NATIONAL DEFENSE
RESEARCH INSTITUTE

Annual Report

1995

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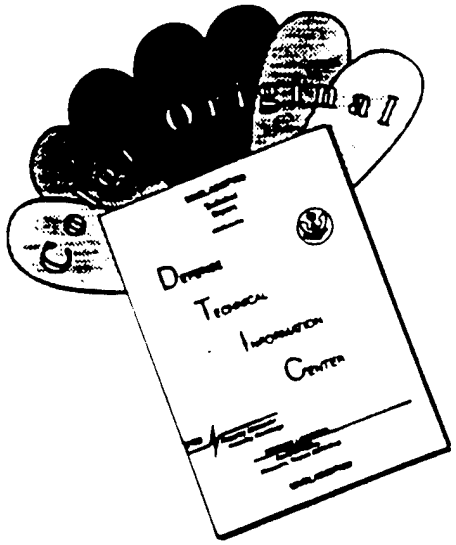

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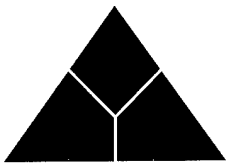

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RAND prepares administrative reports to convey information to its clients on the status of work being done for them.
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2 International Security and Defense Policy Center

Gregory F. Treverton, Director

3 Acquisition and Technology Policy Center

Eugene C. Gritton, Director

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Susan D. Hosek, Director

ATPC	Acquisition and Technology Policy Center
BRAC	Base realignment and closure
CERCLA	Comprehensive Environmental Response and Liability Act
CERFA	Community Environmental Response Facilitation Act
DoD	Department of Defense
EFOG	Enhanced fiber-optic-guided
EU	European Union
FFRDC	Federally funded research and development center
FRPC	Forces and Resources Policy Center
GDP	Gross domestic product
GPS	Global positioning satellite
ISDPC	International Security and Defense Policy Center
KNT	Kuomintang (nationalist party of Taiwan)
OSD	Office of the Secretary of Defense
SARA	Superfund Amendments and Reauthorization Act
TOW	Tube-launched, optically tracked, wire-guided missiles
UAV	Unmanned aerial vehicle
WMD	Weapons of mass destruction

1 Introduction

Preface

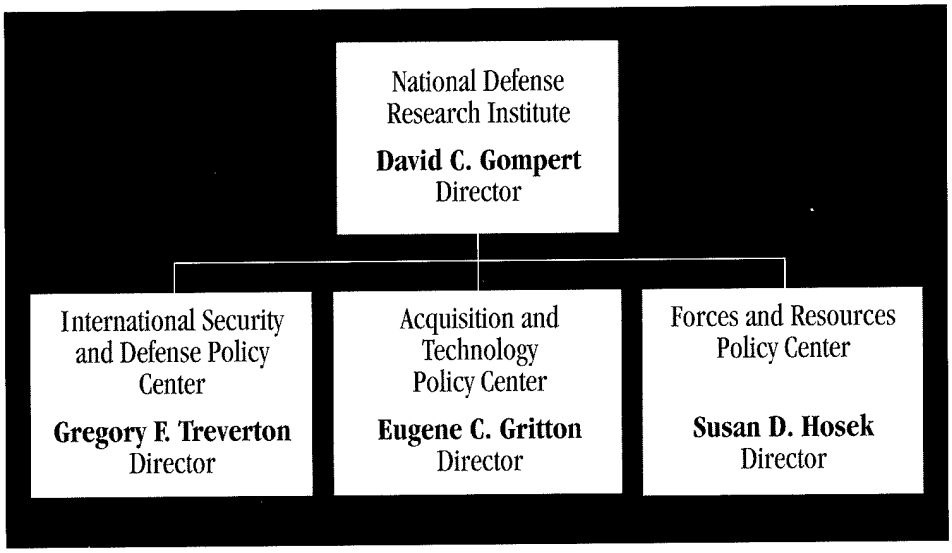
The National Defense Research Institute (NDRI) is a federally funded research and development center (FFRDC) that supports the Office of the Secretary of Defense (OSD), the Joint Staff, and the defense agencies. NDRI's mission is to help policymakers confront national security decisions that require disciplined analysis. It does so by bringing science, analytical rigor, and an understanding of world and national affairs to the study and choice of policy.

NDRI's Research Centers

NDRI conducts policy research through three centers, each of which serves and is guided by a family of sponsors. The research emphases in each center correspond closely with the responsibilities of three of the undersecretaries in OSD—Policy, Acquisition and Technology, and Personnel and Readiness—who are principal sponsors of NDRI research.

The **International Security and Defense Policy Center** seeks to understand how the security environment is changing, how those changes affect U.S. interests, and what strategies would be appropriate for protecting those interests and shaping the environment.

The **Acquisition and Technology Policy Center** searches for opportunities presented by the technological



NDRI's Three Policy Centers

revolution and explores ways to develop and acquire effective military systems in an era of resource constraints.

The **Forces and Resources Policy Center** concentrates on issues affecting the people who make up U.S. forces, on the forces needed to carry out U.S. military strategies, and on the optimum use of resources. It analyzes policy options with an eye toward assuring high quality military personnel.

In addition, NDRI carries out research that transcends the boundaries of its research centers and the specific interests of individual sponsors. Such "crosscutting" research addresses some of the most critical and challenging issues facing top Defense Department officials and their staffs.

The RAND Environment

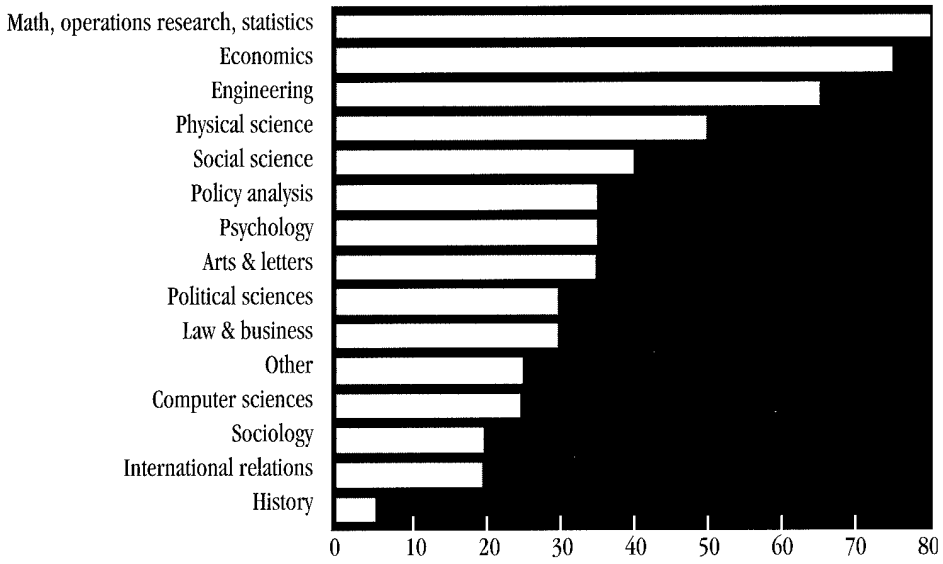
NDRI's centers operate within RAND, a private, nonprofit institution that has for almost 50 years studied issues relating to the national security and public welfare of the United States. NDRI draws its researchers from RAND's staff of 569

NDRI's Research Is Interrelated

professionals trained in a broad range of disciplines. RAND's staff is located in Santa Monica, California and Washington, D.C.

NDRI can also call on RAND's two other national security FFRDCs for additional analytical resources. Since the end of World War II, Project AIR FORCE has helped U.S. leaders determine the size, shape, and missions of the U.S. Air Force. RAND's Arroyo Center has addressed mid- and long-range policy questions for the U.S. Army.

NDRI also draws on RAND analytic talent from outside the defense arena. RAND's Critical Technology Institute analyzes national policy alternatives relating to science and technology. Numerous other RAND research centers provide specialists with skills that prove particularly useful when investigating policy issues.



RAND'S RESEARCH DISCIPLINES (IN NUMBERS OF STAFF)

Remaining Engaged in the Face of Constraints

In the turbulence that followed the end of the Cold War, the path of U.S. security policy was unclear. But as the broad outlines of the new global geopolitical environment have become more discernible, certain policy directions have emerged. Foremost among them is the need for international engagement and military superiority. Superiority, in turn, depends on applying information technology to enhance U.S. military advantages and preserving the unmatched quality of American military personnel. At the same time, all these endeavors must be carried out more resourcefully for the Nation to preserve its superiority, protect its interests, and meet its international responsibilities while addressing other priorities on the public agenda.

International Engagement

For most of the twentieth century, world war and global rivalry demanded U.S. involvement and leadership. Today, global economics provides the reason and the script. The U.S. economy is now an integral part of the world economy—the health, expansion, and security of which are thus of vital importance. From this vantage point, at least three geopolitical factors argue for continued U.S. involvement in the international scene.

- The United States' strong and growing interest in the regions that make up the core of the integrated world economy: Europe, East Asia, and, of course, North America.

- The dependence of these core regions on the stability of the Greater Middle East and the former Soviet Union, which contain most of the dangers as well as most of the energy reserves for the advanced core regions.

- The United States' interest in countering the most threatening of these dangers: the spread of nuclear, biological, and chemical weapons.

The United States also has more specific interests in these key regions.

Europe

The most important goals in this region are to stabilize the Balkans and to integrate and thus secure the new democracies in East Central Europe through the enlargement of NATO and the European Union (EU). These endeavors, in turn, should precipitate major reforms in NATO aimed at making it more effective in projecting power and thus permitting the United States to rely more on its European allies to help defend vital interests wherever they may be threatened.

East Asia

The peaceful unification of Korea and the stabilization of relations between Taiwan and China are the most immediate concerns. Beyond them lies the need for a new security framework for the region, one that provides for a unified Korea, a less dependent Japan, and an emerging China. These immediate concerns and the longer-term framework will define the U.S. role in the region.

Western Hemisphere

In this generally promising region, the United States has especially strong interests in Mexico's stability and progress and in the peaceful transformation of Cuba. But its interests range throughout the region, even though the external threats have largely dissipated. To enhance the stability and thus the progress of other nations in this area, the United States is interested in creating a closer hemispheric security community.

The Greater Middle East

Two issues define the United States' primary interest in this region. First, achieving a comprehensive Arab-Israeli peace promises a far more secure and stable region. That stability is key to transforming this region from a flash point to a place where nations coexist peacefully. A second interest is ensuring that Iraq and Iran—possibly bolstered by the threat of weapons of mass destruction—do not limit the world's access to the oil fields of the Middle East.

The Former Soviet Union

Reduction and control of the nuclear material and weapons left behind from the Cold War remain critical and unfinished business. Whereas the restoration of effective Russian power throughout the region is a more distant concern, it is best avoided by supporting Russian political and economic reform as well as the independence of Ukraine. In these endeavors, the United States' European partners should take on increased responsibilities, particularly considering the importance of EU economic cooperation.

