years from now, and what level of defense preparedness will be needed? The years ahead cannot be ignored simply because they are uncertain. The United States will need a coherent military strategy for the coming era, and defense policymaking, by its nature, is an exercise in long-range planning. Tomorrow's forces are being decided upon today, and, equally important, U.S. policy actions in the near term will influence the course of international affairs for the long term. For these reasons, strategy analysts must peer into the future and ask: "What will be required some years from now, and how can we best act today to help bring about the kind of world that we seek tomorrow?" To help answer this thorny question, this report addresses U.S. military strategy for the coming two decades.

DESCRIPTORS (U) *MILITARY STRATEGY, *DEFENSE PLANNING, POSTURE (GENERAL), UNITED STATES, UNCERTAINTY, STRATEGIC ANALYSIS, FORECASTING, GLOBAL.

AD-A281 690

NAVAL WAR COLL NEWPORT RI ADVANCED RESEARCH PROGRAM

(U) The Revolution in Military Affairs and Its Effect on the Future Army.

JUN 94 58P

PERSONAL AUTHORS: Lesser, Harry K , Jr

UNCLASSIFIED REPORT

ABSTRACT (U) There is general consensus within the Department of Defense and the Department of the Army that we are in the early stages of another Revolution in Military Affairs (RMA). A RMA occurs when the application of new technologies into military systems combines with innovative operational concepts and organizational adaptation to fundamentally change the character and conduct of conflict by producing a dramatic increase in the combat potential and military effectiveness of armed forces. This project involved an extensive review of published and unpublished material on the RMA and the synthesis of that material into appropriate recommendations about future Army doctrine, technology, and force structure which have the potential to significantly increase the Army's combat power in order for the RMA to achieve its potential. Senior military and civilian leadership must make a solid commitment to changing Army doctrine, operational concepts, and force structure to enable a transformation from the current maneuver warfare paradigm to a new Knowledge Warfare paradigm.

DESCRIPTORS (U) *COMBAT EFFECTIVENESS, *MILITARY MODERNIZATION * MILITARY DOCTRINE, ADAPTATION, ARMY, CONFLICT, DEPARTMENT OF DEFENSE, LEADERSHIP, TRANSFORMATIONS, WARFARE, MILITARY ORGANIZATIONS, MILITARY FORCES (UNITED STATES).

AD-A280 766

AIR WAR COLL MAXWELL AFB AL

(U) Close Air Support Doctrine, Dynamic Future or Dogmatic Past?

APR 94 31P
PERSONAL AUTHORS: Bryan, William H.

UNCLASSIFIED REPORT

ABSTRACT (U) Close Air Support (CAS) is our oldest and most controversial air support mission. Although there have been significant changes in technology and force structure in each of the services, the doctrine for the employment of CAS has changed very little. The recent Roles and Missions reports have only increased the debate of how and where CAS is performed. The Army, with its fleet of attack helicopters, now finds itself as a provider of CAS. The Marine Corps has always provided its own CAS and will continue to do so but the evolution of the Joint Force Air Component Commander (JFACC) is causing some concern over the possible loss of CAS assets. The Fire Support Coordination Line (FSCL) has become a point of dispute since the Army has fielded organic weapons systems with increased ranges and seeks to place the FSCL at greater ranges. Consequently, the area that has generally become the zone of action for CAS has grown exponentially. Precision guided munitions (PGMs) have come of age and now give us the capability to strike with lethality with reduced risk of fratricide. Our CAS doctrine needs to be revised and refined to reflect the tremendous advances in technology and changes in force structure and capability that have occurred in the armed forces in recent years.

DESCRIPTORS (U) *FIRE SUPPORT, *MILITARY DOCTRINE, *GUIDED WEAPONS, *CLOSE SUPPORT, *PRECISION BOMBING, ARMY, ATTACK HELICOPTERS, FRATRICIDE, LETHALITY, MARINE CORPS, MISSIONS, PRECISION, REGIONS, RISK, WEAPONS, GUIDED PROJECTILES.

IDENTIFIERS (U) CAS (Close Air Support), Air support, JFACC (Joint Force Air Component Commander), FSCL (Fire Support Coordination Line), Organic weapons systems, PGM (Precision Guided Munitions), *Close air support.

AD-A280 107

ARMY WAR COLL CARLISLE BARRACKS PA

(U) Army National Guard Air Defense Artillery Modernization: A Vision for the Future.

MAY 94 96p
PERSONAL AUTHORS: Gonzales, Michael R.

UNCLASSIFIED REPORT

ABSTRACT (U) Proposed Force reductions and the evolution of a new National Military Strategy (NMS) mandate an even more vital role for the Reserve Components in this nation's defense. Studies have proven that one branch where the Reserve Components can make a valuable contribution is Air Defense Artillery. All Reserve Component Air Defense Artillery forces are currently organic to the Army National Guard. To remain a viable part of the total force, these organizations must be assigned realistic missions and manned, trained, equipped, and resourced commensurate with mission requirements. In view of the evolving threat and proposed force structure reductions, this study provides a concept for modernizing Army National Guard Air Defense Artillery organizations to enable them to effectively perform their critical wartime force protection role. Although designed primarily to focus on resourcing warfighting requirements, Air Defense Artillery modernization provides the added benefit of enhancing National Guard capabilities in the counter-drug and operations other than war arenas. Approval of this proposal would enable Army National Guard Air Defense to remain an integral, cost-effective, and viable part of the total force into the 21st century.

DESCRIPTORS (U) *AIR DEFENSE, *ARMY OPERATIONS, *ARTILLERY, *MILITARY RESERVES, *MILITARY FORCE LEVELS, *MILITARY MODERNIZATION, AIR, BENEFITS, COSTS, DRUGS, MILITARY STRATEGY, MISSIONS, NATIONAL GUARD, OPERATION, ORGANIZATIONS, PROTECTION, REDUCTION, REQUIREMENTS, STRATEGY, STRUCTURES THREATS, WARTIME, COST EFFECTIVENESS.

IDENTIFIERS (U) Downsizing, Reduction in force, National Military Strategy, National Guard Air Defense Artillery Organization.

AD-A280 106

ARMY WAR COLL CARLISLE BARRACKS PA

(U) The Army Reserve Command of the 21st Century Force: An Element of the Federal Army.

MAY 94 37P
PERSONAL AUTHORS: Herring, David M.

UNCLASSIFIED REPORT

ABSTRACT (U) The Force that was required for the Cold War is not the Force for the 21st Century. As the Active Army transforms into the Force of the 21st Century, the United States Army Reserve (USAR) must transform to support that Force. As a major element of the USAR, the Army Reserve Commands (ARCOM) of today must likewise change. Projecting today's ARCOMs into the 21st Century Force that supports the U.S. National Security Objectives in the rapidly-changing contingency environment requires a rethinking, refocusing, restructuring of the U.S. Army Reserve Force for the future. The USAR must enhance its position as an element of the Federal Force by working towards total integration with the Active Army. It must play an active role in contingency planning to fully support the Unified Commanders with combat support and combat service support units (CS/CSS) fully ready for rapid deployment to meet any crisis. In doing so the USAR must focus its efforts on clearly identified goals, functions and structure that add value, elimination of waste, continuous improvement, flexibility, adaptability and responsiveness. With these as a guide, an ARCOM for the 21st Century Force can be developed.

DESCRIPTORS (U) *NATIONAL SECURITY, *ARMY PLANNING, *MILITARY RESERVES, ARMY, COMBAT SUPPORT, DEPLOYMENT, ELIMINATION, ENVIRONMENTS, FUNCTIONS, INTEGRATION, RAPID DEPLOYMENT, RECREATION, SECURITY, STRUCTURES, UNITED STATES, VALUE, WARFARE, WASTES.

IDENTIFIERS (U) United States Army Reserve Command, Future army, Futurism, 21st Century, Contingency operations.

AD-A279 522

ARMY WAR COLL CARLISLE BARRACKS PA

(U) A National Military Strategy Process for the Future.

APR 94 43P
PERSONAL AUTHORS: Riley, Don T.

UNCLASSIFIED REPORT

ABSTRACT (U) The purpose of this study is to examine the process used to develop the National Military Strategy and evaluate the effectiveness of the process for long-range planning. The paper reviews the strategy formulation pro- democratic society and then considers the regulations and policies developed since 1986 that govern the process. With that background, the study evaluates the system using the most recently published National Military Strategy, which resulted in the Base Force, and the defense strategy contained in the Bottom-Up Review. This examination reveals the difficulty of developing and implementing a long-range strategic vision. Finally, a review of the status of development of the present National Military Strategy serves to analyze progress made within the system. This review does not assess the strategies themselves. It discusses substantive content minimally and only for the purpose of analyzing the formulation process. The study focuses on how effective the Joint Strategic Planning System is in producing a long range military strategy. The study concludes with recommendations to improve the process.