Thus, U.S. interests give it a major stake in shaping the international environment. The question is frequently asked: Can the United States afford such policies and burdens of engagement? Because our economic needs dictate international involvement, a better question is how can we meet those needs in a way that conforms to our economic limits. Coalitions are fundamental. The task is to transform our Cold War alliances

into partnerships in which mutual vital interests, such as the security of the world energy supplies and safety from weapons of mass destruction, are ensured by common strategies and action, with the costs and risks fairly shared.

Maintaining Superiority: Quality People

The quality of the people in the military is widely acknowledged as a major component of recent successes. More than a decade of painstaking effort was required to fill the ranks with high-quality people. Such people are expensive. The absence of a threat to our way of life may foster a complacency that the United States can ill afford. The challenge is to spend wisely the resources necessary to get quality.

High quality not only assures military superiority, but it is also a good investment. Long experience has shown that high-quality people are far more likely to complete training courses and service obligations than lower-quality recruits. The recruiting, retention, compensation, and quality-of-life policies that have attracted and retained these high-quality people need to be scrutinized to ensure that each dollar spent buys the maximum capability.

Maintaining Superiority: Technology

The U.S. military superiority stands unchallenged, and the successful application of technology is one of the major underpinnings of that superiority. The United States is the world leader in military and information technologies. The challenge is how to leverage that technological edge to maintain the hard-won military superiority in a way that reduces costs.

The creative and ambitious use of information technologies may provide an answer. These technologies may allow agility and lethality to substitute for mass. Light forces that can detect threats at a distance and attack them with long-range weapons can deploy faster at less cost and be sustained more economically than the heavy armored forces of the past.

Exploiting information technology may also enable a more responsive yet leaner logistic infrastructure. Reducing the size of the support structure could substantially reduce the costs of national defense.

Relation to NDRI Research Agenda

These areas of focus—international presence, quality people, and high technology—parallel NDRI's organization and its research orientation. Each center maintains a "critical mass" of expertise in certain policy areas. The chart that follows encapsulates the essential capabilities of the three centers that make up NDRI.

These core competencies allow NDRI to conduct research in the areas most critical to policymakers as they define the course of U.S. engagement with a smaller portion of the Nation's resources. The sections that follow detail the centers' capabilities and illustrate recent research efforts.

International Security and Defense Policy Center	Forces and Resources Policy Center	Acquisition and Technology Policy Center
• Regional Expertise • International Security Structures • Defense Strategy and Doctrine • Threat Assessment • Tools for Nonmilitary Power • Strategic Modeling	• Force Planning • Personnel Management • Education and Training • Health Care • Cost Analysis • Resources to Requirements Models • Operations and Logistics Research	• Critical Technologies – Weapons – Information • Modeling and Simulation • Science and Technology Base • Defense Production Base

NDRI Core Competencies

2 International Security and Defense Policy Center

Gregory F. Treverton, Director

International Security

Strategies for key regions

People

Policies to preserve quality of U.S. forces

Technology

Ways to maintain superiority through technology

Themes and Agenda

1995 Research Themes

NDRI's International Security and Defense Policy Center (ISDPC) is the organization within NDRI chartered to analyze the effects of international political, strategic, economic, and technological changes and to assist Department of Defense (DoD) leaders in developing policies to deal with them. ISDPC is the result of two mergers: a 1990 marriage of NDRI's International Security and Defense Policy Program with the Strategy Planning and Assessment Program and a 1994 merger with the International Economic Policy Program.

ISDPC's agenda within NDRI involves the formulation of international security policy, including analyzing future geopolitical environments, assessing alternative national strategies and military balances, and analyzing the connection between national security and international trade and investments. Its primary sponsors are the Office of the Under Secretary of Defense for Policy, the J-5 and J-8 directorates of the Joint Staff, and the unified commands.

ISDPC's research for 1995 was organized around three themes:

Developing New Regional Security Structures for the Twenty-first Century: With security arrangements everywhere in flux, how should the United States act to shape structures to reflect its interests—in Europe, Asia, the Middle East and Gulf, and the Americas? This work draws on RAND's unparalleled regional expertise and its ability to integrate that with detailed military planning.

Identifying New Threats to U.S. Security: How will the proliferation of technology—for weaponry traditionally conceived or for information warfare—threaten U.S. interests? How might threats take on new forms, such as drug trafficking, international criminal enterprise, or religious militancy?

Redefining Power in an Era of Political, Financial, and Technological Uncertainty: How will the balance of power shift as new technology and tactics revolutionize military affairs? And how will the United States project power in situations in which military might is secondary, as in peacekeeping operations, or immaterial, as in financial crises?

Several highlights illustrate the new analytic terrain the center broke for the benefit of its Pentagon sponsors:

Identifying the Next Phases in the Revolution in Military Affairs

ISDPC for several years has been studying the implications of the so-called revolution in military affairs. That revolution, brought on by a confluence of new international strategic alignments and of new technologies, has overturned almost all conventional thinking regarding security affairs over the past several years. The center has assessed the implications of this revolution for U.S. strategy, security policies, coalitions, and international linkages. In particular, the center has used war simulation games to examine how technology and operational concepts might influence hostilities 15 or more years in the future. During 1995, the center broke new ground with studies of how the United States and its allies might be able to perpetuate their advantages stemming from that revolution by identifying new strategies and technologies they can employ to step outside the "advantage/response" cycle that has colored the revolution to date.

Understanding Sources of Vulnerability in the Gulf

Looked at deeply, the threats to stability in the Gulf derive less from Iran's strength than from the vulnerabilities of Gulf states. Iran's revolution is still militant and hostile, and it remains committed to building nuclear weapons; but by other measures, Iran and its economy are a shambles. Yet, Iran will have opportunities short of nuclear weapons: ISDPC research enumerated these by looking at several scenarios involving oil, possible connections between Iran and Iraq, and internal crises in Gulf states. The lessons for policy are mostly cautionary, but they suggest that as its presence increases, the U.S. military needs to stay largely "over the horizon," and that policymakers should pursue measures that recognize the differences between Iran and Iraq.

1996 Research Agenda

For FY96, ISDPC will broaden last year's themes and branch into several new areas. Its research will continue to help defense and foreign policymakers focus on critical areas and policy questions where traditional U.S. interests may no longer coincide with new international realities. ISDPC seeks to build eight subcenters of excellence, each of whose research

agendas would be tightly linked to the policy concerns of specific Defense Department sponsors:

Shaping the emerging security order in Europe in light of U.S. interests. Atop this agenda is framing the specific military requirements for both existing NATO members and prospective new ones as NATO contemplates expansion. That process will bear, as well, on the broader revamping of NATO forces and command structures. At the same time, questions need to be addressed about how Europe's flanks, both north and south, relate to the evolution of NATO's core.

Defining U.S. security interests, policies, and instruments in the Gulf and greater Middle East. Here, the future security structure and its implications for the United States are being driven primarily by two interactions—the peace process around Israel and the prospects for stability in the Gulf, focusing on Iraq and Iran. These interactions occur in the shadow of weapons and technologies of mass destruction and so draw on RAND's strengths in not just regional understanding but in defense planning and counterproliferation.

Understanding East Asia's changing balance of power and its implications for U.S. interests. In East Asia the predominant feature now is the rise of China, which raises immediate concerns about miscalculations in relations with Taiwan and longer-term questions about the role of the United States. Helping sort out the mix of security and economic concerns involved in U.S.-Japan relations is a second key ISDPC task, and the emergence of other Asian powers raises still other questions.

Coping with residual dangers and seizing new opportunities in the former Soviet Union's uncertain future. Russia, like China, looms large in relation to its neighbors, but otherwise most of the questions arise from weakness—of regional militaries, of security structures, perhaps of controls over nuclear and other lethal weapons, and of democratic governance. ISDPC analysis aims to sort out the dangers and the opportunities.

Containing and dealing with the proliferation of WMD (weapons of mass destruction) and lethal technologies. The world beyond the Cold War has spawned a wide range of challenges, for many of which basic analytic work is yet to be done. Counterproliferation studies, including work done by

ISDPC, are developing far-reaching insights about the implications of WD for military engagements, but those are only beginning to seep into mainline force planning. In heading off, rather than coping with, proliferation, there is a need for hard thought about U.S. interests, new ways of cooperating, and new forums for cooperation.

Reshaping U.S. military strategy, models, and forces during a revolution in military affairs. ISDPC will build on its pathbreaking work on the revolution in military affairs by examining the implications of the United States being present in or having access to overseas facilities. It will explore the ramifications of "strategic events" such as nuclear strikes on coalition-partners. . . . And ISDPC will investigate what might constitute a comparable revolution at levels of force below major regional contingencies. ISDPC has begun to include the critical ingredient—information—one generally assumed away in the past, explicitly in both modelling and planning. Additionally, it has started to develop techniques and models for moving beyond threat-based planning.

Redefining military roles as the Americas democratize and integrate economically. This small center will look at progress and opportunities to shape the region's militaries after the 1995 meeting of North and South American defense ministers. It also will plan for specific problem areas, such as Cuba or Haiti.

Developing techniques for assessing joint warfare. ISDPC will help top-tier U.S. military and security leaders, particularly the Joint Staff, assess ways to operate in situations where responsibilities cut across traditional service and operational responsibilities. RAND work informs choices both within and across the Joint War Capabilities Assessment, which is an analytic effort to explore ways that U.S. military leaders can link defense resources to create joint warfighting capabilities that run across service boundaries.

Research Highlight

Taiwan on a Tightrope

The outraged Chinese reaction to the visit of Taiwan's president to his alma mater in the United States surprised many in the West. The Chinese viewed the trip as a deliberate provocation by Taiwan. Why would Beijing regard such an act as provocative? What are the likely outcomes? What are the implications for U.S. policy? In *Change in Taiwan and Potential Adversity in the Strait,* NDRI attempts to answer these questions. The author argues that powerful domestic changes have driven Taiwanese leaders to walk a narrow and perilous path between confrontation and conciliation with China. In the charged environment that exists between the two countries, mistakes, miscalculations, or misunderstandings could easily precipitate conflict. Thus, it is crucial to understand these changes and what they imply for U.S. policy. Most compelling is the need for Washington to speak with one voice and to ensure that the Taiwanese understand that the only acceptable resolution of their status is one that is mutually agreeable to both Taipei and Beijing.

Change in Taiwan

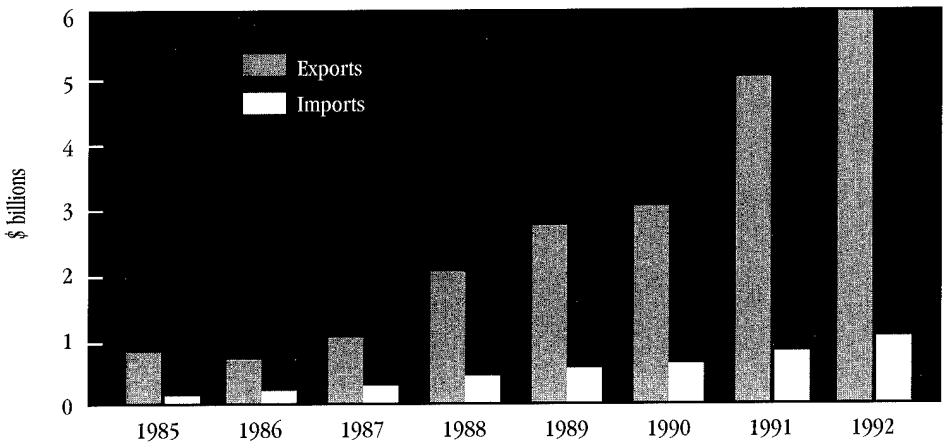
In the past decade, change has swept across Taiwan. Some of it bids to undermine the uneasy status quo with China. Other changes drive the two nations together, reinforcing Taiwan's dependence. Of the former, the most notable is generational: Taiwan's younger generation assumes that—regardless of how the nationality issue plays out with China—Taiwan will remain fundamentally autonomous. The young Taiwanese now moving into power, most of whom have been to the mainland only as tourists, no longer regard the mainland as an antagonist in the struggle to control all of China but see it rather as an external threat to Taiwan. Moreover, the nationalist (Kuomintang or KMT) party is grudgingly accommodating itself to this consensus. The KMT's leadership now includes ethnic Taiwanese who have supplanted old-guard elites and who have a more flexible approach to the issue of Taiwan's status.

Not only is Taiwan more flexible in approaching the mainland, it is increasingly confident of that approach. Whereas Chinese threats once stifled moves toward independence, those same threats no longer seem so menacing. Spurred by the new generation's attitude toward autonomy, Taiwan is seeking to give itself an identity distinct from China. One approach is to internationalize the status question by raising Taiwan's

global profile, largely by persistent lobbying to participate in international organizations such as the General Agreement on Tariffs and Trade. These sorts of activities run directly counter to China's view of Taiwan as another Chinese province and are the actions most likely to antagonize Beijing. Pushed aggressively, they could goad the Chinese into a violent response.

On the other hand, other changes under way have a steadying effect on China–Taiwan relations. One is the democratization of Taiwan. Martial law on the island was lifted only in 1987. In the ensuing few years, public debate has blossomed in a largely uncensored press, and parties and factions have proliferated. This democratization, coupled with a relatively short election cycle of three years, causes political leaders to seek broad-based support for their positions. To win this wide support, they have to avoid extreme positions on either side of the status question.

Second, Taiwan's economic development is forging closer links with the mainland. Taiwan is attempting to shift from a labor-intensive manufacturing economy to a capital- and tech-



SOURCE: National Statistics (1992 figures are forecast estimates).
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TAIWAN'S TRADE WITH CHINA

nology-intensive one. But it still depends heavily on trade, and any violent confrontation with the Chinese would harm it. Furthermore, much of the labor-intensive industry still owned by Taiwanese businessmen that has left the island has relocated to the mainland. This also tends to discourage brinkmanship with China. And China has become a significant trading partner with Taiwan. As the figure shows, trade has grown dramatically, with the balance heavily in Taiwan's favor.

Trade with the mainland is clearly an important—and growing—part of Taiwan's economy, and many do not want to see it upset.

These countervailing changes have forced Taiwan's leaders into a careful balancing act. They must take care not to antagonize China, but, at the same time, they must take a forceful stance in defense of the island's interests or risk the political consequences.

Implications for U.S. Policy

What does all of this imply for U.S. policy?

- First, the United States cannot speak with many voices. Mixed statements are likely to provide license for one faction or another to read into U.S. policy positions that support their particular interests. Such a situation is rife with potential for miscalculation and, ultimately, conflict.

- Second, Taiwan cannot misunderstand the U.S. position on Taiwan's status. Taipei should have no doubt that the only acceptable basis for change is a peaceful and mutually agreeable solution with Beijing. Unilateral moves by Taiwan do not square with this policy.

- Finally, Taiwan is a piece of the broader context of U.S.-China relations. If the United States cuts off dialogue as a way of expressing displeasure with Chinese actions, it pays a price in handling the Taiwan issue. On the contrary, the United States should pursue expanded contacts and discussions. Developing a strategic dialogue that will reduce the potential for miscalculation requires, in contrast, contacts of all sorts, including military-to-military ones.

Research Highlight

Confluence of Change: Domestic and International Realignment in Japan

With one party no longer dominating its political system, Japan likely will enter a period of political fluidity and weak governments that will last well into the twenty-first century.

This flux—the consequence of sweeping political, economic, and social changes at home and abroad that have taken place over the past decade and that will continue beyond the turn of the century—will redefine and redirect Japan's policy priorities. The deep and uninterrupted security relationship that Japan has enjoyed with the United States since 1945 will remain the bedrock feature of Japan's international policy. But a new Japan is emerging by fits and starts, one that is more closely linked to the economies of its East Asian neighbors and less dependent on trade and security ties to the United States.

The factors underlying Japan's redirection are dramatic and touch every facet of Japanese society. A new generation of political and economic leaders is replacing the old guard that has ruled since 1945. Japan's closed, distributor-heavy economic infrastructure is giving way to a more open, market-driven system. And, according to recent public opinion polls, growing numbers of Japanese want the country to take on broader, more activistic international responsibilities in the post–Cold War world.

These are the conclusions of a recent study of domestic change and foreign policy in Japan performed by NDRI. Employing interviews with Japanese politicians, bureaucrats, journalists, business leaders, and scholars, the study analyzed politics, economics, and attitudes in Japan to gauge their impact on Japanese and U.S. policies in the Asia-Pacific region over the next decade or more.

The bottom line is that Japanese security policies will not emerge along one consistent path during this period of change. The following are among the alternative policy routes that Japan may choose:

- Stay the course, maintaining trade and security postures that have been in place for the past 50 years.
- Create a multilateral security system throughout the Asia-Pacific region to complement the U.S. security relationship.

- Move to increase Japanese participation in the United Nations.
- Attempt to more closely integrate its economy with the economic systems of other East Asian countries through regional bodies such as the Asia-Pacific Economic Cooperation council.

At the extreme, the flux could usher in a new era of xenophobia, affecting economics, politics, culture, and the military.

Domestic and Economic Change in Japan

In part, Japan's changes are the product of the Cold War's end. No other major power benefited as much in economic and security terms as Japan did by aligning with the United States in the Soviet-American competition. With the disappearance of that competition, Japanese leaders have been forced to rethink not so much whether as how to maintain that political alignment with the Untied States.

Japan's changes also stem from a generational shift. Gone are the days when Japan's leadership was made up of people shaped by the country's struggle to emerge from World War II. As in the United States, postwar baby boomers are coming to leadership, bringing with them views different from those of their predecessors on politics, economics, and Japan's role in international affairs.

Replacing Liberal Democratic Rule

The era of Liberal Democratic rule ended in 1993. Since then, coalition governments have ruled Japan. Political reform took another turn in early 1994 when Japan adopted a new electoral system combining single-seat constituencies and proportional representation. That development replaced the old system of multiseat medium-sized districts that had produced nearly 40 years of uninterrupted Liberal Democratic Party rule. On the one hand, coalitions have blunted the sharp ideological divisions that defined the context of security policymaking for much of the preceding postwar era. Political support for the extreme alternatives of the nationalist right or the neutralist left has waned.

On the other hand, political realignment has reshaped public debate about security policy. Supporters of pro-American policies no longer confront backers of a more independent, pacifist Japan. Rather, debate now

focuses on concrete issues—how much of the alliance burden Japan should shoulder, the relative merits of military versus nonmilitary security measures, and how to interpret Japan's constitution in light of shifting security considerations.

Creating a Postrecession Economy

Japan has been in the throes of one of the worst economic recessions since the end of World War II. Since 1988, the nation's annual growth rates in terms of real gross domestic product (GDP) have fallen sharply. In 1993, Japan's GDP in real terms dropped by 0.2 percent. This was the worst performance since the 1974 oil crisis, when GDP declined by 0.6 percent.

The latest recession has been more structural than cyclical. It stemmed from the collapse of Japan's "bubble economy" in early 1990, which severely strained Japanese financial institutions and dampened consumer spending as well as business investment. Moreover, the recession resulted from overcapacity in Japanese factories and manufacturing facilities. With the global economic downturn, the output of the plants and the equipment that Japan invested in during the late 1980s have had great difficulty finding markets; Japanese industry has had to shave capacity and employees. Finally, the yen has appreciated to such a degree over the past five years that Japan's products are more and more expensive abroad.

In this economic environment, Japanese firms no longer see the United States as the most attractive country for expanding exports or for direct investments. Increasingly, Japanese companies look to transfer production facilities to East Asia to take advantage of lower labor costs and growing markets. As Japan embraces this "new Asianism," U.S. economic leverage over countries in the region will diminish.

New Policy Challenges for U.S. Policymakers

Given this new environment, Japan's policies toward the United States and its East Asian neighbors will evolve. Here is how some of the changes may play out:

Japanese nationalism may rise.

Under the most likely scenarios, political realignment will not alter the moderate security policy stance that Japan has held throughout the postwar period. But there is an outside chance that stridently nationalistic political elements could emerge in Japan.

This outcome would be most likely if economic relations with the United States deteriorated, the U.S. security commitment to Japan weakened, Chinese geopolitical assertiveness increased, and a hostile, reunited Korea emerged.

Traditional Japanese business practices will continue to evolve in response to continued economic recession. The economic downturn is causing Japan's leaders to reexamine the validity of long-standing economic policies and business practices. At the same time, it is forcing Japanese manufacturers to lower their output and to adopt flexible employment practices.

Export-led development may be a growing Japanese export. Japan may pose a dual trade threat to the United States: directly, by exporting goods, and indirectly, by exporting production know-how to other East Asian countries, which in turn export to the United States.

Japan may be less obliged to succumb to U.S. trade pressure. Japan's exports to East Asia surpassed its outbound trade to the United States in 1990, and the gap has grown ever since. This export diversity gives Japan the ability to turn to multilateral institutions to resist U.S. trade pressure.

Japan may become a bridge between the United States and East Asia. As its non-U.S. trade within the Asia-Pacific region becomes more dominant, Japan may see its role as one of trying to bridge differences between East Asia and the West.

Research Highlight

A Vision of Warfare Yet to Come

- The U.S. superiority in military technology that brought victory in the Gulf War may not guarantee success in future conflicts, because likely opponents will not try to match capabilities. Rather, they will pursue asymmetric approaches that tend to have shorter and cheaper development cycles, making it difficult for the United States to retain its military superiority.

- Since these approaches are unpredictable, the United States can maintain its edge only if it stays more than one step ahead on the challenge-response cycle and if it develops flexible capabilities that allow it to shift rapidly to close unanticipated gaps.