DESCRIPTORS (U) *MILITARY STRATEGY, *MILITARY PLANNING, *LONG RANGE (TIME), *NATIONAL SECURITY, BACKGROUND, FORMULATIONS, POLICIES, REGULATIONS, STRATEGY, VISION, UNITED STATES.

IDENTIFIERS (U) National military strategy, Long range planning, Base force concept, Bottom-up review, Joint strategic planning system.

AD-A279 520

ARMY WAR COLL CARLISLE BARRACKS PA

(U) Ballistic Missile Proliferation a National Security Focus for the 21st Century.

APR 94 50P
PERSONAL AUTHORS: Peterson, Joseph F.

UNCLASSIFIED REPORT

ABSTRACT (U) The global proliferation of ballistic missiles and weapons of mass destruction (WMD) has become one of the most immediate and dangerous threats to U.S. national security. Ballistic missiles were used in four of the last six major wars. Some 190 missiles were fired by Iraqis over a six week period at Iranian cities in 1988. During the War of the Cities Iraq's firing of Scuds against coalition forces and Israel during the Gulf War provided a vivid reminder of the threat these weapons can present to the world community. During the 1980's, many Third World countries assigned a high priority to the acquisition of ballistic missiles. By 1991, more than 20 of these nations either possessed ballistic missiles or were attempting to obtain them. Today 43 nations possess ballistic missiles. Seventeen of these probably have a nuclear weapon capability, with 20 of them possessing also a chemical or biological capability. This paper seeks to define the military challenge ballistic missiles represent; review current U.S. counterproliferation and nonproliferation initiatives and, finally make recommendations on other potential methods or considerations to reduce ballistic missile proliferation.

DESCRIPTORS (U) *BALLISTICS, *MASS DESTRUCTION WEAPONS, *GUIDED MISSILES, *NATIONAL SECURITY, ACQUISITION, COUNTERS, CHEMICAL WARFARE, GLOBAL, ISRAEL, BIOLOGICAL WARFARE, NATIONS, NUCLEAR WEAPONS, SECURITY, THREATS, URBAN AREAS.

IDENTIFIERS (U) *Proliferation, *21st Century, WMD, Gulf War, Third world countries, SCUD missiles.

AD-A279 476

NAVAL WAR COLL NEWPORT RI DEPT OF OPERATIONS

(U) The C4I Strategic-Operational Link and Future Developments Impacting the Operational Commander.

FEB 94 43P
PERSONAL AUTHORS: Thoresen, David P.

UNCLASSIFIED REPORT

ABSTRACT (U) Technology developments within the Command, Control, Communications, Computers and Intelligence (C4I) area are rapidly causing changes throughout the world. U.S. operational commanders should reap benefit from these advances. However, the fact we can disseminate more information, faster, and to a wider audience is not the only measure of effectiveness. Recent experiences during the Gulf War, Somalia, and in development of contingency plans, have shown the dramatic role C4I capabilities can have at the operational level. Future operations across the spectrum of conflict will continue to demand more in the form of C4I support. The concept of forward deployed Forces is shifting to force projection from the Continental United States. Coupled with resource constraints, this shift requires C4I employment concepts and architectures to change. These changes are represented in concepts such as the Joint Staff's C4I for the Warrior and the U.S. Army's Enterprise Strategy Architectural change, such as the new U.S. Army Intelligence and Security Command's (INSCOM) Information Management Architecture (IMA), is beginning to focus technology advances on to equipment, deployment methods, and force structure. The focus of all these efforts is the link between strategic resources and the operational commander. Barriers to fully integrating strategic and operational C4I capabilities do exist. C4I vulnerabilities, multi-level security, joint interoperability, and integrating U.S. and coalition forces continue to be issues that will demand the attention of C4I planners and operational commanders. The future Operational commander, Technology, Application, Impacts.

DESCRIPTORS (U) *ARMY INTELLIGENCE, *COMMAND CONTROL COMMUNICATIONS, *COMPUTER ARCHITECTURE, ATTENTION BARRIERS, BENEFITS, COMPUTERS, CONFLICT, CONTROL DEPLOYMENT, EMPLOYMENT, IMPACT, INTELLIGENCE, INTEROPERABILITY, MANAGEMENT, RESOURCES, SHIFTING SOMALIA, UNITED STATES, VULNERABILITY.

IDENTIFIERS (U) C4I (Command Control Communication Computers and Intelligence), IMA (Information Management Architecture), INSCOM (Intelligence and Security Command).

AD-A279 188

MITECH INC PLEASANTVILLE NJ

(U) Research Requirements for Future Visual Guidance Systems.

FEB 94 101P
PERSONAL AUTHORS: Olson, Harold W. ; Paprocki, Thomas H.

UNCLASSIFIED REPORT

ABSTRACT (U) Airport visual aids provide essential information to pilots to facilitate their tasks of taking off, landing, and maneuvering the aircraft on the airport surfaces. Application of state-of-the-art technology can significantly improve the design and performance of the lighting, marking, and signage visual aids that provide the pilots with essential air and ground movement guidance. This study was undertaken to identify deficiencies in existing visual guidance systems and to forecast or project needs of the future. It also describes possible applications of new technology for resolving existing deficiencies and developing state-of-the-art visual guidance systems of the future. The study report identifies a number of potential research areas and new technologies of potential benefit to visual guidance. The recommended research areas are grouped by category according to phase of operation visual guidance, Visual aids, Airport lighting research.

DESCRIPTORS (U) *GUIDANCE, *VISUAL AIDS, AIRCRAFT, AIRPORTS, BENEFITS, DEFICIENCIES, LANDING, NUMBERS, OPERATION, PHASE, PILOTS, STATE OF THE ART, SURFACES, TAKEOFF.

IDENTIFIERS (U) *Visual guidance.

AD-A284 695

AIR UNIV MAXWELL AFB AL AIRPOWER RESEARCH INST

(U) Imaginary Architecture 2000 The Eyes of Global Power.

AUG 94 40P
PERSONAL AUTHORS: Harvey, Charles B.
REPORT NO AU-ARI-93-4

UNCLASSIFIED REPORT

SUPPLEMENTARY NOTE: Errata sheet included

ABSTRACT (U) The end of cold war and the bipolar focus of US military power introduced new uncertainties in the efforts to fathom the nature and source of future threats to American interests and in the posture defense forces should assume . Air Force Manual (AFM) 1-1, Basic Aerospace Doctrine of the United States Air Force addresses the vagaries in national security defense requirements. We do not know what threats the United States will face in the future, where Americans will face them, or against whom the United States might have to apply military forces. Continued access to resources and markets, geopolitical alliances and commitments, and the inherent requirements of global leadership make it essential that the U.S. be continuously able to adapt effectively to changes in the environment in each region of the world. Accordingly, one of the four cornerstones in the US defense strategy is forward presence. Although the changing global environment allows us to reduce our permanent foreign deployments, some US forces must remain deployed overseas in areas of US interest. The forward presence of US forces makes for more credible deterrence, promotes reqional stability, and provides us an initial capability for crisis response and escalation control. A key aspect of this challenge is the ability to defend worldwide military, political, and economic interests and commitments. Accordingly, US forces must be postured to respond to crises with immediacy and propriety, with an objective being to control escalation and resolve conflicts on terms favorable to the US and its allies.

DESCRIPTORS (U) *NATIONAL SECURITY, *GLOBAL, *DEFENSE PLANNING, POLICIES, GEOPOLITICS, DEPLOYMENT, MILITARY OPERATIONS, IMAGES.

AD-A283 936

ARMY WAR COLL STRATEGIC STUDIES INST CARLISLE BARRACKS PA

(U) Responding to Terrorism Across the Technological Spectrum.

JUL 94 41P
PERSONAL AUTHORS: Hoffmanan, Bruce

UNCLASSIFIED REPORT

ABSTRACT: (U) The author examines the changing nature of terrorism. In comparison to professional, terrorists , pursuing specific political or ideological objectives, today's amateurs often act from religious or racial convictions. Their objective may be to kill large numbers of people. They are less predictable and, therefore, more difficult to apprehend before the incident occurs, and have lethal devices ranging from the relatively simple fertilizer bomb to biologically-altered viruses. Since the United States will ramain an attractive target, we need to understand and prepare for this new kind of terrorism. Terrorism, Revolution in military affairs, Insurgency, Guerrilla warfare, Technological warfare, Conventional warfare, amateur terrorist, Professional terrorist.