These are the conclusions NDRI analysts reached after conducting a series of Persian Gulf war games. The games were intended to predict major changes in operational concepts and technological capabilities over the next 20 years; yet, they revealed much more: a future that calls into question some fundamental national security assumptions.

The Games and What They Show

Members of the different military services and defense organizations played six series of post–Gulf War games. The Gulf War was selected as the baseline because it represented a revolution in military affairs: coalition forces dominated the conflict. The games were simultaneous in that they all occurred in 2015; yet, they were sequential in that both sides were able to learn from the experience of one game before beginning another. The "enemy" was given alternative sets of capabilities, ranging from one on a near par with the United States to one with a much smaller force.

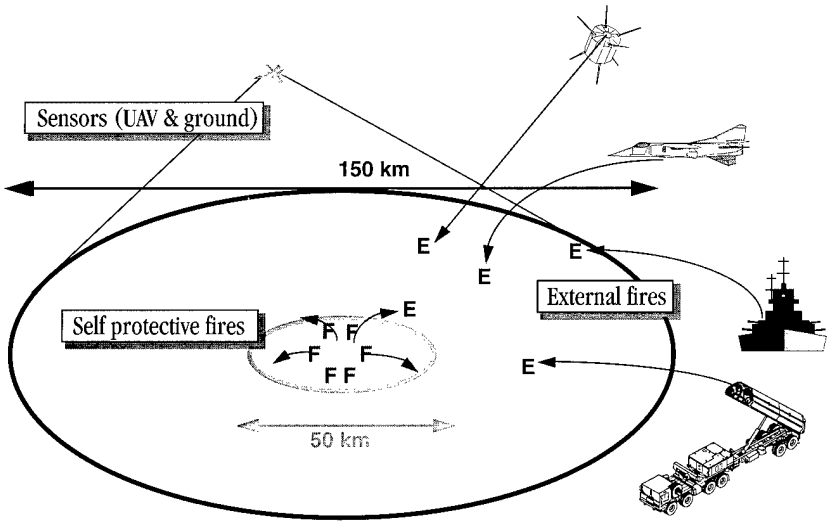
The games showed the pattern of warfare unfolding as a dialectic of challenge and response, with each side inventing challenges for the other and responding to the other's challenges, in turn. For instance, one of the enemy's major objectives was to slow the buildup of coalition forces in the theater. In three of the succeeding series, the enemy used a variety of measures to stop coalition forces at air and sea ports: conventional long-range missiles, special operations forces, and biological, chemical, and nuclear weapons. The United States

responded by reducing the density of its forces in the theater: streamlining logistics support, phasing deployment into the theater, using fewer heavy weapon systems, and using more weapons with greater reach.

Another enemy objective was to circumvent U.S. superiority in intelligence and information gathering. The enemy met this challenge by avoiding advanced technologies that make it easy to find and attack formations and by extensive planning so that operations could proceed even if all communications in the theater were disrupted.

This cycle of challenge and response continued until the fifth series, when the United States achieved a revolution in military affairs by establishing a network of advanced sensors for locating enemy forces. The networks are manned by highly mobile, readily deployable reconnaissance cavalry units each consisting of six vehicles and 20 soldiers.

The figure depicts a notional employment of such a unit (the "Fs" are friendly units, and the "Es," enemy). The unit's primary purpose is not to fight; rather, its mission is to call down external, long-range firepower



CONCEPTUAL DEPLOYMENT OF RECONNAISSANCE CAVALRY

on enemy forces located by a suite of air and ground sensors. One unit can cover 18,000 square kilometers, and a regiment (100 units) of them can control 62,000 square kilometers. Thus, the United States achieved a technological advantage that rendered the enemy incapable of responding in any meaningful way.

But the revolution was short-lived. In the sixth series, the enemy, recognizing that it could not match the U.S. force on technological grounds, adopted an asymmetric strategy and surprised the United States by attacking an unconventional and unprotected target: the oil fields of a U.S. ally. By eliminating the bulk of that oil production, the enemy could use its own oil fields to control the price of oil, achieving its major objective. At this point, the United States had no recourse.

Conclusions and Insights

The following key insights are emerging from the games:

The theater of operations is getting bigger. Warfare is spilling over the boundaries of what used to be viewed as a theater of operations. No longer is the area of conflict defined only by the area of the opposing armies. U.S. superiority in the immediate theater of operations can frustrate the enemy, forcing him to attack targets outside. We, therefore, need to rethink our notion of regional conflict and the parameters that circumscribe the battlefield. In the emerging theater of operations, it may be that all the world's a stage.

The combat arena is becoming less densely populated. As weapons have become more lethal, battlefields have become less dense with fewer soldiers per square kilometer. In the games, the enemy's use of lethal power (biological, chemical, and nuclear weapons) to slow deployment of coalition forces required the United States to reduce force density. The revolutionary sensor networks the United States developed in the fifth series represent an extreme movement toward greater area and less troop density.

Maneuver by long-range weapons is increasingly important, and these weapons are becoming more operational. Increased technological capability may allow long-range weapons to accomplish the goals previously achieved by maneuvering ground forces. That is, munitions delivered by long-range weapons may be moved around the battlefield and may attack enemy formations or control terrain.

As a result, long-range weapons are assuming increased importance at the operational level of war.

In the challenge-response cycle, the challenge always shapes the response and the response defines the next challenge. Although the United States has effectively challenged its enemies with its technological superiority, the enemy has responded and will respond with clever ideas for circumventing that technological edge. Because clever ideas are much easier and less expensive to generate than new technology, the United States needs to rethink its current focus on technological superiority. Other ways may exist to outsmart the enemy with fewer investments and shorter development cycles.

All revolutions in military affairs are ephemeral. To stay on top of the dialectic, the United States must stay more than a step ahead of the enemy. Because the design of the next response is always evident in the current challenge, we can influence the threat of the future. To shape the future to our advantage, we need to rethink the two major regional conflict scenarios on which U.S. global military strategy is based and our reliance on leading edge technology. We need to think 20 to 30 years or more into the future. Although such a vision may be blurred by uncertainties, it is perhaps time to develop better approaches to managing such uncertainties. This is the only way to achieve the prescience needed to see the forms of warfare yet to come.

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3 Acquisition and Technology Policy Center

Eugene C. Gritton, Director

International Security

Strategies for key regions

People

Policies to preserve quality of U.S. forces

Technology

Ways to maintain superiority through technology

Themes and Agenda

1995 Research Themes

The Acquisition and Technology Policy Center (ATPC) is the division of NDRI that addresses issues of accelerating technological change in the context of the revolution in world politics and the transformation of the U.S. military establishment. ATPC's research typically follows several interrelated lines of inquiry:

- Warfare in the information age
- Implications of new technology
- Maintaining the defense technology and production base
- Effectiveness of acquisition strategy
- Reorganizing the infrastructure
- Applying advanced analytic methods.

ATPC's primary clients are the offices of the Under Secretary of Defense (Acquisition and Technology); the Advanced Research Projects Agency; the Assistant Secretary of Defense (C3I); the Ballistic Missile Defense Office; and the Defense Intelligence Agency.

ATPC broke new ground pursuing research in four major areas in 1995.

Assessing the information revolution's impact on military, civilian, and intelligence affairs. Three ATPC research efforts focusing on new forms of information warfare were particularly noteworthy in this area of inquiry:

Warfare in the Information Age—This research centered on ways that vital information and data networks can be threatened, damaged, or destroyed by various aggressors in a variety of settings. ATPC analysts took the lead in investigating ways that the United States could protect its information systems and communication networks from new sources of threat. To increase awareness of this issue among policymakers, ATPC created and conducted lifelike exercises, dubbed "The Day After . . . in Cyberspace," for numerous high-level military, governmental, and civilian decisionmakers.

Netwar—ATPC analysts investigated ways that threats and aggression may originate through novel avenues, such as computer networks like the Internet, and be carried forth by a new set of aggressors with access to computers. Not only traditional governmental and military sources could wage this kind of warfare, but unconventional aggressors—such as political or narco-terrorists, organized

criminal groups, or insurgent groups—also could wage war in this fashion.

Improving the capability of future military projection forces by using advanced technology. This research studied the impact of precision-guided munitions, targeting controls, and battlefield situation awareness. To enhance the capabilities of our light rapid-projection forces, ATPC provided the underlying analytic support to the rapid-force-projection initiative (Advanced Concept Technical Demonstration).

Exploring future theater ballistic missile defenses. ATPC researchers examined different ways to defend theater battlefields. They also are investigating the best methods U.S. military leaders should employ to integrate the increasingly complex and diverse amounts of real-time information that is becoming available on battlefields, including data from remote sensing, ground sensing, and intelligence sources.

Investigating ways to develop new acquisition strategies. ATPC researchers explored what lessons policymakers might find in three recent Pentagon acquisitions—High-Altitude Endurance Unmanned-Aerial Vehicles, F-22, and F/A-18 jets. This research aimed to help improve acquisition management control and oversight. ATPC researchers also explored how alternative organizational forms could improve acquisition oversight and management in the Office of the Under Secretary of Defense (Acquisition and Technology).

1996 Research Agenda

As the information revolution continues, modes of conflict and even concepts of national security may change dramatically. ATPC's Fiscal Year 1996 research agenda is based on the notion that the security environment in the year 2000 and beyond may require defense strategies not previously emphasized, because of the emergence of technologies not previously viewed as critical to national security.

ATPC's increasing emphasis on conflict in the information age draws impetus from the recent establishment of the Information Warfare Executive Board by the Deputy Secretary of Defense and from research capital that the center accumulated as it supported the Board's initial policy deliberations. RAND has argued that the information revolution is both affecting the way conventional conflict is fought and providing new avenues by which

U.S. national and economic security can be threatened. Interest in these new threats has reached beyond DoD to decisionmakers concerned with law enforcement and commerce. Because these are near-term threats, research related to them is needed in the current fiscal year. Meanwhile, ATPC is broadening its research on the effects of the information revolution on traditional modes of warfare.

ATPC will place continued emphasis on mapping out technology investment strategies for developing systems to support U.S. military operations in the post–Cold War era and on issues related to the defense technology and production base. That era is already here, and U.S. troops could be facing new-era threats with systems designed chiefly to counter Soviet forces. ATPC is continuing its research on light forces, on technological support for urban and other "low-intensity" operations, and on military applications of robotics. It is revisiting the topic of breakthrough technologies that might lead to revolutions in military affairs, while initiating efforts on technologies aiding counterproliferation. In all cases, emphasis is being placed on the acquisition and life-cycle costs of the systems studied.

The defense technology and production base that would produce such technologies also requires immediate attention. Much of that infrastructure is in the private sector, where industry downsizing and restructuring is well under way and will continue with no guarantee that the outcome will favor DoD objectives. Here, ATPC is expanding Fiscal Year 1995 work on prioritizing research and development to improve the acquisition of advanced, high-quality systems (including those needed to replace current platforms as they age).

The center plans to help DoD devise new approaches to resource allocation decisions. Lower military budgets require innovative approaches to acquisition in general, and ATPC will examine the use of commercial technologies for military applications and for ways to streamline acquisition regulations and oversight.