DESCRIPTORS: (U) *TERRORISM, *UNCONVENTIONAL WARFARE, BOMBS, CONVENTIONAL WARFARE, FERTILIZERS, ADVANCED WEAPONS, GUERRILLA WARFARE, INSURGENCY, TARGETS, LOW INTENSITY CONFLICT, TERRORISTS, UNITED STATES, VIRUSES, WARFARE, NUCLEAR WARFARE, CHEMICAL WARFARE, BIOLOGICAL WARFARE, VULNERABILITY, THREAT EVALUATION, VIRUS DISEASES.

IDENTIFIERS: (U) RMA (Revolution In Military Affairs), Revolution in military affairs, Technological warfare, Amateur terrorists, Professional terrorists, Political ideologies, Religious ideologies, Fertilizer bombs.

AD-A283 836

ARMY WAR COLL STRATEGIC STUDIES INST
CARLISLE BARRACKS PA

(U) The Revolutlon in Military Affairs and Conflict Short of War.

JUL 94 48P
PERSONAL AUTHORS: Metz, Steven; Kivit, James

UNCLASSIFIED REPORT

ABSTRACT: (U) Many American strategic thinkers believe that we are in the beginning stages of a historical revolution in military affairs (RMA). This will not only change the nature of warfare, but also alter the global geopolitical balance. To date, most attention has fallen on the opportunities provided by the RMA rather than its risks, costs, and unintended consequences. In the arena of conflict short of war, these risks, costs, and unintended consequences may outweigh the potential benefits. The Cold War notion of conflict short of war is obsolete. Politically and militarily, the Third World of the future will be full of danger. The future will most likely be dominated by peace enforcement in failed states, new forms of insurgency and terrorism, and gray area phenomena. Many if not most Third World states will fragment into smaller units. Ungovernability and instability will be the norm with power dispersed among warlords, primal militias, and well-organized politico-criminal organizations. U.S. policy in the Third World is likely to be more selective and the U.S. homeland may no longer provide sanctuary. Renewed external support will restore the lagging proficiency of insurgents and terrorists. Emerging technology will have less impact on conflict short of war than on conventional, combined-arms warfare. It will, however, have some role.

DESCRIPTORS: (U) *MILITARY STRATEGY, *MILITARY DOCTRINE, *WARFARE, *FORECASTING, GEOPOLITICS, NATIONAL SECURITY, MILITARY FORCES (UNITED STATES), TERRORISM, LOW INTENSITY CONFLICT, UNCONVENTIONAL WARFARE, ADVANCED WEAPONS, COUNTERFORCES (MILITARY), CRIMES, DRUG INTERDICTION, TECHNOLOGY FORECASTING.

IDENTIFIERS: (U) RMA (Revolution In Military Affairs), Post Cold War Era, Future wars, OOTW (Operations Other Than War), Peacemaking, Peacekeeping, Nonlethal weapons, Detectors, Political criminal organizations, Organized crime, Counter narcotics.

AD-A283 589

ARMY WAR COLL STRATEGIC STUDIES INST
CARLISLE BARRACKS PA

(U) Two Historians in Technology and War.

JUL 94 55P
PERSONAL AUTHORS: Howard, Michael; Guilmartin, John F., Jr.

UNCLASSIFIED REPORT

ABSTRACT: (U) In April 1994, the Army War College's Strategic Studies Institute held its annual Strategy Conference. The theme for this year's conference was "The Revolution in Military Affairs: Defining an Army for the 21st Century". New technology is one of the most compelling aspects of the current Revolution in Military Affairs (RMA). Technological advances have offered advantages to one side or another at various times since the dawn of history and the advent of armed conflict. The Army must understand this revolution in all of its parts. Just as importantly, professional soldiers must retain their professional perspective and avoid becoming enchanted with technology. While technologically sophisticated weapons can help secure victory, technology in and of itself cannot win wars. Ultimately, wars are won or lost in the minds of soldiers and their leaders. Soldiers can learn about warfare from either personal experience or from studying history. The study of the history of warfare provides the student with an opportunity to examine critical aspects of warmaking without the risk. Fortunately for those who study the reasons for, and results of, conflict, this year's Strategy Conference began with a keynote address by one of the world's foremost military historians, Sir Michael Howard. His address was followed, in the first formal session, by a paper presented by Dr. John F. Guilmartin, Jr. who analyzed the technological limits of strategy.

DESCRIPTORS: (U) *CATALYTIC CONFLICT (WARFARE), *MILITARY PLANNING, *MILITARY HISTORY, WARFARE, MILITARY STRATEGY, MILITARY TRAINING, HISTORY, ADVANCED WEAPONS, STRATEGY, FORECASTING.

AD-A283 588

ARMY WAR COLL STRATEGIC STUDIES INST
CARLISLE BARRACKS PA

(U) Whither the RMA: Two Perspectives on Tomorrow's Army.

JUL 94 54P
PERSONAL AUTHORS: Bracken, Paul; Alcala, Raoul H.

UNCLASSIFIED REPORT

ABSTRACT: (U) The authors present two different views of the Army's future. One author contends that the Army will be shaped by domestic concerns as much as by external threats and that military power will remain a dominant factor in determining the status of nations. The other holds that doctrines will provide the basis for force structure, training, and weapons acquisition, and that the Army's ability to stay intellectually ahead of the technology will be, perhaps, its greatest challenge in the next century. Revolution in Military Affairs (RMA), Domestic concerns, External threats, Economic power, Military power, International relations, Technology.

DESCRIPTORS: (U) *MILITARY DOCTRINE, *MILITARY ORGANIZATIONS, *ARMY PLANNING, ACQUISITION, ARMY, DOCTRINE, DOMESTIC, ECONOMICS, EXTERNAL, INTERNATIONAL, INTERNATIONAL RELATIONS, NATIONS, POWER, STRUCTURES THREATS, TRAINING, WEAPONS, MILITARY FORCE LEVELS, ARMY, INTERNATIONAL POLITICS, THREAT EVALUATION, ARMY TRAINING, ADVANCED WEAPONS, TECHNOLOGY FORECASTING.

IDENTIFIERS: (U) RMA (Revolution in Military Affairs), *Revolution in military affairs, Future wars, Post Cold War Era, New World order, Force structure, Industrial base, Economic constraints, Military power, External threats.

AD-A283 267

ARMY TRAINING AND DOCTRINE COMMAND FORT MONROE VA

(U) Dismounted Battle Space: US Army Battle Dynamic Concept.

JUN 94 10P
REPORT NO. TRADOC-PAM-525-200-3

UNCLASSIFIED REPORT

ABSTRACT: (U) The changing world environment has resulted in a change in the National Military Strategy (NMS). This has lead to a new visionary concept for the Army of the Twenty-First Century, "Future Full Dimensional Operations". This vision incorporates the changes in threat, advances in technology, this adoption of a power projection history, influence a new doctrine--a doctrine for Full Dimensional Operations. Battlefields of the future will be characterized by fast moving forces with unprecedented lethality. Real-time information will be required to develop intelligence and synchronize the employment of forces and systems to destroy the enemy's capability to wage war. Improved sensors will find, identify and accurately locate targets in depth. Increasingly lethal weapons will engage enemy forces, operating at a much faster tempo than we have known before. They will overwhelm and destroy the enemy around the clock in all types of weather and terrain. To achieve decisive results, future Army commanders, at all echelons must be able to apply all available combat power to dominate their battle space. The concept of battle space facilitates the type of innovative and imaginative approach to warfighting required of leaders on future battlefields. This concept is not confined by time, boundaries, graphics, countermeasures, or other physical and intellectual constraints.

DESCRIPTORS: (U) *MILITARY DOCTRINE, *MILITARY STRATEGY, *ARMY OPERATIONS, *ARMY PLANNING, *ARMY TRAINING, BATTLEFIELDS, LETHALITY, ADVANCED WEAPONS, JOINT MILITARY ACTIVITIES, COMMAND CONTROL COMMUNICATIONS, DEPTH, AIR LAND BATTLES LONG RANGE (DISTANCE), KILL MECHANISMS, THREAT EVALUTION, DECISION MAKING.

IDENTIFIERS: (U) *Battle space, National military strategy, Future wars, Power projection, Full dimensional operations, Operations in depth, Coalition operations, Combined operations.

AD-A281 758

ARMY WAR COLL STRATEGIC STUDIES INST CARLISLE BARRACKS PA

(U) The Revolution in Military Affairs: A Framework for Defense Planning.

JUN 94 54P
PERSONAL AUTHORS: Mazarr, Michael J.