To determine which technologies to develop and incorporate into weapon systems during the next decade and beyond, a more flexible, robust simulation modeling environment is invaluable. ATPC's strengths in this area are well matched to the Defense Modeling and Simulation Office's needs in its continuing program to bring about modeling and simulation improvements.

ATPC's studies agenda for Fiscal Year 1996 reflects the technological shifts and changing security considerations of its primary sponsors.

- **Managing conflict in an information age:** How can the United States thwart assaults on the computer and information infrastructure that bears on national security?

- **Understanding changing strategic and military relationships brought about by new technologies:** How are new critical technologies changing the definition of conflict and the nature of power?

- **Maintaining core industrial capabilities in a changing U.S. economy:** How can the United States restructure its industrial base so as to sustain vital defense technology and production capabilities?

- **Stretching acquisition dollars as defense outlays shrink:** How can the United States improve its military acquisition process and its ability to focus acquisitions on evolving threats?

- **Identifying military equipment for the twenty-first century:** How can the United States use computer simulations and modeling to assess the military utility of future weapon-system concepts to counter threats a decade or more away?

Research Highlight

Turning Light Forces into Heavy Hitters: New Technologies for U.S. Rapid-Reaction Missions

In recent years, light, rapid-reaction forces have become a staple of U.S. military strategy and planning. Rather than defending predetermined territories with large, prepositioned forces, current U.S. plans call for quick and decisive deployments of lightly armed forces into locations of potential or actual hostilities.

Recent research performed by RAND's National Defense Research Institute and its Arroyo Center suggests that emerging technologies will eliminate or substantially reduce a major drawback of this developing role for light forces: their vulnerability to attacks from heavily armored enemies.

Equipping these forces with new or expected-to-be-developed hunter-killer capabilities—a combination of standoff weapons, sophisticated reconnaissance and targeting systems, and efficient counterbattery weapons—greatly increases their lethality and survivability. Such an arsenal would be more effective than these forces' current firepower, which relies heavily on direct-fire, line-of sight technologies and would allow light forces to carry out the wider range of missions that military strategists have envisioned for them.

Specifically, RAND's studies suggest that light forces equipped with enhanced fiber-optic-guided (EFOG) missiles, which can be fired with high accuracy at the enemy from distances as great as 15 kilometers, would destroy more targets than they do with their current weapon of choice—tube-launched, optically tracked, wire-guided missiles (TOW). Combined with reconnaissance and sensing systems, these new weapons allow light forces to engage enemy forces from greater distances, maneuver more quickly, cover more territory, and follow more flexible tactics than with weapon systems they currently employ.

RAND conducted the research as part of the Rapid-Force Projection Technologies project, one of the Pentagon's new advanced-concept technical demonstrations. Using computer simulations, RAND analysts tested, compared, and contrasted new technologies and systems that would allow light forces to better withstand and overcome attacks from larger, more heavily armed forces in varying terrain. The study also developed

computer software to simulate related emerging technologies, such as acoustic sensors and command and control system architectures.

Revolution in Military Affairs: Light Forces, Heavy Responsibilities

The Pentagon's interest in light forces is the result of an ongoing revolution in military affairs that has influenced military thinking profoundly over the past decade. Incorporating new tactics and technologies, this revolution substitutes agility and lethality for mass in battlefield situations. Strategists are attracted to light forces because they can detect and attack threats with fewer personnel, be deployed faster and at less cost, and be sustained more economically than the heavy armored forces of the past.

However, whereas deployments of light forces carry advantages over earlier strategies in terms of responsiveness, flexibility, and cost, they also involve risks. Particularly in the early phases of a conflict, these forces are vulnerable to attack from heavily armored enemies. In the first stages of the Desert Shield buildup, for example, U.S. forces are widely acknowledged to have been unable to withstand attacks under certain conditions.

This vulnerability limits the types of roles and missions that light forces can perform. Planners, who would like to employ them in a growing variety of situations, have had to restrict where and when they would call for their use.

Simulating the Alternatives

RAND researchers developed and combined an extensive array of sophisticated computer simulations to address three questions:

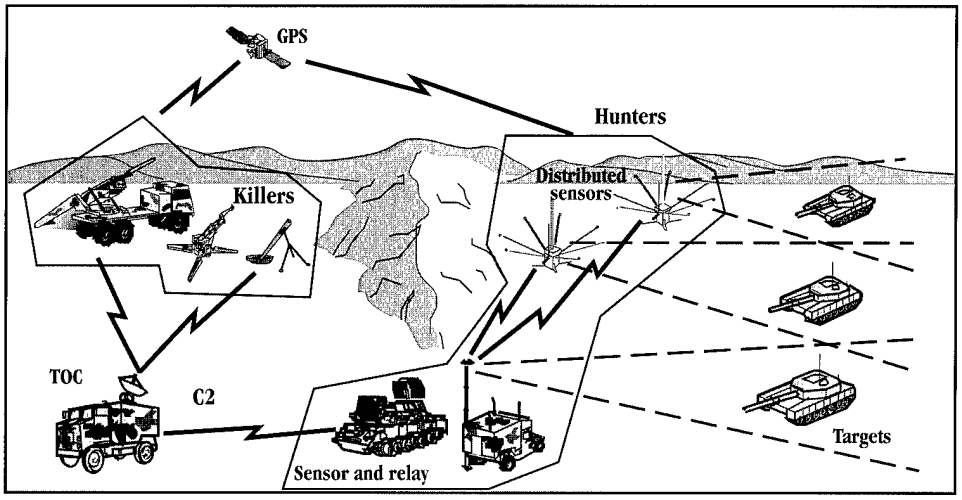
- How does a current light airborne force perform against existing heavy forces?
- Can a light airborne force be enhanced or reconfigured to repel existing heavy forces?
- What are the vulnerabilities of a light airborne force to a future heavy force?

Researchers examined these questions using simulated conflicts in two regions with quite different terrain, Southwest Asia and East Europe. These models allowed the researchers to frame a variety of attacks by massed enemy troops supported by tanks and other heavy armor against U.S. light forces equipped with current and alternative mixes of weapons.

Current Light Forces Can Be Overrun

Our analysis showed that a U.S. light airborne force, similar in size and composition to the current 82nd Division Ready Brigade, could blunt an initial onslaught from a heavy enemy force employing Soviet-made equipment and Soviet-style battle tactics. However, that U.S. light force, if equipped with its current array of direct-fire and indirect-fire weapons—such as Apache attack helicopters, Sheridan light tanks, TOW missiles, and towed-artillery tubes—eventually would be unable to sustain its defense and would be overrun. While able to inflict significant losses, U.S. troops would be unable to destroy enough enemy equipment at long range to undermine the attacker's overwhelming numerical superiority, thereby allowing more enemy troops and armor to come into close range than U.S. forces could handle.

How long light forces survived depended on the terrain. In simulated engagements in flat deserts of Southwest Asia, U.S. light forces could fend off initial enemy attacks. Long lines of sight in the desert allowed light forces to engage the enemy with TOW missiles and other direct-fire weapons before the enemy could engage them. In the hilly and more heavily vegetated East Europe scenario, U.S. light forces were less



HUNTER-KILLER IS A KEY LIGHT-FORCE ENHANCEMENT

successful fending off initial attacks. The close terrain afforded less opportunities to see, attack, and engage approaching forces at range. In both types of locales, however, enemy forces approaching *en mass*, with a considerable force-size advantage eventually closed and overwhelmed the U.S. light force.

New Technologies Can Enhance Light Forces

New technologies could improve the chances of U.S. light forces overcoming attacks from existing heavy forces. In simulated battles, U.S. forces using enhanced direct-fire weapons, such as the Army's new Armed Gun System light tank, would fare modestly better than forces equipped with current firepower. Nonetheless, making improvements to U.S. forces' direct-fire weapons alone would not prevent their eventual demise at the hands of heavy enemy assaults in Southwest Asia or East Europe.

Adding new standoff weapons such as the EFOG missile to U.S. light-force arsenals would be a more successful tactic. Coupled with mobile reconnaissance vehicles that could pinpoint enemy targets, EFOG missiles would be a highly effective addition to light forces. Particularly in Southwest Asia, where open terrain allows for long-range detection by reconnaissance vehicles, these standoff missiles would be able to destroy sufficient numbers of enemy armor at long range, so that U.S. direct-fire weapons would be able to handle remaining enemy weapons in close, line-of-sight engagements. Moreover, light forces could become even more lethal if the United States were to improve the speed with which reconnaissance hunter vehicles communicated with standoff killer missiles.

Future Heavy Forces Pose New Problems

Even with these enhancements, U.S. light forces would not be as successful against future enemy forces equipped with longer-range weapons, more accurate targeting systems, and upgraded forward-looking infrared sensors. Further improvements would be needed to maintain a battlefield edge for U.S. light forces. In particular, light forces' arsenals would need to be augmented by precision-guided counterbattery weapons as a means to target and destroy at long range as much of an improved enemy force as possible. In both Southwest Asia and East Europe, the Damocles high-mobility artillery rocket system, which contains smart munitions with target recognition capabilities, would provide the most effective counterbattery addition.

Improving the Odds

Our analysis suggests that light airborne forces can be improved in defensive operations against a larger heavy force. New technology concepts, such as standoff weapons and hunter vehicles, can extend the battle space, allowing the fight to begin sooner and at greater range. By so shaping the battlefield, these improvements would help minimize the consequences of having light forces be forced to engage attacking forces at close ranges.

RAND research also suggests that force enhancements can be tailored to improve light forces' chances of surviving heavy force attacks. Enhancements would depend on the type of terrain in which light forces would operate—open versus close territory—and on the type of threat they would encounter—existing or future. In open terrain, our simulations showed that large benefits might be obtained from relatively few enhancements. Operations in close terrain would require more extensive enhancements.

Research Highlight

Strategic War . . . in Cyberspace

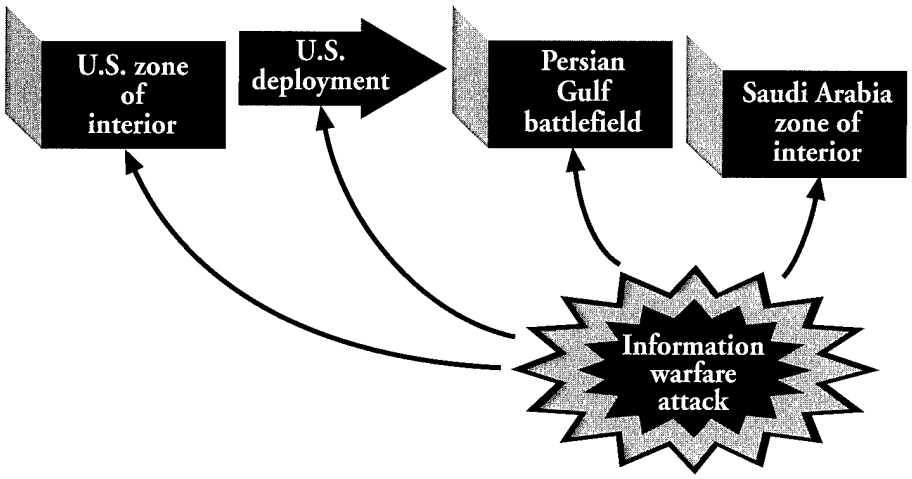
National security is becoming progressively more dependent on and identified with assets related to the "information revolution." As part of this revolution, both defense and civilian activities are becoming more heavily dependent on computers and communications, and a variety of key information systems are becoming more densely and extensively interlinked. With the many benefits of the information revolution have also come vulnerabilities. Civilian data encryption and system protection are rudimentary. Talented computer hackers in distant countries may be able to gain access to large portions of the information infrastructure underlying both U.S. economic well-being and defense logistics and communications. Current or potential adversaries may also gain access through foreign suppliers to the software encoded in U.S. transportation and other infrastructure systems. We could thus one day see actions equivalent to strategic attack on targets of national value within the U.S. homeland and on essential national security components and capabilities. In short, there will exist the capability for *strategic information warfare.*

Recognizing this possibility, in January 1995, the Secretary of Defense established an Information Warfare Executive Board to facilitate "the development and achievement of national information warfare goals." RAND was asked to provide an analytic framework and exercise for identifying defensive information warfare issues, for exploring their consequences, and for highlighting starting points for policy development. Among those points emanating from the exercise were the following:

- Establish within the Executive Office of the President a focal point for federal leadership in support of a coordinated response to the information warfare threat.
- Assess the vulnerability of key elements of current U.S. national security and national military strategy to strategic information warfare.
- Explore the feasibility of developing a minimum essential information infrastructure, permitting effective overseas force deployments and keeping the nation functioning even in the face of a sophisticated information warfare attack.

The exercise leading to these conclusions was conducted by a RAND team and is described in *Strategic Information Warfare: A New Face of War.* It was run three times with participation by senior members of the national security community and representatives from U.S. government domestic agencies and the telecommunications and information system industries. The exercise confronted participants with a challenging hypothetical political-military crisis in the year 2000. In this crisis, a conventional Iranian military threat and an internal threat to Saudi Arabia are made more acute by critical information and communication system failures in the U.S. homeland and elsewhere. These failures appear to result from both strategic information warfare conducted from outside the United States and from the actions of domestic anti-interventionist groups.

The exercise scenario thus highlighted from the start a fundamental aspect of strategic information warfare: There is no "front line." Though defense planners are used to thinking of information-related attacks in terms of such actions as jamming in-theater military communications, strategic targets in the United States may prove just as vulnerable. So also may targets in allied "zones of interior" and in the



THE CHANGING FACE OF WAR: FOUR STRATEGIC INFORMATION WARFARE THEATERS OF OPERATION

systems supporting U.S. force deployment. As a result, the attention of exercise participants quickly broadened to include four distinct theaters of operation, as shown in the figure.

Strategic information warfare challenges conventional approaches to defense as a result of various defining and closely coupled characteristics:

Low entry cost

In contrast to the strategic nuclear environment of the Cold War, a strategic information attack on the United States might be made without access to large financial resources or state sponsorship. The "weapons" could be software "logic bombs" or computer worms and viruses, the "delivery systems," cellular telephones, and the Internet.

Blurred traditional boundaries

In cyberspace, the boundaries between nations and private-sector organizations are porous, rendering distinctions between war and crime and between public and private interests less meaningful. International activist organizations may function largely over the Internet and provide (perhaps unintentional) cover for information warriors within their ranks.

Expanded role for perception management

New information-based techniques may substantially increase the power of deception and image manipulation activities. Disinformation may make it difficult for the U.S. government to build political support for actions needed to ensure national security.

Lack of strategic intelligence

Vulnerabilities to strategic information warfare are poorly understood. The identities of potential adversaries may be unknown, and classical intelligence collection and analysis methods may not apply. New methods of analysis and interorganizational relations may have to be developed.

Difficulty of tactical warning and attack assessment

There will be formidable problems in distinguishing between strategic information warfare attacks and other kinds of activities and events, such as espionage, accidents, system failures, and hacker pranks. An inability to make such distinctions could lead to very cautious military responses to regional challenges such as those hypothesized in the exercise.

Difficulty of building and sustaining coalitions

Coalition responses could be at risk to the weakest information links binding the alliance. An inability to protect partners from information warfare attacks could jeopardize the United States' ability to form and sustain coalitions.

Vulnerability of the U.S. homeland

The U.S. economy and society rely increasingly on a high-performance networked information infrastructure for everything from air travel and electric-power provision to management of citizens' financial accounts. A new set of lucrative strategic targets thus presents itself to potential information warriors.

These characteristics were elucidated over the course of the exercise, which was based on a methodology RAND had developed previously for exploring counterproliferation and related intelligence issues. The output of the exercise was a set of initiatives intended to minimize the likelihood of a crisis of the type portrayed or, failing that, to minimize its consequences. These recommendations, presented above, reflect both the potential gravity of the threat as viewed by the exercise participants and their desire not to overreact to what is now largely a hypothetical problem. It is possible, after all, that the evolving information infrastructure will be equipped with adequate protections as its commercial developers respond to local vulnerabilities and concerns. However, the tendency of the exercise participants was to view information infrastructure vulnerabilities and the potential for strategic information warfare far more seriously the more they learned about the subject and debated its implications.

Research Highlight

Improving the DoD's Hazardous Waste Cleanup Program

The complete cleanup of hazardous wastes—solvents, petroleum products, metals, munitions wastes—from DoD bases is mandated by the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) of 1980 and the Superfund Amendments and Reauthorization Act (SARA) of 1986. However, it has become increasingly apparent that, given the available resources, complete cleanup may be many years away and interim cleanup goals may have to be established in the meantime. With interim goals, cleanup efforts could be focused on tasks that would contribute the most to reducing risk to human health, readying lands for reuse, or speeding the cleanup process. Lower-priority tasks could be postponed.

Can such goals be harmonized with one another and with CERCLA and SARA as written? RAND researchers explored this question by evaluating cleanup projects at nine closing bases in California, using a case studies approach. They chose California because of the state's demonstrated commitment to accelerating the cleanup process. The researchers found that, although cleanup projects occur in a complex context that tends to inhibit innovation, there are enough flexibilities in the law to allow interim goals. At one of the bases studied in depth, project managers seized the available opportunities to speed the cleanup process. At another, progress was delayed—as it is at most DoD bases—by complying with the letter of the law.

Cleanup Context

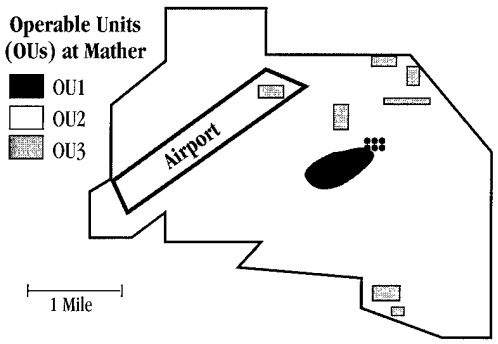
There are both obstacles to and opportunities for instituting interim cleanup goals. On the one hand, competing boundaries identifying cleanup sites make it difficult to divide a base according to cleanup priorities. Under CERCLA, bases are divided into groups of contaminated sites known as "operable units." More often than not, operable units are drawn to enhance the convenience and economy of a total base cleanup rather than to isolate the most risky hazardous waste sites. Under the Community Environmental Response Facilitation Act (CERFA), passed in 1992, bases are divided into parcels according to plans for reuse. These internal base boundaries are not necessarily compatible. Establishing interim goals is also inhibited by the many preliminary studies that CERCLA and

SARA require to inform a total base cleanup plan.

On the other hand, a careful examination of CERCLA and SARA reveals allowances for phased cleanup schedules. In an urgent situation, the DoD can authorize the removal of contaminants before the completion of the preliminary studies. The DoD also has instituted base realignment and closure (BRAC) cleanup teams that can adjust cleanup schedules and internal base boundaries to accommodate interim goals. The BRAC cleanup teams are composed of DoD project managers and local regulators representing the Environmental Protection Agency and the California Environmental Protection Agency, which enforce CERCLA and SARA.

Mather Air Force Base

Like most DoD cleanup projects, the cleanup at Mather Air Force Base, just outside Sacramento, has been costly and slow. Since 1989, $40 million has been spent, mostly on preliminary studies, yet only three small waste removal projects have been undertaken. The problem is the base-wide approach to cleanup implied in the drawing of CERCLA operable units. Fifty-nine of Mather's 69 hazardous waste sites are enclosed in one operable unit that effectively encompasses the entire base, making it difficult to divide the cleanup project into smaller, more manageable units. The only parcel of land designated by CERFA for civilian reuse—the airport—traverses two operable units, making it difficult to focus cleanup efforts on the airport.



INTERNAL BASE BOUNDARIES OVERLAP, IMPLY TOTAL BASE CLEANUP

If the project management at Mather had used the BRAC cleanup team to adjust the internal base boundaries, it could have focused the cleanup effort on the airport parcel and delayed cleanup of the remaining sites, perhaps indefinitely. To ensure the lasting safety of the airport, the cleanup project would also have had to identify any neighboring sites with contaminants that might spread to the airport. This sort of limited cleanup strategy focused on preparing lands for reuse would also incorporate risk reduction since the airport parcel would have to be clean enough for humans to use now and in the future. Furthermore, it would be significantly less expensive than total cleanup. The estimated cost for cleaning the airport parcel is only about half the cost of cleaning the entire base.

March Air Force Base

March Air Force Base, which lies about 75 miles east of Los Angeles near the city of Riverside, has also been divided into three operable units. Again, one of the operable units is so large that cleaning it is tantamount to cleaning the entire base. However, the project management at March seized the opportunity to readjust boundaries and schedules, and so began a contaminant removal program—with DoD authorization—before completing the preliminary studies. Five years later, most of the cleanup at March has been completed, even though the preliminary studies have yet to be finished.

The success of March's speed-driven approach is due largely to the skill and experience of the project managers, who knew how to take advantage of the flexibilities in CERCLA and SARA. They also knew how to make DoD's contracting service centers compete with one another over costs and schedules. This practice runs contrary to DoD's general preference for large regional contractors conducting entire cleanups at several bases in a region. The March contracting model suggests that administrative economies of scale associated with regional contractors may be less important than creating a competitive environment in which the DoD project manager acts as the general contractor.

Although fast and efficient, the March model may still require testing if it is to have wide application. A community less friendly toward DoD than Riverside may find a speedy cleanup effort suspicious. At March Air Force Base, local, state, and federal regulators and the community accepted the

removal of contaminants as the core cleanup strategy. If they had not, the site could still be viewed as unremediated.