UNCLASSIFIED REPORT

ABSTRACT: (U) The author argues that the current revolution in military affairs is part of a larger sociopolitical transformation. The new technologies both propelling and resulting from this transformation are having a profound impact on warfare. The author urges military and civilian strategists, planners, and decision makers to think about armed conflict in ways so novel that those used to dealing with the unchanging truths about war may feel threatened. To help understand the ambiguities and complexities presented by the RMA, he offers a framework of four principles for defense planning. Revolution in Military Affairs (RKA), information, sensing and precision strike technologies.

DESCRIPTORS: (U) *DEFENSE PLANNING, *WARFARE, *MILITARY MODERNIZATION, CONFLICT, PLANNING, TRANSFORMATIONS, MILITARY STRATEGY, SYMPOSIA, DECISION MAKING.

IDENTIFIERS: (U) RMA (Revolution in Military Affairs).

AD-A279 378

NAVAL WAR COLL NEWPORT RI DEPT OF OPERATIONS

(U) Bomber Force 2000: Operational Concepts for Long-Range Combat Aircraft.

FEB 94 61P
PERSONAL AUTHORS: Beene, Jeffrey K.

UNCLASSIFIED REPORT

ABSTRACT: (U) This research paper seeks to synthesize analyses of air power theory and doctrine, historical insights from major operational current thinking, and the emerging strategic environment to detail concepts for improved planning and execution of future air operations. These operations would fully integrate bombers as longrange combat aviation assets. The search for a type of aircraft to fit the doctrine derived from early interpretations of air power theory has hindered development of bomber potential. The use of atomic weapons at the end of World War II and the ensuing Cold War further obscured understanding of bombers--their real contribution hinging on viewing them as long-range combat aircraft. Today the bomber is not obsolete, but its traditional nuclear paradigm is. The emergence of regional threats combined with a shrinking defense establishment and the global compression of time and space demand full integration of bomber aircraft into the U.S. air power arsenal. These aircraft provide a theater commander with a unique capability to rapidly respond across the spectrum of conflict from a peacetime show of force to major nuclear or non-nuclear conflict. However, for the operational commander to employ bomber assets effectively requires a full recognition of bomber attributes and a thorough understanding of their capabilities. Strategic, Reorganization,Technology, Conflict, Capabilities.

DESCRIPTORS: (U) *AIR POWER, *BOMBER AIRCRAFT, *MILITARY DOCTRINE, COLD WAR, COMPRESSION, CONFLICT, ENVIRONMENTS, GLOBAL, INTEGRATION, PEACETIME, PLANNING, AERIAL WARFARE, RECOGNITION, THEORY, THREATS, TIME, WEAPONS.

AD-A277 871

AIR FORCE NEWS AGENCY KELLY AFB TX

(U) Air Force Update. Bomber Force Projection.

FEB 94 20P

UNCLASSIFIED REPORT

ABSTRACT: (U) Over the next several decades, our national security will increasingly depend on conventional bombers to meet the demands of responding rapidly and decisively to security threats that may emerge in various regions of the world. A security strategy focused on regional dangers calls for the ability to deter and counter a range of potential threats even though the location and technological sophistication of these threats will be hard to predict. The nation's long-range bomber force has unmatched potential to provide conventional power for initial response to regional crises within hours and for sustained operations in any region of the world. As all services reduce their force structures, the bomber's precision, lethality, flexibility and range will continue to increase its value in airpower's contribution to national security. The national military strategy requires us to prepare for a second contingency that could arise while some forces are still engaged in the first. If such a threat emerged, a portion of our bomber force could swing to the second theater and strike time-critical targets until follow-on forces arrive. The bombers ability to neutralize high-value targets provides the United States essential freedom of action to stop an enemy offensive and allows the nation to build up its own Joint forces.

DESCRIPTORS: (U) *BOMBER AIRCRAFT, *JET BOMBERS, *CONVENTIONAL WARFARE, *NATIONAL SECURITY, *MILITARY STRATEGY AIR FORCE, UNITED STATES, LONG RANGE DISTANCE), LETHALITY, STEALTH TECHNOLOGY, MILITARY EXERCISES, JOINT MILITARY ACTIVITIES, MANNED, CRUISE MISSILES, STANDOFF MISSILES, FLYING PLATFORMS.

IDENTIFIERS: (U) Force projection, 21st Century, National military strategy, Contingency warfare, Regional warfare, *Global power projection, B-2 Aircraft, B-1 Aircraft, B-52H Aircraft.

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