Summary and Recommendations

The experience of the DoD cleanup program at California's closing bases shows that the goals of risk reduction, land reuse, and speed can be realized and harmonized with CERCLA and SARA by recognizing the flexibilities in the law. These flexibilities allow project managers and local regulators to

- renegotiate regulatory agreements
- redraw internal base boundaries
- focus cleanup efforts on the most important reuse parcels and the most risky sites
- accelerate cleanup by removing contaminants before completing preliminary studies
- encourage competitive contracting.

The DoD and the Environmental Protection Agency can facilitate cleanup by supporting the project managers and local regulators—more specifically, by providing them with

- summaries of the flexibilities in CERCLA and SARA
- clearer policy guidelines on how to begin contaminant removal before completion of preliminary studies
- greater support at the site level expressed through greater investments in human resources.

The innovative strategies that DoD and project managers have used to facilitate the cleanup process point to needed improvements in the law. If Congress is to revise CERCLA and SARA, those revisions should

- address the risks of contaminants spreading from sites remaining in federal hands into areas designated for reuse
- eliminate obstacles to redrawing internal base boundaries
- reduce delays resulting from the preliminary studies.

Dealing with hazardous wastes at California's closing bases clearly illustrates that cleanup too long delayed—in the interest of fulfilling a total cleanup program—is cleanup never realized.

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4 Forces and Resources Policy Center

Susan D. Hosek, Director

International Security

Strategies for key regions

People

Policies to preserve quality of U.S. forces

Technology

Ways to maintain superiority through technology

Themes and Agenda

1995 Research Themes

The Forces and Resources Policy Center (FRPC) is chartered to investigate policies to preserve the quality of U.S. forces. It dates back to RAND's original Defense Manpower Research Center, which was created by the Defense Advanced Research Projects Agency in 1972. Originally, its research helped the DoD study issues relating to the need for the draft and the advent of the all-volunteer military.

When NDRI was formed in 1985, the center became a program in the new federally funded research and development center. NDRI reorganized in 1994, adding materiel as well as human resources to the center's focus and changing its name to FRPC. Today, the center's primary sponsors are the offices of the Under Secretary of Defense (Personnel and Readiness); the Assistant Secretary of Defense (Reserve Affairs); the Director, Programs, Analysis, and Evaluation; and the J-1 division of the Joint Staff.

The shrinking size and changing composition of U.S. military forces are driving FRPC's research in fiscal years 1995 and 1996. The transition to a smaller, more tightly budgeted defense force presents novel policy and management challenges to civilian and military policymakers. Military careers may change in ways that require fundamental shifts in personnel policies, compensation methods, and family programs. Smaller forces may require higher levels of readiness, with implications for active-duty and reserve personnel. And, as Pentagon budgets shrink, the military is being called upon to carry out its support operations more efficiently.

The following elements colored the large themes of FRPC research in 1995:

- **Recovering from downsizing.** FRP analysts investigated whether and to what degree defense-dependent communities and industries were successful in recovering from defense downsizing. The U.S. military's personnel ranks shrank by one-third over the past several years, and several FRP studies examined the experience of affected workers, companies, and communities.

- **Personnel supply in a changed security world and a smaller budget environment.** FRPC analysts explored whether further changes in the size or composition of U.S. forces are appropriate, given the Pentagon's projected tight budget constraints.

- **Personnel policies in a changing military.** In a number of studies, FRPC analysts explored new challenges facing the services in crucial personnel areas: recruiting, compensation, equal opportunity, retention, and planning for future careers. Not only will the set of skills that the services needs after the turn of the century change; so, too, will the pool of potential recruits for whom a new set of messages will be needed encouraging them join, stay, and advance in the military.

- **Reserve and National Guard roles in a post–Cold War world.** FRPC researchers investigated how the Defense Department's growing reliance on reserve units in the post-drawdown environment would affect their personnel and readiness. They also looked at reserve units' growing involvement in operations other than war—disaster relief, humanitarian programs, peace operations, nation assistance, security and police operations, and counter-drug support. And FRPC analysts explored the role of the National Guard as the Defense Department turns to those state outfits to take on more federal missions and domestic disaster responsibilities.

- **Establishing force-structure costs for the twenty-first century.** Because of dramatic changes in the defense environment, policymakers are reconsidering U.S. military force structures. They are examining whether to make changes in force redeployments, base realignments, the active-reserve balance, and unit activation or deactivation plans. FRPC research has helped the Pentagon design, develop, and implement a force-costing system to evaluate alternate resource and budget choices.

1996 Research Agenda

- **Recruiting and retaining personnel in a smaller U.S. military.** How can the United States build and sustain a high-quality, affordable military force during the post–Cold War drawdown? Why do people join, stay, or leave the military ranks? How can the services make sure that officer promotions are color- and gender-neutral? Fundamental international changes, coupled with continuing advances in technology, will lead to further evolution of the all-volunteer force. Interest in military service by the nation's youth has begun to wane, leading FRPC to renew research on recruiting programs and enlistment behavior.

- **Privatizing military functions as Pentagon budgets decline.** How can the Defense Department most efficiently shift responsibilities for managing military housing, civilian personnel, logistics, and other activities to civilian contractors? Declining defense budgets and public demand for greater efficiency in public programs require the Defense Department to improve resource management and business operations. Recent changes in U.S. business practices can serve as a general model for more effective reform, but private-sector lessons must be modified to accommodate unique military and public-sector aspects. FRPC analysts will explore research allocation and business reform, especially for support operations.

Research Highlight

Reserve Personnel: Improving or Not?

The call-up of more than 240,000 reservists for the Persian Gulf War marked the largest mobilization of the reserves since the Korean War. Although largely successful, the call-up spawned a number of concerns. First, some components had to delay deployment because of low levels of skill qualification. Some senior officials, noting these readiness problems, worry about the ability of the reserves to attract sufficient numbers of experienced personnel. That concern is reflected in a congressional direction to the Army National Guard to boost the number of prior-service personnel in its ranks. Others worry that such a large call-up could cause recruiting problems or foster a mass exodus. The drawdown of active and reserve forces has served only to intensify these worries. NDRI researchers address these and other concerns in *Enlisted Personnel Trends in the Selected Reserve, 1986–1994.*

How Are the Reserves Doing?

Drawing on an extensive analysis of trends in personnel indicators for active and reserve personnel from FY86 to FY94, RAND's research shows that:

- With respect to prior-service personnel, the reserves
  - have been successful at attracting them,
  - have been doing better at holding onto them,
  - have been doing a better job at matching the prior-service skill with the reserve assignment.
- ODS has not adversely affected the reserves' ability to recruit or retain people.

But

- Attrition among those who have joined without military experience appears to be increasing.

Recruiting and Retention Trends

The reserves are not having difficulty attracting experienced people to join their ranks. Examining the willingness of two groups—junior personnel with between two and six years of experience and more-senior people with seven to twelve years—to join the reserves, RAND researchers find that the reserves are continuing to attract prior-service personnel at a stable rate. The drawdown of the active forces has put more people in the recruiting pool, which means that the reserves

are attracting larger numbers, even though the rate is constant.

But attracting experienced people is only part of the problem. If the reserves do not retain those they attract, they do not get much benefit from them. Although attrition of first-year recruits varies by component, the reserves are succeeding in this area as well. The spread of losses varies considerably, with the Air National Guard losing only 6 percent of its first-year junior recruits and the Army Reserve losing 37 percent. But the trend of attrition across all components is down, substantially so in some cases. For example, loss rates among junior personnel in the Army National Guard have dropped 11 percentage points since FY86.

Matching Skills

The advantage of recruiting people with prior military experience is that they increase the overall experience level of the reserves and reduce the training requirements. The greatest benefit occurs if people are assigned in the same skill position they held in the active force. Trends here are also encouraging. All components have improved their job-match rates except the Army National Guard, where the rate has held constant. Even there, the Guard has held a relatively high match rate constant while absorbing large numbers of prior-service personnel from the active force drawdown.

Attrition Trends

Nor does Operation Desert Storm seem to have caused reservists to rethink their commitment. Overall departures have remained constant over the eight-year period, averaging slightly over 21 percent for the force as a whole. But overall attrition is not the only important indicator of well-being. It is also important to look beneath the surface at how different groups are behaving to get a better indication of future trends. RAND researchers distinguish between those who enter the reserves with no prior military experience and those who join with either active or reserve experience. Charting behavior based on year of entry, they find that those with prior military experience show no change in the rate at which they leave. However, those with no experience who have recently joined appear to be leaving at an increased rate. RAND researchers caution that these data may not show anything about the propensity of this group to remain in the reserves. It might be that the reserves are concentrating on retaining those with prior service.

Skill Qualification

Although the selected reserve components have been doing better at matching the skills of the prior-service personnel with reserve jobs, skill qualification remains a stubborn problem, particularly for the Army components. Job and unit turbulence are the primary reasons for the low qualification rates. The Army components have improved their rates by only about 2 to 3 percentage points since the end of the Cold War, and about 30 percent of the personnel are not qualified in their assigned duty.

Conclusions

Analysis of recent personnel indicators suggests that the selected reserve components have improved in a number of respects. Selected reserve components are fielding a senior, experienced, and high-quality enlisted force. These components have been successful at increasing their prior-service content, although this increase results from a larger pool of assets caused by the drawdown rather than from an increased rate of joining. The reserves have markedly increased their job-match rates for new prior-service gains, and the attrition rates of the gains have also declined. Skill qualification remains stable, and turbulence shows a modest reduction.

That said, some concerns remain. Attrition for those without prior service has increased. This increase may result from a conscious selection policy, as units choose to retain the more qualified prior-service people as the force shrinks. However, this trend bears watching as retirements increase and the reserves take in more people without military experience. Skill qualification remains a problem, and reducing job turbulence both within and across units will require systemic reforms.

Research Highlight

Creating a Pilot Corps for the Twenty-first Century

The U.S. armed services are undergoing a fundamental reshaping and restructuring, driven by tighter budgets, new security challenges, new technology, and selective reliance on reserves. The Air Force, for example, has reduced pilot ranks by a third since 1986 in response to Pentagon belt tightening. While these changes will affect all military services, their impact on the supply of active-duty and reserve pilots in the U.S. Air Force and U.S. Navy and on the experience levels of pilots in those services may be particularly direct and imminent.

Because the Air Force has trained an insufficient number of pilots recently, its demand for pilots will outpace supply in the near future. Moreover, its pilot ranks will be characterized by imbalances in levels of experience through the beginning of the next century. Such an outcome will be a reversal of the adequate supply of pilots that the Air Force has had for the past decade or more.

By the year 2002, the Air Force could face a "critical" shortage, needing as many as 1,400 pilots to meet a projected force requirement of 13,700 pilots. Furthermore, the Air Force could find itself with more senior pilots and fewer junior ones than it would prefer. This pilot shortage and skewed experience distribution will reduce the number of pilots with active-duty experience who are available to enter the Air Force Reserve and Air National Guard after 2002.

The Navy apparently will avoid these difficulties. Traditionally, the Navy has trained proportionately more pilots than the Air Force, because its retention rate for younger pilots has been lower than the Air Force's rate. In addition, the Navy's pilot drawdown began later and was slower than that of the Air Force.

Those are the conclusions of a recent NDRI report. The report summarizes several studies related to the defense drawdown's impact on pilots that the institute conducted for the Office of the Secretary of Defense.

Implications of Pilot Shortages in a Shrinking Air Force

The Air Force will not just be short of pilots. The distribution of experience levels within its pilot corps after the turn of the century may be skewed. Without changes in training and retention strategies, the Air

Force could end up in 2002 with a pilot population that is more senior than it would prefer, a disproportionate share of its pilots having achieved a rank where they typically would have moved out of cockpits into ground-based staff positions. The potential pilot shortage and skewed experience distribution within pilot ranks would also pose operational challenges, because there will be a shortage of pilots with six to ten years of service. These pilots are very experienced and are likely to be in cockpits or to be providing essential operational supervision in the services' flying squadrons.

Alternatives for Closing the Gap

Pilot shortages are nothing new. In 19 of the 44 years from 1950 through 1993, the Air Force's pilot population was below the service's demand. Traditionally, training new pilots and retaining pilots have been the two principal instruments used to mitigate shortages.

RAND researchers looked at a variety of options that the Air Force could adopt beginning in Fiscal Year 1997 to forestall or change the character of the shortage projected to occur by the turn of the century. Those options were

- Retaining more pilots from 1998 through 2002
- Training more pilots beginning in 1997
- Training more pilots beginning in 2000
- Training more pilots if retention goes down.

As the accompanying figure shows, no strategy solves the basic numbers problem. Nor does any strategy adequately change the ratio of senior pilots to junior pilots.

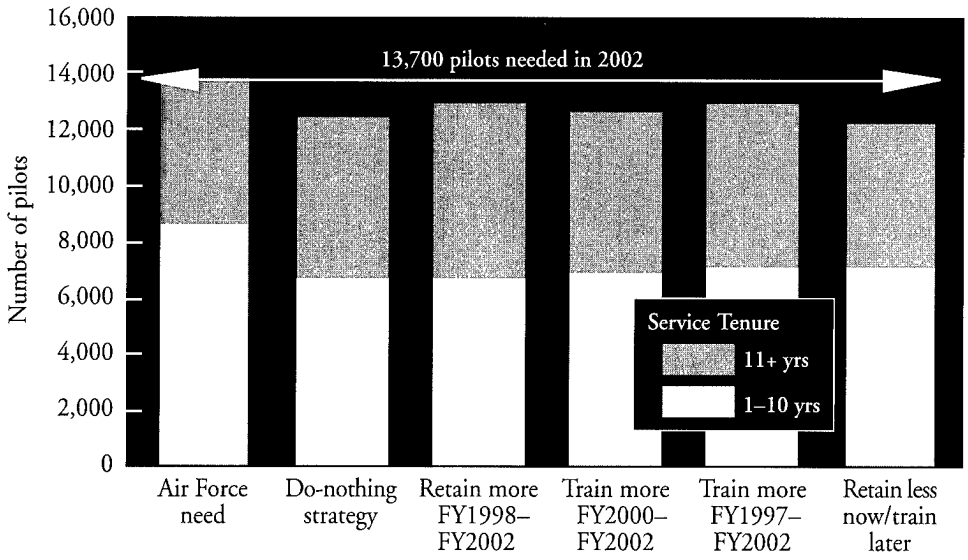
RAND's findings indicate that the best solution is to train more pilots early, and this strategy has been largely incorporated in current Air Force plans. This approach could reduce the projected shortage to 900 pilots in 2002 and, more than any of the alternatives that RAND researchers studied, would help reduce the shortfall and create a pilot corps that more closely matches the required experience profile. In addition, a number of other measures, outlined below, could be taken to minimize the national-security impact of that 900-pilot shortage.

Other Ways to Affect Demand and Supply

Reducing Air Force demand projections is one way to close or eliminate the gap between supply and demand: If the Air Force can further reduce the number of pilots it places in staff or training positions, it may not need 13,700 pilots in 2002, the RAND analysis suggests.

The Air Force should also consider changing its assignment policy for pilots. By moving away from voluntary assignments, whereby pilots choose the location and type of their duty, the Air Force should be better able to absorb new pilots into operational units and thus more closely approximate the experience patterns it desires.

Finally, as shortages materialize in the future, the Air Force may have to staff critical flying billets at the expense of less critical billets. In addition, the Air Force may have to place selected Air Force Reserve and Air National Guard personnel on active duty or use prior-service personnel to fill critical needs.



OTHER WAYS TO AFFECT DEMAND AND SUPPLY

Reserves May Suffer

The projected pilot shortages may affect the number of pilots who join reserve units after leaving active duty. Historically, more than 75 percent of Air Force Reserve pilots and more than 50 percent of Air National Guard pilots have come from the active-duty ranks. And because of recent Air Force reductions of pilot rosters during the defense drawdown, the number of pilots waiting to join reserve units today is near an all-time high.

But this situation is likely to change dramatically by the year 2002. Given the overall reduction in the pilot pool and the limited number of new pilots trained in the early 1990s, the number of individuals with six to twelve years of experience—the cohort that is most attractive to the reserves—who will leave active duty also will drop. This outcome spells a bleak hiring environment for certain reserve units that are most dependent on active-duty Air Force personnel for their pilots.

Research Highlight

Life After Cutbacks—Tracking California's Aerospace Workers

Contrary to popular belief, workers in California's aerospace industry weathered the defense budget downturns of the late 1980s and early 1990s in relatively good shape.

Their employment histories during the period differed little from other durable-goods-manufacturing workers in the state. Aerospace workers were earning more than nonaerospace durable-goods-manufacturing workers in 1989, and the difference increased as aerospace workers' wages grew faster through 1994.

These are the findings of a recent NDRI study of the effects of defense downsizing on California's aerospace industry workers. The study looked at aerospace workers in California between 1989 and 1994 to gauge whether they suffered disproportionate hardships during recent defense budget downturns.

This study examined the experience of all aerospace workers employed in California in 1989—517,000 individuals—and followed their employment history through 1994. The study compared that group with the work histories of 315,000 individuals employed in nonaerospace durable-goods-manufacturing operations in the state.

In a nutshell, between 1989 and the end of 1994,

- Aerospace workers and other durable-goods-manufacturing employees exited the California work force at about the same pace.
- Aerospace employees who lost jobs were out of work for roughly the same amount of time as their nonaerospace durable-goods-manufacturing counterparts.
- Once they found new employment, workers from both industry groups reentered the state's work force in the same proportions.
- 1989's aerospace worker group earned higher wages than nonaerospace durable-goods-manufacturing industry workers through 1994, and their real wages rose during the period by an average of 5 percent versus 3 percent for their nonaerospace contemporaries.

California Contractions in Context

The end of the Cold War brought profound changes to the U.S. military

and to sectors of the civilian economy that have been linked closely to the armed services. The new political and economic environment of the 1990s is defined by leaner Pentagon budgets, fewer uniformed personnel, and growing closure lists of bases, shipyards, and other facilities.

The aerospace industry has been at the center of these contractions. As the Pentagon's budgets and employment levels shrank, its need for sophisticated aerospace products dropped. And for some companies heavily dependent on defense business, minor changes in Pentagon budget outlays translated into major dislocations on the factory floor. Nationwide, the aerospace industry's job base has decreased 30 percent since 1987.

Nowhere have those changes been more apparent than in California and the Los Angeles basin. At the peak of aerospace employment in 1987, the state was home to one in four U.S. aerospace jobs. In Los Angeles County alone, aerospace jobs accounted for 10 percent of the national total.

Since then, the aerospace industry in California has become a shadow of its former self. The state's aerospace employment rolls are down 33 percent compared with 1987, whereas in Los Angeles County, the industry's job base is only 50 percent of its size eight years ago.

Aerospace was not the only sector that fell on hard times during the late 1980s and early 1990s. California's nonaerospace durable-goods-manufacturing industries also contracted during the recession, seeing employment fall from 974,000 in 1989 to 803,000 in 1994.

Government Assistance Programs

The federal government responded to this industry downturn by setting up programs to assist aerospace workers. While different in scope and focus, all of these programs were based on a common assumption that aerospace workers and employees of other industries dependent on defense contracts suffered unique hardships.

This study tested that broad assumption. It tried to define in quantitative terms aerospace workers' employment experience during the downturn, to explore whether that experience differed from that of workers in comparable nonaerospace manufacturing operations, and to identify worker groups most affected by the downturn.

RAND's Unique Data

RAND researchers created a unique database using statistics drawn from wage files and unemployment income files provided by California's Employment Development Department. These statistics allowed researchers to track wage, employment, and demographic characteristics of *each individual aerospace worker* who was employed in California in 1989, a group that totaled 517,000 individuals. This statistical resource also allowed researchers to assemble the same data for some 315,000 people who were employed in similar durable-goods-manufacturing jobs in nonaerospace industries in California. The state's database did not reveal the identities of individual employees, but it nevertheless allowed RAND to follow these two sets of workers for six years. This study period corresponds to the time that the state suffered the brunt of the defense downturn and had not yet received benefits from the new federal assistance programs.

Aerospace Workers Were Not Uniquely Disadvantaged

The study revealed the following:

- On average, 1989 aerospace workers who were employed in any industry at the end of 1994 were earning slightly higher inflation-adjusted wages than they did before the defense downturn.

- Aerospace workers in 1989 were earning wages 10 to 15 percent higher than nonaerospace durable-goods-manufacturing employees of similar age and education, and that wage difference held through 1994.

- Aerospace workers were slightly less likely to use unemployment insurance; however, aerospace workers who drew benefits were on the system one to three weeks longer, on average, than nonaerospace workers.

Among the 1989 California aerospace workers still working six years later, two-thirds remained employed in the industry in 1994. Another 9 percent of these workers had moved to other manufacturing jobs in nonaerospace industries. Wages for these two groups of workers, who constituted the vast majority of the study's initial study pool of aerospace employees who were working in 1994, grew an average of 5 percent during the period.

Another 14 percent of 1989 California aerospace workers who were employed in 1994 had moved to service industry

jobs. These workers' wages dropped more than did wages of other durable-goods-manufacturing workers who moved into service jobs (a 17 percent drop versus a 12 percent drop). But even with that larger wage drop, the former aerospace employees—perhaps because they tended to be older and better-educated—earned more than former manufacturing workers who made similar switches into the service sector.

Even though aerospace workers endured the defense budget downturn in better shape than popular press reports have suggested, a significant share experienced turbulence in the labor market. One-fourth of the 1989 pool of aerospace workers who were employed at the end of 1994 saw their wages fall 15 percent or more during the period. In addition, some aerospace workers experienced long periods of unemployment. In most cases, however, labor market turbulence was no greater for aerospace workers than for workers who were employed in other durable-goods-manufacturing sectors.

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